A47/A11 Thickthorn Junction

Scheme Number: TR010037

Volume 6
6.5 Environmental Statement
EIA Scoping Report

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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The A47/A11 Thickthorn Junction Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT
6.5 EIA Scoping Report

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1 Introduction

1.1 Purpose of the report

1.1.1 Scoping is an important part of the Environmental Impact Assessment (EIA) process and determines which environmental topics are to be examined during the course of the assessment and reported in the Environmental Statement (ES).

1.1.2 This Scoping Report describes how the EIA will be undertaken, and identifies the technical environmental disciplines that will be considered. Defining the environmental scope is one of the most critical parts of the study, as it sets out the method for the detailed assessment. This EIA Scoping Report will be submitted to the Planning Inspectorate in order to inform its Scoping Opinion. The Planning Inspectorate may not adopt a Scoping Opinion in response to a request until it has consulted the person who made the request and the consultation bodies or notifies the person making the request that it requires additional information in order to adopt an opinion. The ES will be submitted as part of the application for a Development Consent Order (DCO).

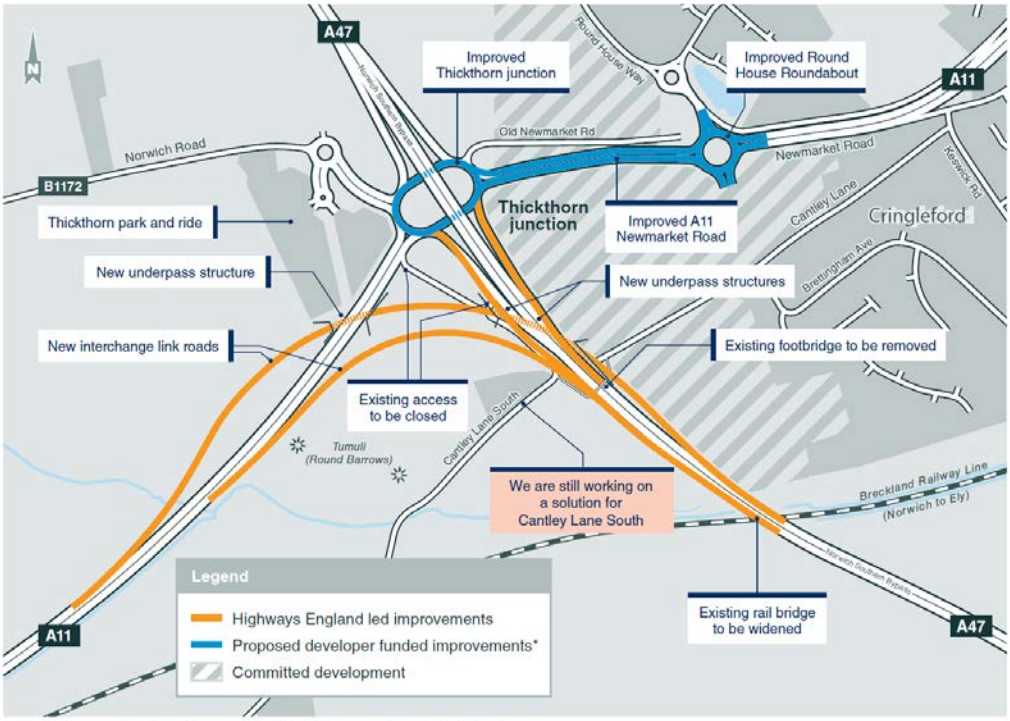
1.1.3 The scope of the EIA may be amended following receipt of the Scoping Opinion or if understanding of environmental conditions change. The final version of this EIA Scoping Report will be issued as a Technical Appendix of the ES. This will provide a full audit trail for the EIA process that is undertaken.

1.2 Proposed Scheme location

1.2.1 The A47 trunk road forms part of the strategic road network (SRN) and provides for a variety of local, medium and long-distance trips between the A1 and the eastern coastline. The corridor connects the cities of Norwich (population over 210,000) and Peterborough (population over 180,000) and the towns of Wisbech, Kings Lynn, Dereham, Great Yarmouth and Lowestoft.

1.2.2 The Proposed Scheme is situated on the south-western edge of Norwich and provides access to the A47 via the A11 for Eaton, Cringleford, Hethersett and Wymondham (see Figure 1.1).

Figure 1.1: Proposed Scheme location



1.3 Proposed Scheme overview

1.3.1 It is proposed to create an interchange link road between the A11 and A47. A one way A11 south to A47 east free-flow link with the provision of a segregated left turn between the A47 east and A11 south in the reciprocal direction is proposed to re-route strategic traffic away from the existing junction. The side road strategy, currently under development, still has two potential solutions for Cantley Lane link (hereby referred to as Option A and Option B). Both options provide bi-directional free flowing interchange links between the A11 south and the A47 east to the south of the roundabout and are henceforth collectively referred to as the 'Proposed Scheme'. The DCO site boundary is shown on Plan A.1 in Appendix A.

1.4 Approach to EIA scoping

1.4.1 The main aims of this EIA Scoping Report are as follows:

- To identify and report the baseline conditions of the existing environmental asset.
- To determine which (if any) environmental topics are to be further examined during of the EIA and hence reported in the ES.
- To identify all relevant environmental constraints present, as part of the iterative design process, thereby ensuring adverse effects can be minimised.

- To identify if there are opportunities for environmental enhancement associated with the site of proposed works that could be incorporated into the design.

1.4.2 The Environmental Constraints identified within this EIA Scoping Report have been mapped and are shown in Appendix B.

1.4.3 This scoping exercise has been completed in accordance with the Design Manual for Roads and Bridges (DMRB) Volume 11 and the Planning Inspectorate (PINS) Advice Note 7, to a Scoping Level for all environmental topics contained within Highways England's Interim Advice Note (IAN) 125/15.

1.5 Legislative context and the need for Environmental Impact Assessment

1.5.1 The Proposed Scheme is defined as a Nationally Significant Infrastructure Project (NSIP) under Section 14(1)(h) and Section 22 of the Planning Act 2008 (PA 2008) (as amended) by virtue of the fact that:

a) It comprises the construction / alteration of a highway.
b) The highway to be constructed is wholly in England.
c) The Secretary of State will be the highway authority for the highway.
d) The speed limit for any class of vehicle on the highway is to be 50 miles per hour or greater, and the area of development is greater than 12.5 hectares.

1.5.2 In accordance with the legislation, a DCO is therefore required to allow the construction and operation of the Proposed Scheme.

1.5.3 The Proposed Scheme falls under schedule 2, part 10 Infrastructure Projects (f) Construction of roads of The Infrastructure Planning (EIA) Regulations 2017. The threshold at which part 10 (f) schemes need to screen for EIA is where the area of works exceeds 1 hectare (ha). The area of works associated with the Proposed Scheme does exceed 1 ha and Highways England have determined that EIA is required on the basis that there is a potential for significant effects on the environment.

1.5.4 In accordance with Regulation 8(1)(b) of the EIA Regulations, Highways England notifies the Secretary of State for Transport (Secretary of State) that an environmental statement will be submitted with the DCO Application for this project.

1.5.5 The Localism Act 2011, appointed the Planning Inspectorate (the Inspectorate) as the agency responsible for operating the DCO process for NSIPs. In its role, the Inspectorate will examine the application for the Proposed Scheme and then will make a recommendation to the Secretary of State who will make the decision on whether to grant or to refuse the DCO.

1.5.6 In accordance with section 104(2) of the PA 2008, the Secretary of State is required to have regard to the relevant National Policy Statement (NPS), amongst other matters, when deciding whether or not to grant a DCO. The relevant NPS for the Proposed Scheme is the National Networks National Policy Statement (NNNPS) which was designated in January 2015.

1.5.7 Other matters that the Secretary of State would consider important and relevant include national and local planning policy. The National Planning Policy Framework (NPPF) published in March 2012 (Ref 8) is relevant national planning policy.

1.5.8 The layout of the ES will comprise three volumes for ease of reading as follows:

- Non-technical Summary
- Volume 1 – main body of the ES
- Volume 2 – Figures
- Volume 3 – Technical Appendices

1.5.9 Volume 1 will provide the main body of the ES, and explain the details of the Proposed Scheme. It will contain the technical chapters documenting the baseline position assessment methodologies and assessment results using qualitative and quantitative data (where applicable). This volume contains the following chapters:

- Chapter 1 Introduction
- Chapter 2 The Proposed Scheme
- Chapter 3 Consideration of Alternatives
- Chapter 4 Construction and Programme
- Chapter 5 EIA methodology
- Chapter 6 Air Quality
- Chapter 7 Cultural Heritage
- Chapter 8 Landscape
- Chapter 9 Biodiversity
- Chapter 10 Geology & Soils
- Chapter 11 Materials
- Chapter 12 Noise & Vibration
- Chapter 13 People and Communities
- Chapter 14 Road Drainage and the Water Environment
- Chapter 15 Climate
- Chapter 16 Combined and Cumulative Effects
- Chapter 17 Conclusion

1.6 Approach to assessment

1.6.1 The environmental assessment will be undertaken in accordance with the requirements presented in the DMRB Volume 11, Section 3, Interim Advice

Note 125/15 Environmental Assessment Update (IAN 125/15) and Major Project Instruction Environmental Impact Assessment: Implementing the requirement of 2011/92/EU as amended by 2014/52/EU (EIA Directive), for each of the relevant environmental topics:

- Air Quality
- Cultural Heritage
- Landscape
- Biodiversity
- Geology & Soils
- Materials
- Noise & Vibration
- People and Communities
- Road Drainage and the Water Environment
- Climate
- Combined and Cumulative Effects

1.6.2 The output of the environmental assessment is to report the likely significance of environmental effects using established significance criteria, as presented within DMRB Volume 11, Section 2, Part 5. This requires an assessment of the receptor of resource's environmental value (or sensitivity) and the magnitude of change (impacts).

1.6.3 DMRB states that the approach to assigning significance of effect relies on reasoned argument, professional judgement and taking on board the advice and views of appropriate organisations. For some disciplines, predicted effects may be compared with quantitative thresholds and scales in determining significance.

1.6.4 Assigning each effect to one of the five significance categories enables different topic issues to be placed upon the same scale, to assist the decision-making process. These five significance categories are set out in Table 1.1.

Table 1.1: Descriptions of the significance of effect categories

Significance Category	Typical Descriptors of Effects
Very Large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Large	These beneficial or adverse effects are very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a resource or receptor.

Significance Category	Typical Descriptors of Effects
Slight	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
Neutral	No effects or those that are beneath levels of perception, within normal bounds or variation or within the margin of forecasting error.

Source: DMRB Volume 11, Section 2, Part 5, Table 2.3

1.6.5 The environmental value will be identified for each of the individual topics that have been carried forward from the scoping exercise for further environmental assessment, along with the magnitude of change. In this way, the potential significance of environmental effects will be determined for each relevant environmental topic. Five significance categories can result from the assessment, as defined in Table 1.2. It is important to note that significance categories are required for positive (beneficial) as well as negative (adverse) effects. The greater the magnitude of impact, the more significant the effect. For example, the consequences of a highly valued environmental resource suffering a major detrimental impact would be a significant adverse effect. Impacts that are Moderate or above, beneficial or adverse, will be considered significant.

Table 1.2: Assessing significance of potential effects

		Magnitude of Potential Impact (Degree of Change)				
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
Environmental Value (Sensitivity)	**Very High**	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
	Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
	Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

Source: DMRB Volume 11, Section 2, Part 5, Table 2.4

1.7 Population and human health

1.7.1 The Infrastructure Planning (EIA) Regulations 2017, transposing the European Directive 2014/52/EU, have introduced the requirement for 'the direct and indirect significant effects of the proposed development on... population and human health' (Regulation 5(2(a))) to be assessed within EIAs.

1.7.2 There is no consolidated methodology or practice for this topic, however the scope of the assessment is considered to be covered by existing Highways England guidance as set out below. This recognises the specific requirements of the NNNPS for consideration of health, specifically within paragraphs 4.79-4.82. This will address health by utilising the following guidance:

- Air Quality: HA 207/07, IAN 185/15, IAN 175/13, IAN 174/13, IAN 170/12
- Noise and vibration: HD 213/11, IAN 185/15
- Road Drainage & The Water Environment HD 45/09
- Equestrians, Cyclists, and Community Effects: DMRB Volume 11 Section 3 Part 8

1.7.3 It is considered that these assessments, conducted principally in isolation as is required by their methodologies, will not provide a sufficient analysis of the effects of the Proposed Scheme. To enable such conclusions to be drawn, a qualitative assessment of information collated via the topic assessment listed above will be undertaken and presented within the Cumulative Effects chapter of the ES.

1.8 Major accidents and disasters

1.8.1 The Infrastructure Planning (EIA) Regulations 2017, transposing the European Directive 2014/52/EU, have introduced the requirement for 'expected significant effects arising from the vulnerability of the proposed development to major accidents or disasters that are relevant to that development' (Regulation 5(4)) to be assessed within EIAs.

1.8.2 For the Proposed Scheme, a separate chapter assessing the potential impacts of major accidents and disasters during the construction and operation phases is not required for the following reasons:

- The Proposed Scheme is not considered to have high vulnerability to major accidents or disasters. Whilst the legislation is not explicit, the language of the revised Infrastructure Planning Regulations 2017 is aimed towards hazardous industries or operations (those with a 'high vulnerability' to major accidents).
- The design, construction and operation of the Proposed Scheme must comply with legal requirements, codes and standards, such as:
  - Health and Safety at Work etc. Act 1974 (HSWA)
  - The Management of Health and Safety at Work Regulations (1999)
  - Construction (Design and Management) (CDM) 2015 Regulations
  - The Workplace (Health, Safety and Welfare) Regulations 1992
  - Design Manual for Roads and Bridges (DMRB)
  - IAN 191/16, Safety Governance for Highways England
- The term major accidents and disasters refers to events both within and external to the Proposed Scheme that have the potential to cause significant harm to the environment (including but not limited to populations, biodiversity, land, soil, water, air, material assets, cultural heritage).

1.8.3 The impact of any unplanned events (accidents or disasters) has been considered against the current baseline conditions. The volume and type of traffic using the Proposed Scheme will not change significantly from that using

the current road alignment, and therefore it is reasonable to conclude that there is no general increase in risk.

1.8.4 Notwithstanding this conclusion, the following specific issues have been reviewed:

- The potential for construction-related accidents, causing harm to construction workers, are not within the scope of the EIA, unless these could also cause harm to an environmental receptor including members of the public beyond the boundaries of the construction site. Existing legislation around safe working practices and CDM will ensure that such risks are mitigated appropriately without the need for further assessment.
- The potential for extreme weather events, combined with the presence of the Proposed Scheme (for example, the Proposed Scheme affecting flood patterns) will be adequately assessed within the Road Drainage and the Water Environment chapter, the separate Flood Risk Assessment (FRA) and the Climate chapter, without the need for further assessment.
- The potential for other external hazards to impact the Proposed Scheme, such as earthquakes, landslides, mine collapse or sinkholes, will, where relevant, be in compliance with the design requirements of the DMRB and the Geology & Soils chapter and will not require further assessment.
- Accidental spillage of contaminants such as hydrocarbons and their subsequent release into the drainage system will be considered in the Road Drainage and the Water Environment chapter.
- There are no registered Control of major accident hazards regulation (COMAH) sites with three miles of the Proposed Scheme and therefore no need to consider any associated risks.
- The safety of the Proposed Scheme will be evaluated through a Road Safety Audit, which will be undertaken during design, at the end of construction and post-construction, to identify road safety problems and to suggest measures to eliminate or mitigate any concerns.

1.8.5 A table will be included in the ES which identifies where this has been considered in respect of relevant technical chapters (e.g. Road Drainage and the Water Environment in respect of flood risk and culvert design).

1.8.6 In summary, the independent assessment of the likely significant environmental effects arising from the vulnerability of the Proposed Scheme to major accident and/or natural disaster is scoped out of this EIA. As justified above, major accidents and disasters will be sufficiently addressed within the scheme design and relevant technical chapters.

1.9 Heat and radiation

1.9.1 The Infrastructure Planning (EIA) Regulations 2017, transposing the European Directive 2014/52/EU, have introduced the requirement for ‘A description of the

likely significant effects of the development on the environment resulting from, inter alia - …heat and radiation' (Schedule 4, part 5(c)) to be assessed within EIAs.

1.9.2 Due to the nature of the Proposed Scheme as a highway scheme, it is considered unlikely that heat and radiation effects associated with the proposals are likely to arise. Further assessment has therefore been scoped out.

1.10 Transboundary screening matrix

1.10.1 Regulation 32 of the Infrastructure Planning (EIA) Regulations 2017 requires planning inspectorate to notify other European Economic Area (EEA) States and publicise an application for development consent if it is of the view that the proposed development is likely to have significant effects on the environment of another EEA Member State, and where relevant to consult with the EEA State affected.

1.10.2 The closest international land boundary is over 175km from the Proposed Scheme.

1.10.3 The study areas for the various ES topics define the extent of effects anticipated and are described fully in Chapters 5 to 14 and are summarised as follows:

- Air Quality: 200m around the works.
- Cultural Heritage: 1km around the works.
- Landscape: 1km around the works.
- Biodiversity: various – 2km for internationally, nationally and locally designated nature conservation sites; 30km for SACs designated for bat populations; 10km for statutory sites designated for bird interest; 2km non-statutory designated nature conservation sites; 500m for Great Crested Newts; 250m for water vole and otter; 100m buffer for other preliminary ecological assessments including Phase 1 habitat survey badger, reptiles, and breeding birds.
- Geology & Soils: all locations where physical works and ground disturbance would take place, and in addition extends to 1km beyond this in order to identify any past pollution incidents which may have affected soil within the works area.
- Materials: determined through professional judgement by the influence of the Proposed Scheme.
- Noise & Vibration: 1km around the works; potentially further depending on extent of noise impact due to changes in traffic flow.
- People and Communities: various – see Section 12.2.
- Road Drainage and the Water Environment: 1km around the works but extended where there are features that may be affected by pollutants transported downstream.
- Climate: not applicable.

1.10.4 As none of these reach other EEA Member States, no transboundary effects are anticipated and are therefore scoped out of the assessment process.

1.10.5 A Habitats Regulation Assessment (HRA) screening exercise will be undertaken in accordance with Advice Note 10: Habitat Regulation Assessment relevant to nationally significant infrastructure projects (Planning Inspectorate, 2012b). The screening exercise will assess the potential for adverse impacts on European sites and therefore the need for HRA Appropriate Assessment.

1.11 Planning policy context

National policy

1.11.1 The national policy is particularly relevant to developments that will be promoted as a NSIP. When the DCO application for the Proposed Scheme is to be progressed as an EIA development, an environment assessment will be undertaken in compliance with national policies and regulations and will also consider whether legal duties and obligations set out within the Road Investment Strategy (RIS) and Highways England Licence would be met. A summary of key policies that are included in the NNNPS and in the RIS is provided in Sections 1.11.2 to 1.11.5.

National Networks National Policy Statement (NNNPS)

1.11.2 The NNNPS sets out the need for, and the Government's policies to deliver development of, NSIPs on the national road network in England and sets out the primary basis for making decisions of development consent for NSIPs in England. The Government recognises in the Appraisal of Sustainability accompanying the NNNPS that some developments will have some adverse local impacts on noise, emissions, landscape/visual amenity, biodiversity, cultural heritage and water resources. The significance of these effects and the effectiveness of mitigation is uncertain at the strategic and non-locational specific level of the NNNPS. Therefore, whilst applicants should deliver developments in accordance with Government policy and in an environmentally sensitive way, including considering opportunities to deliver environmental benefits, some adverse local effects of development may remain.

1.11.3 Outside the NSIP regime, Government policy is to bring forward targeted works to address existing environmental problems on the Strategic Road Network (SRN) and improve the performance of the network. This includes reconnecting habitats and ecosystems, enhancing the settings of historic and cultural heritage features, respecting and enhancing landscape character, improving water quality and reducing flood risk, avoiding significant adverse impacts from noise and vibration and addressing areas of poor air quality.

Road Investment Strategy (RIS)

1.11.4 In December 2014, the Department for Transport (DfT) published the RIS for 2015-2020. The RIS sets out the list of schemes that are to be developed by Highways England over the period covered by the RIS.

1.11.5 Highways England, as the strategic highways company and appointed by the Secretary of State must, in exercising its functions and complying with its legal duties and other obligations, act in a manner which it considers best calculated to, among others:

- Minimise the environmental impacts of operating, maintaining and improving its network and seek to protect and enhance the quality of the surrounding environment.
- Conform to the principles of sustainable development.

Highways England policy

Highways England Licence

1.11.6 The Highways England Licence document sets out key requirements which must be complied with by the Licence holder as well as statutory guidance. In exercising its functions and complying with its legal duties and obligations, the Licence holder must act in such a manner which it considers best calculated to:

- Ensure the effective operation of the network.
- Ensure the maintenance, resilience, renewal, and replacement of the network.
- Ensure the improvement, enhancement and long-term development of the network.
- Ensure efficiency and value for money.
- Protect and improve the safety of the network.
- Cooperate with other persons or organisations for the purposes of coordinating day-to-day operations and long-term planning.
- Minimise the environmental impacts of operating, maintaining and improving its network and seek to protect and enhance the quality of the surrounding environment.
- Conform to the principles of sustainable development.

1.11.7 In complying with section 4.2 (g) and its general duty under section 5(2) of the Infrastructure Act 2015 to have regard for the environment, the Licence holder must:

- Ensure that protecting and enhancing the environment is embedded into its business decision-making processes and is considered at all levels of operations.
- Ensure the best practicable environmental outcomes across its activities, while working in the context of sustainable development and delivering value for money.
- Consider the cumulative environmental impact of its activities across its network and identify holistic approaches to mitigate such impacts and improve environmental performance.

- Where appropriate, work with others to develop solutions that can provide increased environmental benefits over those that the Licence holder can achieve alone, where this delivers value for money.
- Calculate and consider the carbon impact of road projects and factor carbon into design decisions, and seek to minimise carbon emissions and other greenhouse gases from its operations.
- Adapt its network to operate in a changing climate, including assessing, managing and mitigating the potential risks posed by climate change to the operation, maintenance and improvement of the network.
- Develop approaches to the construction, maintenance and operation of the Licence holder's network that are consistent with the government's plans for a low carbon future.
- Take opportunities to influence road users to reduce the greenhouse gas emissions from their journey choices.

Highways England Delivery Plan

1.11.8 The Highways England Delivery Plan sets out Highways England's long-term plans for the modernisation and renewal of our road network over the 5-year period from 2015-2020. It provides a brief outline of what Highways England have delivered during 2015-2016 and sets out a clear programme of activity for 2016- 2017, as well as annual and future commitments. It complements the original Delivery Plan (Highways England Delivery Plan 2015–2020), outlining progress made with this work.

1.11.9 Key performance indicators (KPI) and other Performance Indicators have been set out from the January 2016 Operation Metrics Manual produced in collaboration with DfT and Office of Rail and Road. Environmental KPIs include:

- Number of Noise Important Areas (NIA) mitigated. Highways England aim to mitigate 1,150 NIAs through interventions, to reduce the noise exposure of the population within the NIA.
- Delivery of improved biodiversity, as set out in Highways England's Biodiversity Plan. Highways England aim to reduce the net loss of biodiversity by the end of the first Road Period, on an ongoing annual basis.
- Helping cyclists, walkers, and other vulnerable users of the network through a number of new and upgraded crossing. The measure of success is an increase in the number of completed new crossings and upgraded crossings.

1.11.10 Furthermore, a series of ring fenced funds for actions beyond business as usual are available across environmental disciplines, including Cultural Heritage, Landscape, Biodiversity, Road Drainage and Water Environment and Geology & Soils. There are also separate funds available for Air Quality, Noise & Vibration and People and Communities.

2 The Proposed Scheme

2.1 The need for the Proposed Scheme

2.1.1 The Thickthorn interchange connecting traffic between the A11 south to the A47 east experiences high levels of congestion, acting as a bottleneck, leading to longer and unreliable journey times.

2.1.2 There are a number of reasons for these delays. Investigations to date have highlighted these issues as:

- Roundabout traffic capacity
- The increasing traffic is outgrowing the capacity of the road, causing tailbacks and delays
- Development in the local area, which can lead to potentially more vehicles on the road

2.1.3 If nothing is done to improve capacity and connectivity, these delays are forecast to get worse in future years. In developing the Proposed Scheme Highways England aim to address these issues by improving the junction. The Proposed Scheme is also intended to support economic growth by making journeys safer and more reliable.

2.2 Proposed Scheme objectives

2.2.1 The objectives of the Proposed Scheme are:

- Supporting economic growth

Contributing to sustainable economic growth by supporting employment and residential development opportunities. The Proposed Scheme aims to reduce congestion-related delay, improve journey time reliability and increase the overall capacity of the A47.

- A safe and serviceable network

Improving road safety for all road users through being designed to modern highway standards appropriate for a strategic road.

- A more free-flowing network

Increasing the resilience of the junction in coping with incidents such as collisions, breakdowns, maintenance and extreme weather. The improved A47 Thickthorn Junction would be more reliable, reducing journey times and providing capacity for future traffic growth.

- Improved environment

Protecting the environment by minimising adverse impacts and where possible deliver enhancements by improving the environmental impact of transport on those living along the existing A47 and by minimising the impact of new infrastructure on the natural and built environment.

- An accessible and integrated network

Ensuring the proposals take into account local communities and access to the road network, providing a safer route between communities for cyclists, walkers, equestrians and other non-motorist groups.

- Value for money

Ensuring that the Proposed Scheme is affordable and delivers good value for money.

2.3 Proposed Scheme location

2.3.1 The Proposed Scheme involves improvements to the Thickthorn Junction on the A47 / A11. It is situated within a rural landscape, at the western extents of the urban area of Norwich, south of Cringleford; the suburban development extent of Norwich.

2.3.2 The junction is at approximate National Grid Reference (NGR) TG`8421 05495, and is located at the point where the A47 Norwich Southern Bypass converges with the A11; the main route connecting Norwich with Thetford, Cambridge and London. The junction lies approximately 1.2km south of Cringleford, 3.3km to the west of Hethersett and 8km west of Wymondham. Immediately adjacent to the Proposed Scheme is agricultural land and woodland. The agricultural land comprises of both arable and pastoral farm uses, such as pig farming.

2.3.3 The Proposed Scheme lies in a topographically flat area with slight undulations. The existing A47/A11/B1172 road alignment, and railway corridor to the south, strongly influences the pattern of the landscape locally. The junction is located in a lowland agricultural area, characterized by medium scale rectangular arable fields bound by hedgerows and linear belts of trees. There is an extensive network of hedgerows varying in quality with some gaps. There is a large number of veteran trees namely oak species and notable pockets of coniferous woodland, enclosing residential properties at Cantley Lane South. The closest main watercourse is the River Yare, which is approximately 1.3km east of the Proposed Scheme.

2.3.4 Northwest of the A11, the Thickthorn Park and Ride Facility is located. Other services include a hotel, electricity substation, a service station and two fast food restaurants. To the east of the Proposed Scheme, the Round House roundabout connects Cringleford with the A11. In addition to the slip roads connecting to the A47 and A11, the Thickthorn roundabout has connections serving the B1172 Norwich Road to / from Hethersett and a connection to a little section of the Old Newmarket Road.

2.3.5 On the northern side of the Proposed Scheme there is a shared-use footway/cycleway passing under the A47, from the B1172 (Thickthorn Park and Ride) to the Old Newmarket Road. Toucan crossings are provided on the A47 on and off slip roads, with a path crossing Round House Way on the northern side of the roundabout and follows the adjacent road to Colney Lane. There is a connection across the A11 to Cantley Lane east of Round House Way.

2.3.6 Cantley Lane is severed by the A47 connecting onto the westbound A47 off slip road and onto the A11 southbound carriageway. However, there is an existing bridged footway / cycleway access over the A47.

2.3.7 There is no residential property or private access onto the trunk road. There are residential properties off Cantley Lane, off the B1172 and off a service road alongside the A11 into Norwich. Old Newmarket Road connects to the Thickthorn roundabout and provides access to one listed dwelling near Round House Way and the Non-Motorised User (NMU) route as described earlier.

2.3.8 The Breckland railway line passes south of the Thickthorn junction approximately 700m away.

2.3.9 The land potentially required temporarily and/or permanently for the construction, operation and maintenance of the Proposed Scheme (hereafter referred to as the DCO site boundary), is shown on Figure A.1 in Appendix A. It is important to note that the current proposed draft DCO site boundary may be subject to change, but currently captures what is thought to be a reasonable worst-case land take.

2.4 Proposed Scheme description

Overview

2.4.1 The Proposed Scheme is intended to:

- Create bi-directional free flow links between A11 and A47 eastern link
- Improve the existing A11 signalised junction
- Improve the existing A11 Round House roundabout
- Reconnect Cantley Lane with Cantley Lane South
- Consist of a site area within the DCO site boundary of 85ha and have a total length of new carriageway of 4.7km

Side road strategy

2.4.2 A number of concerns were raised over the proposed reconnection of Cantley Lane South to Cantley Lane including potential increased traffic flows on Cantley Lane, potential rat-running, the environmental impacts along Cantley Land and unacceptable land severance. Having reviewed the feedback following the non-statutory public consultation a number of alternative options have been assessed and two potential solutions put forward - Options A and B (Figure 3.1). A single solution for Cantley Lane will be chosen and assessed accordingly in the ES.

Potential solution for Cantley Lane South - Option A

2.4.3 Option A proposes an overbridge carrying traffic over the A11 between Cantley Lane South and the B1172 Norwich Road. A new culvert is likely be required at

the junction with Cantley Lane South carrying the new road over the minor stream.

2.4.4 The new overbridge over the A11 will be approximately 12m wide (6m wide carriageway and a 3m wide raised verge on both sides) and 100m long. It would most likely be a 3-span structure comprising 50m southern span and 30m each central and northern spans.

2.4.5 A new 110m long footbridge will replace the existing one over the A47. The structure would preferably be a 3-span bridge with piers located at each side of the main A47 trunk road between the main road and the slip roads. The northern abutment will be founded near the top of the cutting. Piled foundations may be required.

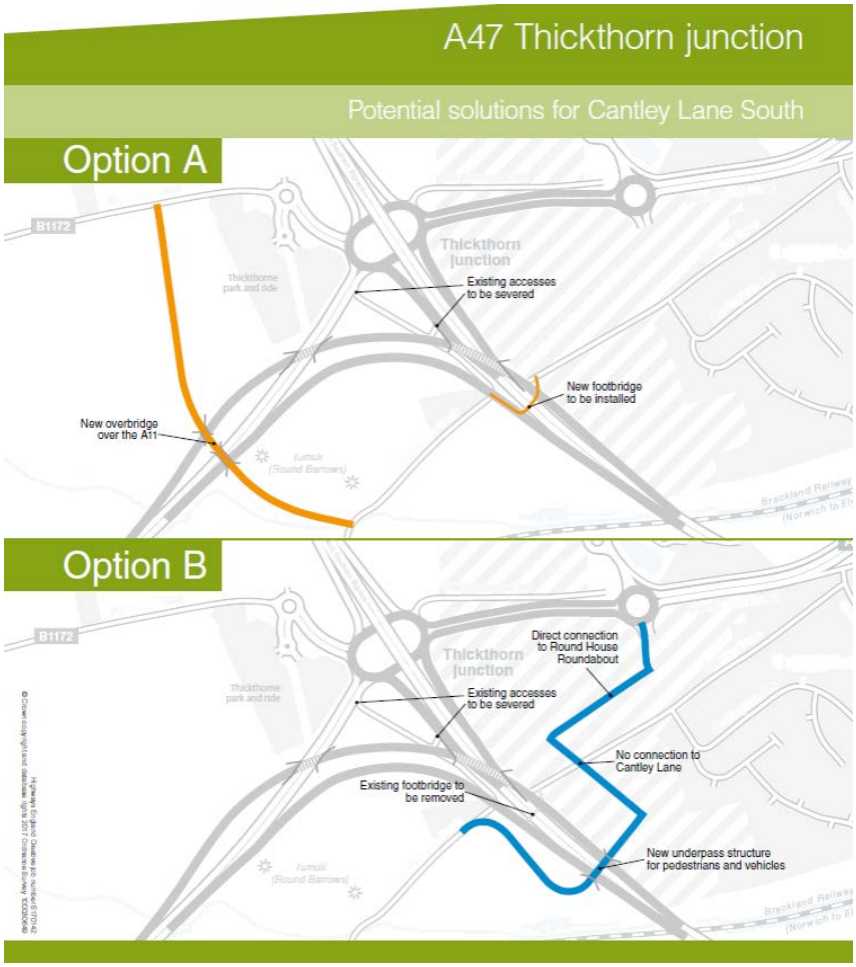
Potential solution for Cantley Lane South - Option B

2.4.6 Option B connects Cantley Lane South with Round House roundabout via an underpass beneath the A47 and passing through the West of Cringleford development land. The cross section for the underpass is approximately 13m wide.

2.4.7 The length of the structure will be approximately 58m long, passing under the A47 mainline and interchange links to the east of Thickthorn Junction. The underpass is likely to consist of two independent structures with a longitudinal separation joint through the deck slab and the abutments. The joints would be located in the area of the new A47 central reserve. The structure is anticipated to comprise of connecting pile abutments and an in-situ reinforced concrete deck slab.

2.4.8 The various concerns raised in relation to the reconnection of Cantley Lane, will be addressed as part of the design process. Details of the two options are illustrated in Figure 3.1.

Figure 3.1: Options for Cantley Lane South



2.5 Timescales

2.5.1 Subject to successfully passing through the DCO process, the key timescales for the Proposed Scheme are as follows:

- Start of construction works – 2020
- Estimated duration of construction – 26 months
- Open for traffic – 2022

3 Consideration of Alternatives

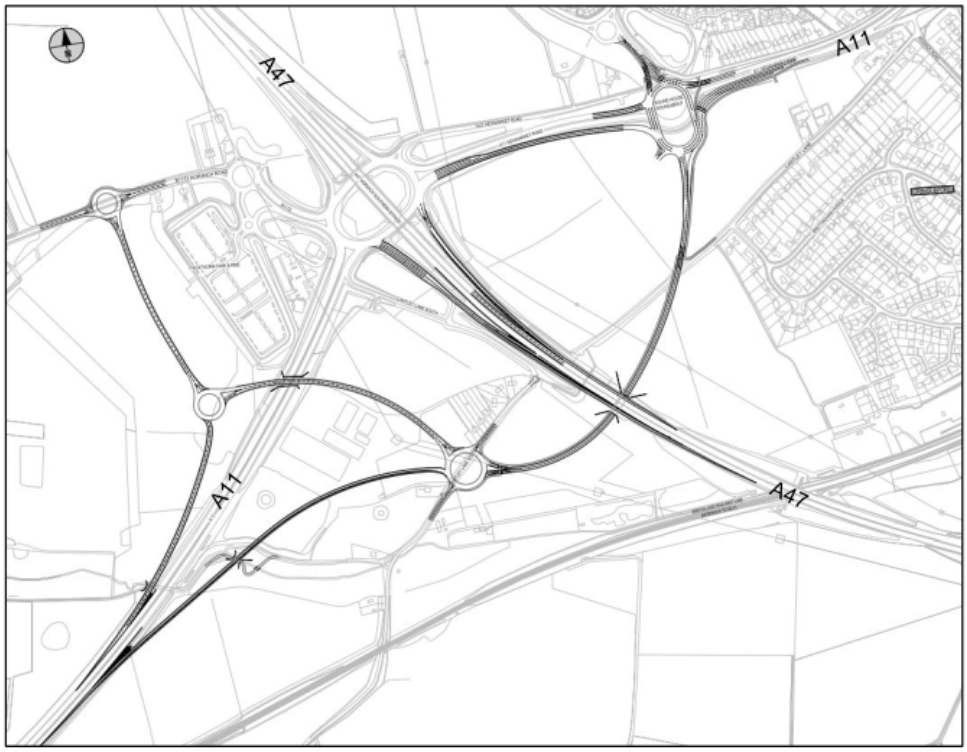
3.1 Alternative options considered

3.1.1 In seeking to resolve the transport problem twenty-six potential options were developed and assessed to identify their performance against environmental, engineering, transportation and economic criteria so that they could be compared and contrasted to allow the most appropriate options to be taken forward. This concluded that Options 13 (alternative 1), 21 and 22 all resolved the transport problem; in so much they should allow for a safer, swifter movement of traffic through the junction. These options are described below.

Option 13 (alternative 1)

3.1.2 This alternative option comprised an offline A11 bi-directional bypass, passing to the east of Thickthorn interchange and connecting an enlarged Round House Roundabout with a grade separated roundabout on the A11 south. The flexibility provided from the A11 south at-grade roundabout in option 13 is retained by using an extended dumb-bell junction arrangement, with only west facing slip roads. A local link from the A11 roundabout to the B1172 would be provided and a simple roundabout would connect Cantley Lane South to the proposed spine road. See Figure 3.2.

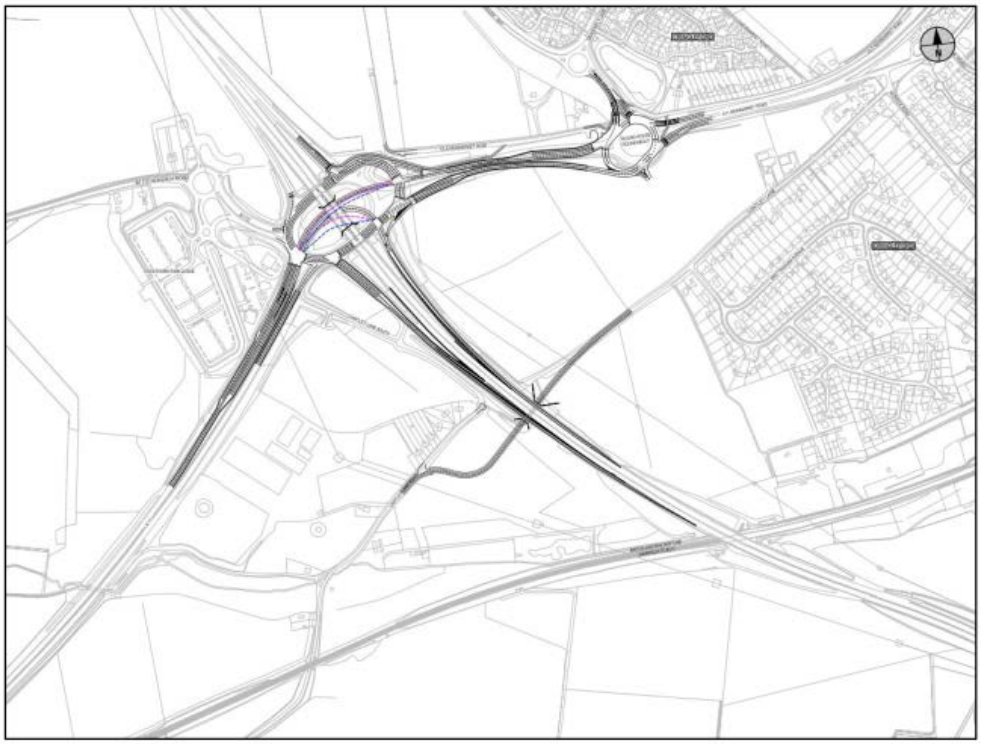
Figure 3.2: Option 13



Option 21

3.1.3 This option comprised an online through-about design separating the A11 south to A11 north through traffic and the A11 south to the A47 east right turn. Round House Roundabout has been slightly enlarged and signalised. Cantley Lane South is reconnected with Cantley Lane. This option also included the removal of the Old Newmarket Road connecting to the Thickthorn Interchange gyratory, reducing the number of entries to five. See Figure 3.3.

Figure 3.3: Option 21



Option 22

3.1.4 This option comprised an A11 south to A47 east offline two-way bypass with an additional link to the B1172. The severance of Cantley Lane South is alleviated by the addition of a roundabout. See Figure 3.4.

Figure 3.4: Option 22

3.2 Option taken forward – the Proposed Scheme

3.2.1 Initial available cost estimate information indicated that the options (Options 13, 21 and 22) were not economically viable. A value management exercise was undertaken to develop alternative solutions that would resolve the problem but reduce the high costs of the scheme. The best performing option was focussed upon (Option 22) and this exercise reduced the cost through reducing the scheme footprint and modifying the proposals to eliminate links and junctions. The option maintained essential movement between the A47 and A11 in both directions and modelling results confirmed that the option would continue to deliver the same improvement to the junction by by-passing predominant flows around the junction, thereby freeing up capacity for other traffic movements. Option 22 was then taken forward for further development (Figure 3.4).

3.2.2 The high costs of the proposed options and the results of the value management exercise described above meant that the options that were identified as not being economically viable were pursued any further. The amended Option 22 that had been developed as a result of the value management exercise was determined by the criteria set out by the RIS and appeared to be economically viable and solves the transport problem. This option was therefore presented at the non-statutory public consultation in March / April 2017 to gauge public opinion.

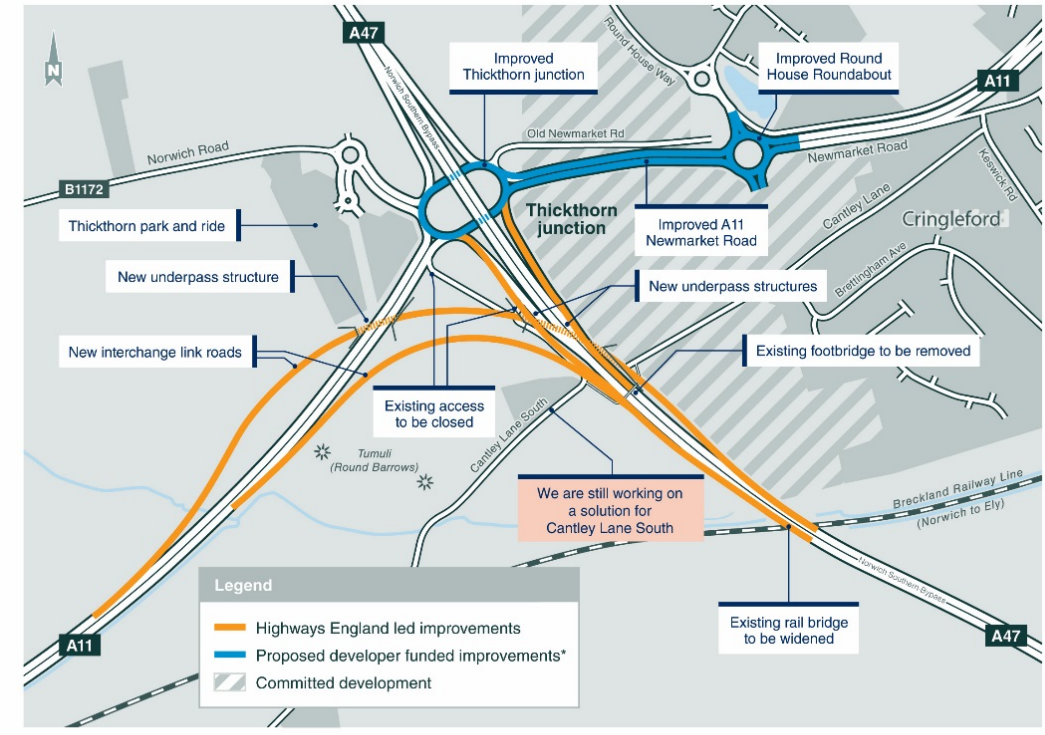
3.2.3 Over 250 people attended the three days of public events and Highways England received 185 responses to the consultation. Around 74% supported the need to improve the junction and agreed the proposals would be beneficial in reducing congestion and improve journey times.

3.2.4 A number of concerns were raised over the proposed reconnection of Cantley Lane South to Cantley Lane including potential increased traffic flows on Cantley Lane, potential rat-running, the environmental impacts along Cantley Land and unacceptable land severance.

3.2.5 Having reviewed the feedback following the consultation and following on from the feedback from members of the public at the Public Information Events a number of alternative options (seven options) have been assessed for the severance of Cantley Lane South. As a result of the high-level assessment, potential solutions for Cantley Lane options A and B (Figure 3.1) were regarded to provide potentially suitable designs that would fulfil the scheme objectives and were progressed for assessment. A single solution for Cantley Lane will be chosen and assessed accordingly in the ES.

3.2.6 Concerns raised during non-statutory public consultation will be considered as part of the design process and development of the side road strategy. The final design and construction plan will be the subject of statutory consultation.

Figure 3.1: Preferred route (Option 22)



*A local scheme progressed by developers with South Norfolk District Council

4 Consultation

4.1 Consultation undertaken to date

4.1.1 An extensive stakeholder mapping exercise was undertaken to identify relevant stakeholders and their key interests. This list was used to inform the participants of a six-week non-statutory public consultation, which was held between 13 March and 21 April 2017.

4.1.2 At all public information exhibition events, members of the Highways England management team, the designers and council officials were available to discuss the proposed options with stakeholders.

4.1.3 In addition to the public information exhibitions, public information points were made available throughout the duration of the consultation period. They were selected within the vicinity of the proposals, and in nearby neighbourhoods to ensure that all stakeholders had the opportunity to collect consultation materials if they were unable to attend one of the scheduled consultation events. The following consultation material was available at the public information points:

- Consultation scheme brochure
- Consultation scheme questionnaire and freepost envelope
- Poster detailing public events and scheme website

4.1.4 The Highways England website made the non-statutory consultation documents available to stakeholders for viewing and downloading, and included the facility to complete and return the questionnaire online. The website was kept up to date with information on all the non-statutory public consultation events and public information points.

Engagement with Local Authorities

4.1.5 Local MPs and Councillors were invited to attend a preview of the Public Information Exhibition before it opened to the public. The preview event was held on the 14 March 2017.

Engagement with Statutory Environmental Bodies

4.1.6 Highways England has not formally engaged with the Statutory Environmental Bodies during the route options development period and during the non-statutory public consultation period. Informal consultation has however been undertaken in support of individual technical assessments and this engagement is referenced within the individual technical chapters as appropriate.

Engagement with landowners

4.1.7 Landowners were engaged as part of the non-statutory public consultation exercise.

Engagement with the community

4.1.8 Non-Statutory public consultation was undertaken over the period 13 March to 21 April 2017.

4.1.9 The scheme proposals were advertised by way of posters, distributing leaflets, brochures and advertisement in local newspapers, and other media sources within the Cringleford and Hethersett area.

4.1.10 Three public information exhibitions were held on the 25, 27 and 28 March 2017 as detailed.

4.1.11 Two hundred and fifty people attended the exhibitions with a total of one hundred and eighty-five responses received.

4.1.12 The information on the scheme proposals was also made available on the Highways England website www.highways.gov.uk/a47Improvement and distributed to local libraries and community halls.

4.1.13 As part of the development of the side roads strategy local residents were sent a leaflet on 31 November 2017 to provide an update on design development of the potential solutions for Cantley Lane South and inform them of forthcoming engineering surveys.

4.2 Proposed consultation

4.2.1 A consultation strategy has been developed which outlines the organisations who will be consulted, methods through which we will consult and the proposed timeline for the consultation. Consultation required to support individual technical assessments is set out within each technical chapter of this report.

Engagement with hard to reach groups

4.2.2 It is anticipated that the Proposed Scheme's Equality Impact Assessment will identify the relevant hard to reach groups. Host local authorities will be consulted about identification of relevant groups. Categories identified and contacted include non-motorised user (NMU) groups, ethnic organisations, local Traveller communities', disability groups and groups representing children and the elderly.

5 Air Quality

5.1 Introduction

5.1.1 This chapter presents the baseline air quality in the vicinity of the Proposed Scheme and describes the proposed approach for the assessment of air quality.

5.1.2 It has been prepared in accordance with the requirements of DMRB Volume 11, Section 2, Part 4 (HA 204/08), DMRB Volume 11, Section 3, Part 1 (HA 207/07), and associated Interim Advice Notes (IANs), namely IANs 170/12v3, 174/13, 175/13 and 185/15, with assessment undertaken to a Scoping Level. This chapter encompasses two sub-topics, as follows:

- Local air quality – emissions of pollutants that are of concern in relation to human health and ecosystems, at a local level.
- Regional air quality – total emissions of pollutants that can disperse over longer distances, affecting both human health and ecosystems.

5.1.3 The potential requirement for assessment to either simple or detailed level will be identified within this chapter. Where necessary, assessment will be presented within the ES.

5.2 Study area

5.2.1 The location of the Proposed Scheme and key environmental constraints located adjacent is shown in Appendix A and B respectively.

5.2.2 The study area for the local air quality assessment covers human health receptors and ecologically Designated Sites within 200m of roads that are expected to be affected by the Proposed Scheme.

5.2.3 Under DMRB Volume 11, Section 3, Part 1(HA 207/07), affected roads are defined where:

- Road alignment will change by 5m or more, or
- Daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) or more, or
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more, or
- Daily average speed will change by 10km/hr or more, or
- Peak hour speed will change by 20km/hr or more

5.2.4 The local air quality assessment involves estimating the change in pollutant concentrations at sensitive receptors resulting from the operation of the Proposed Scheme. The regional air quality assessment assesses the change in emissions resulting from the Proposed Scheme. This is required as emissions not only affect local air quality, but also have an impact on a regional, national

and international scale. Affected roads for the assessment of regional air quality include those that meet the following criteria:

- A change of more than 10% AADT, or
- A change or more than 10% to the number of HDVs, or
- A change in the daily average speed of more than 20km/hr

5.2.5 As scheme specific traffic data is not yet available, it is not possible to describe in further detail the areas which meet the above criteria.

5.3 Existing and baseline knowledge

Overview

5.3.1 Information on air quality in the UK can be obtained from a variety of sources including Local Authorities, national network monitoring sites and other published sources. For the purpose of this assessment, data has been obtained from the Local Authority (South Norfolk Council (SNC)) and Department for Environment, Food and Rural Affairs (Defra). The most recent full year of bias adjusted monitoring data available from SNC is for 2016.

Local Authority review and assessment

5.3.2 There are currently no Air Quality Management Areas (AQMAs) declared within SNC's administrative area. The closest AQMA to the Proposed Scheme is the Central Norwich AQMA which is located approximately 5km to the north east. At this point in time, traffic data is not available and so it is not possible to determine the extent of the Affected Road Network (ARN) and the potential effect on the AQMAs.

Local Authority monitoring

5.3.3 No automatic monitoring is currently undertaken by SNC. Norwich City Council operates two automatic monitors; however, these are located in urban areas approximately 5km north east of the Proposed Scheme and are not considered representative of air quality at the Proposed Scheme site.

5.3.4 SNC currently undertakes non-automatic (diffusion tube) monitoring at 29 sites to assess compliance with the annual mean NO_2 air quality objective. Of these 29 sites, three roadside sites are located in close proximity to the Proposed Scheme. The most recent full year of monitoring data available from these sites is from 2016 and has been presented in Table 5.1.

Table 5.1: Diffusion tube monitoring data for NO_2

Site ID	Location	Site classification	National Grid reference		Annual mean NO_2 concentration ($\mu g/m^3$)		
			X	Y	2014	2015	2016
A	46a Old Newmarket Road, Cringleford	Suburban	619208	304645	21.5	17.1	20.2
B	2 Thickthorn Cottages	Rural	618137	305678	15.9	12.8	15.8
C	25 Broadstreet, Harleston	Suburban	619131	305633	38.6	31.8	38.2

Source: Air Quality Annual Status Report 2017, South Norfolk Council
Note: Annual mean objective is 40 $\mu g/m^3$
All results presented have 100% data capture

Defra projected background concentrations

5.3.5 In addition to the data above, Defra provides estimates of background pollution concentrations for NO_X, NO_2 and PM_{10} across the UK for each one kilometre grid square, for every year from 2013 to 2030. Future year projections have been developed on the base year for the background maps, which is currently 2013. The maps include a breakdown of background concentrations by emission source, including road and industrial sources which have been calibrated against 2013 UK monitoring data. This data can be used to provide specific background pollutant concentrations at receptors included within the assessment and to supplement local monitoring data.

5.3.6 Table 5.2 presents the maximum background concentrations for the area covered by the Proposed Scheme alignment for the year 2016.

Table 5.2: Defra projected background concentrations for the Proposed Scheme (2016)

NO_x	NO_2	PM_{10}	$PM_{2.5}$
22.8	16.1	18.9	12.7

Source: Defra AIR
Note: OS grid squares = 618500, 305500

EU limit value compliance

5.3.7 Defra's Pollution Climate Mapping (PCM) is used to report compliance with the EU limit values and provides NO_2 concentrations for a number of roads across the UK for a selection of future years. The most up to date PCM model outputs were released in August 2017, following the release of Defra's Air Quality Action Plan.

5.3.8 Based on projected roadside NO_2 concentrations in the current version of the PCM model, there are no PCM links within approximately 50km of the Proposed Scheme exceeding 40$\mu g/m^3$ for the year of 2017. The PCM link closest to the Proposed Scheme, (on the A11 east of Bluebell Lane) is located approximately

1.3km east of the Proposed Scheme and has a reported annual mean NO_2 concentration in 2017 of 32µg/m^3, which is well below the annual mean limit value of 40µg/m^3 for NO_2.

5.3.9 The Proposed Scheme is unlikely to cause a non-compliance with the Air Quality Directive. This is because there are a limited number of PCM links in the area, and where there are links concentrations in the current PCM model are below the limit values in 2017.

5.3.10 The ES, will identify any affected road network (ARN) links that overlap with the PCM model and will assess compliance with the Air Quality Directive in accordance with IAN 175/13.

Summary

5.3.11 Monitoring results from 2016 showed no exceedances of the NO_2 air quality objective at any of the monitoring locations located close to the Proposed Scheme, although diffusion tube 'C' did monitor annual mean NO_2 concentrations close to the relevant objective. In addition, there are no AQMAs located within the vicinity of the Proposed Scheme. There is no monitoring data available for PM_{10} however Table 5.2 indicates that background concentrations are well below the air quality objective in the study area.

5.4 Assumptions and limitations

5.4.1 Air quality modelling predictions will be based on the most reasonable, robust and representative methodologies in accordance with best practice guidance. However, there is an inherent level of uncertainty associated with model predictions, including:

- Uncertainties with traffic forecasts
- Uncertainties with vehicle emission predictions
- Uncertainties with background air quality data
- Simplifications made within modelling calculations or post processing of the data that represent atmospheric dispersion or chemical reactions

5.4.2 In order to best manage these uncertainties, the air quality assessment to be undertaken will be verified using local authority air quality monitoring data. The verification process will be undertaken in line with best practice guidance produced by Defra.

5.5 Guidance and best practice

5.5.1 The air quality assessment will take account of the best practice guidance provided by the DMRB 207/07, the Defra technical guidance for undertaking air quality assessments (LAQM-TG (16)), and the following IANs published by Highways England:

- IAN 170/12 'Updated air quality advice on the assessment of Future NO_x and NO_2 projections for users of DMRB Volume 11, Section 3, Part 1, Air Quality'.
- IAN 174/13 'Updated advice for evaluating significant local air quality effects for users of DMRB Volume 11, Section 3, Part 1 Air Quality'.
- IAN 175/13 'Updated advice on risk assessment related to compliance with the EU Directive on ambient air quality and on the production of Proposed Scheme Air Quality Action Plans for users of DMRB Volume 11, Section 3, Part 1 Air Quality (HA207/07)'.
- IAN 185/15 'Updated traffic, air quality and noise advice on the assessment of traffic data into speed-bands for users of DMRB Volume 11, Section 3 Part 1 Air Quality'.

5.5.2 Further updates to the IANs may be published before work commences on the environmental assessment; the assessment will be undertaken in accordance with the latest IANs available at the time.

5.5.3 Table 5.3 presents the relevant air quality objectives that the Proposed Scheme will be assessed against.

Table 5.3: Air quality objectives and limit values

Pollutant	Averaging Period	Air Quality Objectives and Limit Values		Attainment Date	
		Concentration	Allowance	Air Quality Objectives	EU Limit Values
Nitrogen dioxide (NO_2)	Annual	40 µg/m^3	-	31 December 2005[(a)(b)]	1 January 2010[(c)]
	1 Hour	200 µg/m^3	18	31 December 2005[(a)(b)]	1 January 2010[(c)]
Nitrogen Oxides (NO_X)[(d)]	Annual	30 µg/m^3	-		31 December 2000[(c)]
Particulates (PM_{10})	Annual	40 µg/m^3	-	31 December 2004[(a)(b)]	1 January 2005[(c)]
	24 Hour	50 µg/m^3	35	31 December 2004[(a)(b)]	1 January 2005[(c)]

Notes: (a) Air Quality (England) Regulations 2000 as amended in 2002.
(b) Air Quality Strategy 2007.

(c) EU Directive 2008/50/EEC on ambient air quality and cleaner air for Europe and The Air Quality Standards Regulations 2010. Derogations (time extensions) have been agreed by the EU for meeting the NO_2 limit values in some zones/agglomerations.

(d) Designated for the protection of vegetation and ecosystems and referred to as the 'critical level' for NOx.

5.6 Consultation

5.6.1 Consultation will be undertaken with SNC to discuss the assessment approach and the study area once scheme specific traffic data is finalised.

5.7 Potential effects, including monitoring and mitigation measures

Construction

5.7.1 The main risks to sensitive receptors during the construction phase include on-site dust emissions arising from construction activities and vehicle movements. Dust can be mechanically transported (either by wind or re-suspension by vehicles). It can also arise from wind erosion on material stock piles, earth moving etc.

5.7.2 These impacts are expected to be restricted to within 200m of construction activities (as stated in DMRB Volume 11, Section 3, Part 1), and will be controlled through appropriate mitigation measures included within the Construction Environmental Management Plan (CEMP) which would be prepared for the Proposed Scheme. Mitigation measures could include minimising the use of dust generating activities, the use of water as a dust suppressant where appropriate, and keeping stockpiles for the shortest time possible.

Operation

5.7.3 The operational phase of the Proposed Scheme on local air quality has the potential to effect air quality due to:

- Changes in emissions associated with changes in traffic flows (including composition and speed) on the local road network
- Changes in road layout which may bring road traffic emission sources closer to, or further away from, sensitive receptors

5.7.4 The key pollutants for consideration within the assessment of operation phase local air quality effects are:

- Nitrogen oxides (NOx), including NO_2
- Fine particles (particulate matter defined as those less than 10 microns in diameter; PM_{10})

5.7.5 The key pollutants for consideration within the assessment of operation phase regional air quality effects (if the assessment criteria are met) are:

- Nitrogen oxides (NOx), including nitrogen dioxide (NO_2)
- Fine particles (particulate matter defined as those less than 10 microns in diameter; PM_{10})
- Carbon dioxide (CO_2)

5.7.6 No assessment is considered necessary for emissions of any pollutants other than those identified above, as no significant emission sources of these pollutants are introduced or affected by the Proposed Scheme or because concentrations are expected to be well below air quality objectives within the study area.

Summary

5.7.7 Table 5.4 provides a summary of the potential construction and operational air quality effects for the Proposed Scheme.

Table 5.1: Summary of potential air quality effects

Potential construction effects	Potential operation effects
Significant direct effects are unlikely with mitigation measures in place.	Dependant on traffic impacts which are yet to be determined.

5.8 Proposed level and scope of assessment

5.8.1 The scope of assessment during the construction phase will include emissions of NO_2 and PM_{10} from construction plant and vehicles, and dust arising from construction activities. A qualitative assessment of construction phase effects will be undertaken.

5.8.2 For the operational stage effects, a Detailed Level assessment will be undertaken, once scheme specific traffic data is available. In accordance with DMRB, a Detailed Level assessment is recommended due to the complexity of the Proposed Scheme layout and its proximity to receptors on Cantley Lane South.

5.9 Proposed methodology including significance

Construction phase

5.9.1 Key stages of the construction phase and the locations and types of sensitive receptors will be identified in accordance with DMRB 207/07. Appropriate mitigation measures will be identified in accordance Best Practicable Means (BPM) which would be incorporated into the CEMP.

5.9.2 If construction traffic is predicted to last for longer than six months, traffic management measures and the effect of additional construction vehicles will be assessed qualitatively.

Operational phase

5.9.3 A Detailed Level assessment will be undertaken in accordance with the DMRB Volume 11, Section 3, Part 1 (HA 207/07) and associated IANs, and Defra's Local Air Quality Management Technical Guidance (LAQM.TG(16)), which will include:

- An assessment of air quality effects using the latest available version of ADMS-Roads
- Verification of model outputs with local monitoring data
- Prediction of NO_2 and PM_{10} concentrations in the 'Base Year' and the opening year 'Do-Minimum' and 'Do-Something' scenarios at sensitive human health receptors and Designated Sites

5.9.4 For regional air quality impacts, the change in mass emissions that would result from the operation of the Proposed Scheme will be quantified. Emissions with and without the Proposed Scheme will be compared for opening year and design year (Opening year + 15 years) as well as the base year scenario.

Determination of significant effects

5.9.5 IAN 174/13 provides advice for evaluating significant local air quality effects for public exposure and designated sites. Evaluation of the significance of local air quality effects will be undertaken in accordance with IAN 174/13, a summary of which is provided here.

5.9.6 Receptors that have a reasonable risk of exceeding an air quality threshold will be assessed in both a Do-Minimum and Do-Something scenario. The difference in pollutant concentration between the two scenarios is used to describe the magnitude of change in accordance with Table 5.5.

Table 5.2: Magnitude of change criteria

Magnitude of Change in Concentration	**Value of Change in Annual Average NO_2 and PM_{10}**
Large (>4)	Greater than full MoU value of 10% of the air quality objective (4μg/m^3)
Medium (>2 to 4)	Greater than half of the MoU (2 μg/m^3), but less than the full MoU (4 μg/m^3) of 10% of the air quality objective
Small (>0.4 to 2)	More than 1% of objective (0.4 μg/m^3) and less than half of the MoU i.e. 5% (2 μg/m^3). The full MoU is 10% of the air quality objective (4 μg/m^3)
Imperceptible (</= 0.4)	Less than or equal to 1% of objective (0.4 μg/m^3)

Notes: MoU = Measure of Uncertainty (10% of the objective)

5.9.7 The number of receptors where changes are greater than imperceptible, and where concentrations exceed the air quality objectives in the Do-Minimum or Do-Something scenario will be compared to the guideline bands presented in Table 5.6.

Table 5.3: Guideline to number of properties constituting a significant effect

Magnitude of Change in Concentration	Number of Receptors With:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2 to 4)	10 to 30	10 to 30
Small (>0.4 to 2)	30 to 60	30 to 60

5.9.8 Table 5.6 presents guideline bands, setting an upper level of likely non-significance and a lower level of likely significance, for the number of receptors affected by the Proposed Scheme. Between these two levels are the ranges where likely significance is more uncertain, therefore professional judgment would be required. If the Proposed Scheme is above the lower level of likely significance, consideration should be given to all the evidence that may support or detract from the conclusion of a significant effect. The information compiled to complete Table 5.6 will then been used along with the following key criteria to determine the overall evaluation of local air quality significance:

- Is there a risk that environmental standards would be breached?
- Is there a high probability of the effect occurring?
- Would there be a large change in environmental conditions?
- Would the effect continue for a long time?
- Would many people be affected?
- Is there a risk that protected sites, areas, or features would be affected?
- Would it be difficult to avoid, or reduce, or repair, or compensate for the effect?

5.9.9 The Proposed Scheme's compliance with EU limit values will be assessed using IAN 175/13.

5.10 Conclusion

5.10.1 A qualitative assessment of receptors within 200m of construction activities will be undertaken and relevant measures to minimise the air quality impact of construction activities will be included in the CEMP.

5.10.2 The operational air quality impacts will be determined through a Detailed Level assessment due to the complexity of the Proposed Scheme road layout and its proximity to sensitive receptors. This will be reviewed again once scheme specific traffic data is available and the ARN for the Proposed Scheme has been determined.

5.10.3 A detailed level of assessment of air quality effects of the Proposed Scheme will be undertaken in accordance with DMRB HA207/07 and associated IANs, and will be presented within the ES.

6 Cultural Heritage

6.1 Introduction

6.1.1 This chapter provides an overview of the baseline heritage assets in the vicinity of the Proposed Scheme and describes the proposed approach for the assessment of cultural heritage within the study area. For the purpose of this assessment, this includes scheduled monuments, listed buildings, conservation areas, registered battlefields, registered parks and gardens and non-designated features of national, regional or local archaeological, historic or architectural interest and value. These features include archaeological remains, paleo-environmental deposits, historic buildings, historic open spaces, historic features and the wider historic landscape. Such sites can make an important contribution to the local distinctiveness of an area and its sense of place.

6.1.2 This chapter has been prepared in accordance with DMRB Volume 11, Section 2, Part 4, and DMRB Volume 11, Section 3, Part 2, to a Scoping Level. Assessment will be presented within an ES.

6.2 Study area

6.2.1 The study area includes designated and non-designated cultural heritage assets within 1km of the Proposed Scheme. Though there is anticipated to be no physical impacts to designated assets it is considered that a 1km search area for these assets is proportionate given that there are proposed embankments and potential overbridges.

6.2.2 In addition, the Zone of Visual Influence (ZVI), which will be produced as part of the Landscape Visual Impact Assessment (LVIA), will be used to identify any designated assets that would be affected by the construction of the Proposed Scheme.

6.3 Existing and baseline knowledge

6.3.1 The information presented within this scoping report is largely based on the previous stages of design development and assessment.

6.3.2 Data detailing nationally designated cultural heritage assets in the UK has been obtained from Historic England’s National Heritage List for England. Information concerning designated and non-designated heritage assets was obtained from the Norfolk Historic Environment Record (HER).

6.3.3 References used in this section refer to the National Heritage List for England list entry numbers (NHLE numbers) and Norfolk HER reference numbers (MNF numbers).

6.3.4 Table 6.1 summarises the existing baseline specifically for the Proposed Scheme.

Table 6.1: Summary of existing baselines

Existing Baseline
Designated assets The 1km study area around the preferred route has one Grade II* listed building (Church of All Saint, NHLE 1373136, 640m south-east of the Proposed Scheme) and 15 Grade II listed buildings. One scheduled monument (NHLE 1003977) is situated adjacent to the red line boundary and comprises two Bronze Age round barrows surviving as earthworks in a former plantation area known as Big Wood. One grade II* listed registered park and garden, Intwood Hall (NHLE 1000320), is situated approximately 400m south of the Proposed Scheme. The parkland consists of c.16th century walled gardens and surrounding c.18th to c.19th century parkland. Cringleford Conservation Area is situated around 300m east of the Proposed Scheme.
Non-designated assets A borehole log (BGS borehole reference TG10SE/96) in the area of the Cantley Stream, on the north-western side of the A11, records a 0.5m thick peaty gravel deposit at a depth of around 1m below the ground level. Further along the stream, to the south-east, peat deposits are also recorded to a depth of 2.6m and 0.4m from the ground surface (BGS borehole reference TG10SE/106 and TG10SE/130 respectively). This indicates that pockets of peat are potentially present within the area of the Proposed Scheme with Option A. Peat deposits have the potential to contain evidence related to the paleo-environment, and well-preserved archaeological remains, specifically organic remains such as wood, leather, hair and skin. The area around Thickthorn junction, within the route of the A11, the South Norwich Bypass (the A47) and selected surrounding fields, has been surveyed during the construction of the roads in the 1970s and 1980s. The field walking surveys indicate activity within the area from the prehistoric period through to the present day, however there has been little intrusive archaeological investigation. In addition to the scheduled monument, a number of prehistoric finds have been recorded within the study area. Of these, 11 are recorded within the footprint of the Proposed Scheme: A Mesolithic flint blade and Neolithic flint flakes were found along the route of the A11, prior to its construction, at the western end of the Proposed Scheme (NHER 22814). Prehistoric flint implements were recorded in the Cantley Stream Culvert during the construction of the A11 (NHER 22758). Further flint tools and flakes were recorded to the east, within the route of the A11 (NHER 22812, 22813). Cropmarks on the northern side of the A11, in the area of the Proposed Scheme, indicate the presence of ditches possibly forming a prehistoric field system (NHER 59885, 65378). A geophysical survey in the northern half of this field revealed a small number of ditches aligned roughly east to west, a cluster of pits was also identified on the western perimeter of the central part of the Proposed Scheme. Fieldwalking over a number of years, in an area towards the eastern end of the Proposed Scheme, close to Option B, revealed a number of prehistoric finds, including three Bronze Age socketed axes, flint tools and a small quantity of Neolithic, Bronze Age and Iron Age pottery (NHER 16229, 16230). Geophysical survey which also covered this area revealed no archaeological finds or features, however the survey did not pick up known boundary ditches, indicating that factors such as the natural geological substrate, have affected the results. A Late Neolithic/Early Bronze Age flint scatter was identified during field walking prior to the construction of the South Norwich Bypass (A47) (NHER 14273), at the eastern end of the Proposed Scheme. Roman activity in the area was focused upon the town at Caistor St Edmund – *Venta Icenorum* – around 3.7km to the south-east of the Proposed Scheme. There are a number of

Existing Baseline
Roman roads to the south of the study area, into which none of the roads extend. However, Roman activity is evinced by a series of chance finds within the study area. For example, a Roman brooch, along with an early 17th century post-medieval cloth seal, was found during metal detecting of a spoil heap from road construction works at the western end of the Proposed Scheme, within the route of the A11 (NHER 22755). The deserted medieval village (DMV) of Cantley (NHER9469) is situated 80m south of Proposed Scheme. A double-ditched enclosure to the north of the DMV suggests that medieval remains could be present beyond the area identified as the DMV (NHER MNF61763). Medieval pottery finds (NHER25511) within the study area are situated around the area of the abandoned medieval village. A medieval moat is recorded at Thickthorn Park, on the northern side of the A11, around 40m from west of the Proposed Scheme and was incorporated in the later formal design of the parkland (NHER 33732). The former hall, which was situated within the interior of the moat, dates to around 1240 and was replaced in 1812 by Thickthorn Hall (NHER 9352). Thickthorn Park is a post-medieval landscape park dating to the early c.19th century surrounding Thickthorn Hall. The Proposed Scheme extends into the south-eastern edge of the park. Post-medieval evidence within the study area indicates that the area was largely agricultural; field boundaries are identified (NHER 40384) and features associated with country estates such as Thickthorn Park (NHER 33732) and Intwood Hall (NHER 9473) are recorded. Remains of industrial activities are also identified within the study area, around 750m to the north of the Proposed Scheme: a clay extraction pit (NHER 9407) a possible kiln site (NHER 62390) The Norfolk Railway was opened in 1844 (NHER 13571). The eastern end of the Proposed Scheme runs over the top of the railway, across an existing road bridge. A bank running roughly north-east to south-west, to the north of, and parallel to, the railway, is described as an undated Holloway (NHER 9409). The Norwich Road (A11) and Cantley Lane are both shown on the Tithe Map of 1840 (Highways England, 2017) and many of the field boundaries remain unaltered, though some fields have been widened. Modern assets include a possible World War Two rail block (on the line of the railway) (NHER MNF59513). The site of limekilns and a tramway (NHER 16685) are located in Cantley Wood, partially within the red line boundary for Proposed Scheme, and were in use during the 1930s and 1940s.
Historic Landscapes The historic landscape character of the area surrounding the Proposed Scheme is largely described as 20th century agriculture with pockets of 18th to 19th century enclosure surviving. An area of inland managed wetland is identified around the Cantley Stream. The central area of the Proposed Scheme is not categorised through the Norfolk Historic Landscape Characterisation project.

6.4 Assumptions and limitations

6.4.1 The information presented here is based on the information from previous stages of design and assessment.

6.4.2 Buildings of local importance not included within the Norfolk Historic Environment Record (HER) have not been considered to date. Additional assessment will identify any such structures and will consider the impact of the construction and operation of the Proposed Scheme upon them.

6.4.3 The assessment is based upon the proposed site boundary. Detailed design will be undertaken at a later stage and will include associated features such as, compound locations, drainage and landscaping. As such further development has the potential to alter the predicted effects of the construction and operation of the Proposed Scheme.

6.4.4 Information provided by HERs can be limited because it depends on previous opportunities for research, fieldwork, and discovery. Where nothing of historic interest is shown in a particular area; this can be down to a lack of targeted research or investigation rather than the genuine absence of sub-surface archaeological deposits.

6.4.5 Documentary sources are rare before the medieval period, and many historic documents are inherently biased. Older primary sources often fail to accurately locate sites and interpretation can be subjective.

6.4.6 Where archaeological sites have been identified solely from aerial imagery without confirmation from archaeological excavation or supporting evidence in the form of find-spots etc., it is possible the interpretation may be revised in the light of further investigation.

6.4.7 Conclusions and recommendations may therefore be revised during the course of the EIA process on the basis of updated information following further research, survey, and investigation.

6.5 Guidance and best practice

6.5.1 The method for determining and appraising baseline conditions involved a desk-based study and was undertaken in accordance with the published standards and guidance set out below:

- DMRB Volume 11, Section 3, Part 2 Cultural Heritage.
- Historic England (2008) Conservation Principles: Policies and Guidance.
- Historic England (2015) Historic Environment Good Practice Advice in Planning Note 2 (GPA2) - Managing Significance in Decision-Taking in the Historic Environment.
- Historic England (2015) Historic Environment Good Practice Advice on Planning Note 3 (GPA3) - The Setting of Heritage Assets.
- Standard and Guidance from the Chartered Institute of Archaeologists.

6.6 Consultation

6.6.1 Non-statutory public consultation was undertaken between 13 March 2017 and 21 April 2017. A number of respondents commented that the Proposed Scheme would be ‘dangerously close’ to an archaeological site (the scheduled monument). Norfolk County Council have stated that cultural heritage assessment should include a ‘heritage statement (including a desk-based assessment) and full field evaluation (which could include geophysical survey, field-walking, trial trenching and/or other techniques)’.

6.7 Potential effects, including monitoring and mitigation measures

Construction

6.7.1 The Proposed Scheme has the potential to adversely affect designated and non-designated heritage assets during construction. Proposed Scheme would be situated under 20m to the west of a scheduled monument. Buried archaeological deposits and paleo-environmental remains, if present, may be damaged or destroyed by construction excavation and other activities.

6.7.2 The placement of bunds, drainage assets, landscaping, compounds, haul roads and planting would take consideration of below-ground archaeological deposits, and preserving remains in-situ would be explored during the design process. Best practice measures to limit impacts on heritage assets would be employed during construction through the implementation of a Construction Environmental Management Plan (CEMP).

Operation

6.7.3 Below ground archaeological deposits will not be impacted by the operation of the Proposed Scheme. However, the junction improvements have the potential to impact to a varying degree on the setting of some heritage assets through changes in noise levels and visual impact of the movement of traffic. These would include the 16 listed buildings / structures, the scheduled monument and the registered park and garden.

Summary

Table 6.2 provides a summary of the potential construction stage and operational effects upon heritage assets for the Proposed Scheme.

Table 6.2: Summary of Potential Cultural Heritage Effects

Potential Construction Effects	Potential Operation Effects
Potential large adverse effect due to potential direct impact to the setting of the scheduled monument. Potential slight adverse effect due to potential physical impact on paleo-environmental and archaeological remains.	Potential adverse effects due to impacts on the setting of designated heritage assets.

6.8 Proposed level and scope of assessment

6.8.1 Assessment of the construction impacts will be necessary for the Proposed Scheme due to the potential for direct effects on the scheduled monument, paleo-environmental and archaeological remains. In addition, due to the presence of sensitive receptors within close proximity of the Proposed Scheme, assessment of operational impacts is also required. Assessment will be undertaken to a Detailed level and will be used to inform the design of an historic environment strategy and subsequent archaeological works. All

investigations will be based upon the regional research framework for the East of England (Medlycott, 2011).

6.9 Proposed methodology including significance

6.9.1 The assessment will consider all heritage assets, both designated and non-designated. These include scheduled monuments, listed buildings, registered parks and gardens, non-designated below-ground archaeological remains, locally recorded historically important buildings, historic landscapes and conservation areas. There are no registered battlefields or World Heritage Sites within the study area.

6.9.2 This assessment will consider both temporary and permanent construction and operational impacts on heritage assets. Temporary impacts will be classed as impacts on setting through construction-related activities; whereas permanent impacts can be either: physical impacts on the integrity of the asset; or impacts on the setting.

Assessment of value / sensitivity

6.9.3 The value / sensitivity of historic environment receptors will be based upon Table 6.3. Assessment of value/sensitivity will be based on a combination of designated status and professional judgement. It will consider the Secretary of State's non-statutory criteria for the scheduling of ancient monuments, assessment criteria adopted by Historic England as part of the Monument Protection Programme (MPP), and the Secretary of State's Principles of Selection Criteria for Listed Buildings.

6.9.4 It will also recognise that occasionally some heritage assets have a lower or higher than normal value / sensitivity within a local context. Additionally; this assessment process should consider the component of the heritage asset that is being affected, and the ability of the heritage asset to absorb change without compromising the understanding or appreciation of the resource.

Table 6.3: Criteria for assessing value / sensitivity

Value / Sensitivity	Typical criteria
Very High	World Heritage Sites, assets of acknowledged international importance, assets that can contribute significantly to acknowledged international research objectives.
High	Scheduled monuments, grade I and II* listed buildings, grade I and II* registered parks and gardens, registered battlefields, undesignated assets of schedulable quality, undesignated monuments, sites, or landscapes that can be shown to have specific nationally important qualities, and assets that can contribute significantly to national research objectives.
Medium	Grade II listed buildings, grade II registered parks and gardens, conservation areas, undesignated sites of high importance identified through research or survey, monuments or sites that can be shown to have important qualities in their fabric or historical association.

Value / Sensitivity	Typical criteria
Low	Undesignated assets – monuments or archaeological sites with a local importance for education or cultural appreciation, and which add to local archaeological and historical research. Very badly damaged assets that are of such poor quality that they cannot be classed as high or medium, parks and gardens of local interest.
Negligible	Heritage resources identified as being of little historic, evidential, aesthetic or communal interest; and resources whose importance is compromised by poor preservation or survival, or by contextual associations to justify inclusion into a higher grade.

Source: Based on DMRB (Volume 11, Section 3. Part 2), 2007

Assessment of magnitude of impact

6.9.5 The degree of impact to the heritage asset from the introduction of the Proposed Scheme will be assessed in accordance with the criteria presented in Table 6.4.

Table 6.4: Criteria for Assessing the Magnitude of Impact

Magnitude	Criteria
Major	Total loss or fundamental alteration to a heritage asset's significance and/or setting. Addition of new features that substantially alter the setting of a heritage asset.
Moderate	Partial loss or alteration a heritage asset's significance and/or setting. Addition of new features that partially alter setting of a heritage asset to the extent where the significance is impacted.
Minor	Minor loss of an element of a heritage asset and/or its setting. Addition of new features that form largely inconspicuous elements in the setting of a heritage asset to the extent that its significance is slightly impacted.
Negligible	Very minor loss of elements of a heritage asset and/or its setting. Addition of new features that do not alter the setting of a heritage asset.
No Change	No change to the heritage asset.

Source: Based on DMRB (Volume 11, Section 3, Part 2), 2007

Assessment of significance of effect

6.9.6 Effects will be evaluated by combining the assessment of both the value/sensitivity (heritage significance) of an asset, with the magnitude of the impact. This allows the prediction of the significance of the effect, as shown in Table 1.2. These effects can be beneficial or adverse; and temporary or permanent, depending on the nature of the development, the mitigation measures, and any enhancement measures proposed. In accordance with DMRB guidance, effects with an assessment of moderate and above are considered to be significant.

6.10 Conclusion

6.10.1 During construction, there is the potential for a direct effect upon the setting of the scheduled monument, and to paleo-environmental and archaeological remains. Assessment of the construction impacts will therefore be necessary for the Proposed Scheme. In addition, due to the presence of sensitive receptors within 1km of the Proposed Scheme, assessment of operational impacts is also required.

6.10.2 Assessment to Detailed level will be undertaken and will be presented within the ES.

7 Landscape

7.1 Introduction

7.1.1 The Landscape and Visual Impact Assessment (LVIA) chapter of this scoping report aims to identify the potential for significant effects of the Proposed Scheme upon the surrounding landscape and visual receptors (consistent with the requirements of the DMRB Scoping Exercise process). This Chapter has been prepared with reference to DMRB Volume 11, Section 2, Part 4, DMRB Volume 11, Section 3, Part 5, IAN 135/10 and Institute of Environmental Management and Assessment 'Guidelines for Landscape and Visual Impact Assessment, Third Edition'. The potential requirement for assessment to either a Simple or Detailed level has been identified.

7.2 Study Area

7.2.1 In recognition of the guidance given in DMRB Volume 11 Section 3 Part 5 Landscape Effects, the study area for the LVIA extends 1km from the Proposed Scheme limits. This has been limited to 1km due to the containing nature of the local topography and the existing vegetation cover, which limits the potential for wider effects. The study area will be extended for any receptors sitting outside of the 1km which have the capacity to experience significant effects as a result of the Proposed Scheme.

7.3 Existing and baseline knowledge

Landscape character

7.3.1 The Proposed Scheme sits within National Character Area (NCA) 84 Mid Norfolk. The broadly flat, rural landscape is an ancient countryside with a long settled agricultural character but with pressures for change posed by growth, especially around Norwich. Key characteristics relevant to the study area include; the river valleys to the west of Norwich which create a more intricate landscape relative to the more typically flat, glacial till plateau; the patchwork of fields with sinuous lanes and mixed hedges with hedgerow oaks; and the fragmented mixed deciduous and pasture woodlands.

7.3.2 In terms of local landscape character, the study area lies within Land Use Consultants (LUC) (2008) 'South Norfolk Landscape Character Assessment 'C1 Yare Tributary Farmland with Parkland' and 'F1 Yare Valley Urban Fringe' Landscape Character Areas (LCAs). The LUC landscape character assessment describes the Yare Tributary Farmland with Parkland LCA (which coincides with the mid and western extents of the Proposed Scheme) as associating with a shelving landform with a gently undulating topography created by the presence of small tributary stream valleys. It is described as being a sparsely settled landscape at an area of transition between the rural and urban landscape with small farm woodlands and intermittently wooded tributary valleys which create a quiet, rural atmosphere.

7.3.3 The eastern extents of the Proposed Scheme associate with the Yare Valley Urban Fringe local LCA characterised by areas of recent residential settlement on the perimeter of the City of Norwich at a point of transition between the Yare valley and surrounding landscape. The area is characterised by a broad semi enclosed valley with a wide, flat flood plain and enclosing valley sides, occasionally opening up to adjoining tributary river valleys. The area is strongly influenced by modern transportation corridors, in particular the Norwich Southern bypass.

7.3.4 Physical features in the immediate vicinity of the existing A47 corridor which contribute to the landscape character of the wider area include agricultural fields bounded by hedgerows and linear belts of trees. The main trunk roads, including the A47 and A11 are typically bounded by linear belts of trees and shrubs. Notable blocks of mature woodland are also located immediately adjacent to the A47/A11 Thickthorn interchange.

7.3.5 The majority of the context of the Proposed Scheme coincides with the local planning policy defined 'Norwich Southern Bypass Protection Zone' which places expectation on the preservation and enhancement of the landscape setting of the southern bypass and its associated strategic view and gateway relationships with the City of Norwich.

7.3.6 In terms of landscape designations, Intwood Hall Grade II Registered Park and Garden is located to the south-east of the existing A47/A11 Thickthorn junction, however the main visual setting associations of the hall and grounds orientate in a southerly direction, away from the Proposed Scheme.

Visual amenity

7.3.7 The southern, eastern and western extents of the study area associate with an undulating topography and extensive areas of tree cover along the main highway corridors, within field boundaries and forming distinct blocks of woodland. Consequently the extent of views is relatively limited and includes glimpsed views of highway infrastructure associated with the existing Thickthorn interchange, service area, park and ride facilities, high voltage overhead power lines and residential edge of Norwich. The northern extents of the study area include the potential for more extensive, open views across agricultural fields, though again influenced by the notable visual presence of high voltage overhead power lines.

7.3.8 The potential to experience views of the Proposed Scheme associates most notably with occupiers of residential properties and users of the local Public Rights of Way (PRoW) network. The PRoW network also includes the Tas Valley Way long distance route associated with the south-eastern extents of the Proposed Scheme area. The potential for views from residential properties includes those on the western edge of Cringleford, a smaller grouping of residential properties at the eastern end of Cantley Lane South, residential properties within the grounds of Thickthorn Hall and more widely dispersed individual properties on Cantley Lane South and Norwich Road. PRoW footpaths affording views across the study area include those linking with Cantley Lane, running alongside the railway line to Ely and crossing over the

A47 by way of a footbridge to connect with a further spur of the PRoW extending to Round House Park on the western edge of Cringleford.

7.3.9 Views of the Proposed Scheme will also be experienced by users of the Thickthorn Interchange services and park and ride facilities and by road users of the A47, A11, B1172 and Cantley Lane.

7.4 Assumptions and limitations

7.4.1 The content of the Scoping Report is based on a desk study and information gained from previous stages of design development and assessment.

7.4.2 Reference to landscape designation information and an analysis of the physical features of the local landscape have informed understanding of the likely sensitivity of the landscape character and visual receptors and the potential effects upon those assets.

7.5 Guidance and best practice

7.5.1 Guidance and best practice will be followed to industry standards, with particular reference to:

- DMRB Volume 11 Section 3 Part 5 Landscape Effects
- Interim Advice Note 135/10 (IAN 135/10) Landscape and Visual Effects Assessment
- Guidelines for Landscape and Visual Impact Assessment, Third Edition (Landscape Institute & IEMA, 2013)
- An Approach to Landscape Character Assessment (Natural England, 2014)

7.6 Consultation

7.6.1 Non-statutory public consultation was undertaken in March and April 2017. Where relevant, points arising from this previous consultation will be taken into account in the development of mitigation measures for the Proposed Scheme.

7.6.2 Further consultation will be undertaken with statutory and non-statutory consultees as part of the environmental assessment process. In particular, the Local Planning Authority and other relevant stakeholders will be consulted to; identify and agree key viewpoints to inform the assessment; consider the need for specific presentational material (such as photomontage) to assist understanding of the Proposed Scheme; review the methodology to ensure it robustly represents assessment of the potential effects of the Proposed Scheme; and provide comment on the landscape design and mitigation strategy to ensure landscape and visual effects are appropriately addressed within the design of the Proposed Scheme.

7.7 Potential effects, including monitoring and mitigation measures

Construction

Landscape effects

7.7.1 The removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds, traffic management compounds and construction lighting (see Appendix C – Lighting Impact Assessment Methodology) would potentially result in an adverse impact on local landscape elements and character during construction. In particular there would be loss of existing mature woodland to the north of the A11 (immediately south of the park and ride facility) and loss of A47 highway boundary tree and shrub cover within the highway extents between Cantley Lane and the Norwich to Ely railway line. There would also be notable loss of agricultural land immediately south of the Thickthorn interchange.

7.7.2 Proposed Scheme with Option A would, relative to Option B, result in a more extensive influence of construction effects to the south-west of the Thickthorn Interchange with associated loss of mature woodland and agricultural land. Proposed Scheme with Option A would potentially result in significant adverse landscape effects during construction.

7.7.3 Proposed Scheme with Option B would, relative to Option A, result in a more extensive influence of construction effects to the east and south-east of the Thickthorn Interchange and associate with loss of localised areas of hedgerow and agricultural land. Proposed Scheme with Option B would potentially result in significant adverse landscape effects during construction.

Visual effects

7.7.4 The removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds and construction lighting, would potentially result in adverse visual effects on residential properties, PRoW users, and commercial and road users.

7.7.5 Receptors with potential to be adversely affected by the Proposed Scheme during construction include residential properties on the western edge of Cringleford, along Cantley Lane South and Norwich Road and a residential property within the grounds of Thickthorn Hall. The potential for adverse effects would also include users of the Thickthorn Interchange services and park and ride facilities and road users of the A47, A11, B1172 and Cantley Lane. The outlying traffic management satellite compounds would also bring about the potential for adverse visual effects. This would include potential views from commercial receptors at Station Court House adjacent to the A11 to the south-west of the main Proposed Scheme area and residential receptors on Intwood Road to the south-east of the main Proposed Scheme. The south-eastern traffic management satellite compound would also be visible from the designated Registered Park and Garden grounds of Intwood Hall and the route of the Tas Valley Way PRoW.

7.7.6 Proposed Scheme with Option A would, relative to Option B, result in accentuated construction visual effects on receptors to the south-west of the Thickthorn Interchange, including residential properties along Cantley Lane South and users of the PRoW alongside the Norwich to Ely railway line. Proposed Scheme with Option A would potentially result in significant adverse visual effects during construction.

7.7.7 Proposed Scheme with Option B would, relative to Option A, result in accentuated construction visual effects on receptors to the east and south-east of the Thickthorn Interchange, including residential properties on Cantley Lane South and on the western edge of Cringleford and users of the PRoW linking Cantley Lane and Round House Park. Proposed Scheme with Option B would potentially result in significant adverse visual effects during construction.

Operation

Landscape effects

7.7.8 At year 1 of operation the juvenile state of mitigation planting associated with the Proposed Scheme would potentially result in adverse effects on landscape character due to the relative prominence of Proposed Scheme infrastructure prior to the establishment of integrating Proposed Scheme mitigation planting. The adverse effect would also associate with the initial year 1 loss of mature tree and hedgerow landscape elements relative to the existing baseline and to the loss of agricultural land.

7.7.9 By year 15 of operation, the establishment of Proposed Scheme landscape mitigation would contribute to a reduction in the extent and significance of landscape effects. There would however remain the potential for residual adverse landscape effects as an outcome of the relative increase in highway infrastructure.

7.7.10 At year 1 of operation Proposed Scheme with Option A would potentially result in significant adverse landscape effects, reducing to not significant adverse effects by year 15.

7.7.11 At year 1 of operation Proposed Scheme with Option B would potentially result in significant adverse landscape effects, reducing to negligible by year 15.

Visual effects

7.7.12 At year 1 of operation, prior to the establishment of Proposed Scheme landscape mitigation, there would be potential for adverse visual effects associated with views of the road/highway infrastructure and vehicles. Receptors with potential to be adversely affected by the Proposed Scheme during operation include residential properties on the western edge of Cringleford and along Cantley Lane South and Norwich Road. The potential for adverse effects would also include users of the Thickthorn Interchange services and park and ride facilities and road users of the A47, A11, B1172 and Cantley Lane. By year 15 of operation, the establishment of Proposed Scheme

landscape mitigation would contribute to a reduction in the extent and significance of visual effects.

7.7.13 Proposed Scheme with Option A would include the visual influence of an elevated link road connecting Cantley Lane South and Norwich Road, highway overbridges across the A11 and a footbridge over the A47. Proposed Scheme with Option A would, relative to Option B, accentuate the visual effects experienced by receptors to the south-west of the Thickthorn Interchange, including residential receptors along Cantley Lane South and along Norwich Road. At year 1 of operation Proposed Scheme with Option A would potentially result in significant adverse visual effects, reducing to not significant adverse by year 15.

7.7.14 Proposed Scheme with Option B would include the visual influence of an at grade or in cutting road and underpass structure beneath the A47 associated with a link road between Cantley Lane South and Round House roundabout. Proposed Scheme with Option B would, relative to Option A, result in accentuated operation visual effects on receptors to the east and south-east of the Thickthorn Interchange, including residential properties on Cantley Lane South and on the western edge of Cringleford and users of the PRoW linking Cantley Lane and Round House Park. Proposed Scheme with Option B would potentially result in significant adverse visual effects at year 1 and year 15 of operation.

7.7.15 There would also be potential for adverse night time visual effects as a result of the influence of vehicle headlights and potential scheme lighting on residential properties. Night time lighting effects would potentially result in significant adverse visual effects at year 1 reducing to not significant adverse by year 15 following the establishment of Proposed Scheme mitigation planting.

Summary

7.7.16 Table 7.1 provides a summary of the potential construction and operational effects of the Proposed Scheme upon the surrounding landscape and visual receptors.

Table 7.1: Summary of potential landscape and visual effects

Potential Construction Effects	Potential Operation Effects
Landscape: Construction effects associated with the removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds and construction lighting. *Option A* - Potential significant adverse impact on local landscape elements and character. *Option B* - Potential significant adverse impact on local landscape elements and character.	Landscape: Year 1 operational effects associated with a reduction in extent of tree and hedgerow cover, loss of agricultural land and prominence of highway infrastructure. *Option A* - Potential significant adverse impact on local landscape elements and character. *Option B* - Potential significant adverse impact on local landscape elements and character.

Potential Construction Effects	Potential Operation Effects
	Landscape: Year 15 operational effects associated with the relative increase in highway infrastructure. *Option A* - Potential not significant adverse impact on local landscape elements and character. *Option B* - Potential negligible impact on local landscape elements and character.
Visual: Construction effects associated with the removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds and construction lighting. Receptors with potential to be adversely affected include residential properties on the western edge of Cringleford and along Cantley Lane South and Norwich Road, users of the Thickthorn Interchange services and park and ride facilities and road users of the A47, A11, B1172 and Cantley Lane. *Option A* - Potential significant adverse impact on visual receptors. *Option B* - Potential significant adverse impact on visual receptors.	Visual: Year 1 operational effects associated with views of the road/highway infrastructure and vehicles. Receptors with potential to be adversely affected include residential properties on the western edge of Cringleford and along Cantley Lane South and Norwich Road, users of the Thickthorn Interchange services and park and ride facilities and road users of the A47, A11, B1172 and Cantley Lane. *Option A* - Potential significant adverse impact on visual receptors. *Option B* - Potential significant adverse impact on visual receptors. Visual: Year 15 operational effects associated with residual change in views following the establishment of Proposed Scheme mitigation planting. *Option A* - Potential not significant adverse impact on visual receptors. *Option B* - Potential significant adverse impact on visual receptors.

7.8 Proposed level and scope of assessment

7.8.1 Given that significant effects upon both landscape character and visual amenity are likely for the Proposed Scheme during both construction and operation and the scale of the proposed works, the Proposed Scheme meets the criteria set out in IAN 135/10 Landscape and Visual Effects Assessment for a Detailed level of assessment.

7.9 Proposed methodology including significance

7.9.1 No single prescribed methodology exists for assessing landscape and visual impact; however, the assessment will follow best practice guidelines as set out in Section 7.5.

7.9.2 A further desktop study and walkover survey will be undertaken to review and update the baseline information gathered in previous assessments. This will clarify both the study area and Zone of Theoretical Visibility (ZTV), and allow

the project Landscape Architect to undertake a local Character Assessment to understand the Landscape Value and associated sensitivity to change of each character area.

7.9.3 The ZTV will be based upon the area from which the development will theoretically be visible to a person with a viewer height of 1.6m above ground level. Digital Surface Model (DSM) data will be used to create the ZTV model. As outlined above the ZTV will be verified and refined during the site survey.

7.9.4 The significance of effect on the landscape character and its constituent elements will be determined by combining the sensitivity of the affected landscape with the magnitude of change attributable to the Proposed Scheme. The consideration of sensitivity will be determined by a combined judgement of the landscape's susceptibility and value.

7.9.5 The criteria for assessing landscape sensitivity is presented in Table 7.2, and the criteria for assessment of the magnitude of change is presented in Table 7.3.

Table 7.2: Criteria for assessing landscape sensitivity

Sensitivity	Typical Descriptors
High	Landscapes, which by nature of their character, would be unable to accommodate change of the type proposed. Typically, these would be landscapes: • With either a very simple or a very complex pattern. • With limited presence of existing built features or linear infrastructure, including highways. • Associating with areas of intimacy or tranquillity. • Of high quality with distinctive elements and features making a positive contribution to character and sense of place. • Likely to be designated e.g. National Park and Area of Outstanding Natural Beauty (AONB), but the aspects which underpin such value may also be present outside designated areas, especially at the local scale. • Areas of special recognised value through use, perception or historic and cultural associations. • Likely to contain features and elements that are rare and could not be replaced.
Medium	Landscapes, which by nature of their character, would be able to partly accommodate change of the type proposed. Typically, these would be landscapes: • With a distinct, coherent pattern. • With notable presence of existing built features or linear infrastructure, including highways. • Associating with a broad sense of enclosure brought about by landform or vegetation cover.

Sensitivity	Typical Descriptors
	• Comprised of commonplace elements and features creating generally unremarkable character but with some sense of place. • Locally designated, or their value may be expressed through non-statutory local publications. • Containing some features of value through use, perception or historic and cultural associations. • Likely to contain some features and elements that could not be replaced.
Low	Landscapes which by nature of their character would be able to accommodate change of the type proposed. Typically, these would be landscapes: • Comprised of some features and elements that are discordant, derelict or in decline, resulting in indistinct character with little or no sense of place. • Not designated. • Containing few, if any, features of value through use, perception or historic and cultural associations. • Likely to contain few, if any, features and elements that could not be replaced.

Source: Derived from IAN 135/10 with amendment

Table 7.3: Criteria for assessing magnitude of landscape change

Magnitude	Description
Major Adverse	Total loss or large-scale damage to existing character or distinctive features and elements, and/or the addition of new but uncharacteristic conspicuous features and elements.
Moderate Adverse	Partial loss or noticeable damage to existing character or distinctive features and elements, and/or the addition of new but uncharacteristic noticeable features and elements.
Minor Adverse	Slight loss or damage to existing character or features and elements, and/or the addition of new but uncharacteristic features and elements.
Negligible or No Change	Barely perceptible change or no change to existing character or elements.
Minor Beneficial	Slight improvement to character by the restoration of existing features and elements, and/or the removal of uncharacteristic features and elements, or by the addition of new characteristic elements.
Moderate Beneficial	Partial or noticeable improvement to character by the restoration of existing features and elements, and/or the removal of uncharacteristic and noticeable features and elements, or by the addition of new characteristic features.
Major Beneficial	Large scale improvement to character by the restoration of existing features and elements, and/or the removal of uncharacteristic and

Magnitude	Description
	conspicuous features and elements, or by the addition of new distinctive features.

Source: Derived from IAN 135/10 with amendment

7.9.6 Key visual receptors will be visited to identify the nature of existing view and the potential magnitude of change associated with the Proposed Scheme.

7.9.7 Visual impact significance will be determined by combining the sensitivity of the visual receptor with the magnitude of change attributable to the Proposed Scheme. The consideration of sensitivity will be determined by a combined judgement of a receptor's susceptibility and the value attached to a particular view.

7.9.8 The criteria for assessing visual sensitivity is presented in Table 7.4, and the criteria for assessment of the magnitude of change is presented in Table 7.5.

Table 7.4: Criteria for assessing visual sensitivity

Sensitivity	Typical Receptors
High	Residential properties. Users of PRoW or other recreational trails (e.g. National Trails, footpaths, bridleways etc.). Users of recreational facilities where the purpose of that recreation is enjoyment of the countryside (e.g. Country Parks, National Trust or other access land etc.). Views with a value derived from association with a heritage asset or a planning designation or where associated with a literary or artistic point of reference.
Medium	Outdoor workers. Users of scenic roads, railways or waterways or users of designated tourist routes. Schools and other institutional buildings, and their outdoor areas.
Low	Indoor workers. Users of main roads (e.g. trunk roads) or passengers in public transport on main arterial routes. Users of recreational facilities where the purpose of that recreation is not related to the view (e.g. sports facilities).

Source: Derived from IAN 135/10 with amendment

Table 7.5: Criteria for assessing magnitude of visual change

Magnitude	Description
Major Adverse	The Proposed Scheme, or a part of it, would become a dominant detracting feature or focal point within the view.
Moderate Adverse	The Proposed Scheme, or a part of it, would form a noticeable detracting feature or element within the view which would be readily apparent to the receptor.

Magnitude	Description
Minor Adverse	The Proposed Scheme, or a part of it, would be perceptible but not alter the overall balance of features and elements that comprise the existing view.
Negligible or No Change	Barely perceptible change or no change to existing views.
Minor Beneficial	The Proposed Scheme would result in a perceptible enhancement of the view but would not alter the overall balance of features and elements that comprise the existing view.
Moderate Beneficial	The Proposed Scheme would result in a noticeable enhancement of the view which would be readily apparent to the receptor.
Major Beneficial	The Proposed Scheme would result in a prominent enhancement of the view and contribute to the defining focus or feature of the view.

Source: Derived from IAN 135/10 with amendment

7.10 Conclusion

7.10.1 Given that significant effects upon both landscape character and visual amenity are likely for the Proposed Scheme during both construction and operation and the scale of the proposed works, the Proposed Scheme meets the criteria set out in IAN 135/10 LVIA for a Detailed level of assessment.

7.10.2 Assessment will be presented in the form of a Detailed LVIA as part of the ES.

8 Biodiversity

8.1 Introduction

8.1.1 This chapter presents the key ecological receptors within the footprint and surrounding areas of the Proposed Scheme. It has been prepared in accordance with DMRB Volume 11, Section 2, Part 4, DMRB Volume 11, Section 3, Part 4, and IAN 130/10, to a Scoping Level, and where necessary, the requirement for assessment to either simple or detailed level will be identified. The potential impacts on these receptors as a result of the Proposed Scheme has also been assessed. This will form the basis of any recommended further survey and assessment requirements, determine the magnitude of impacts, the requirements for mitigation measures, and overall significance of effects. Where required, assessment will be presented within the ES.

8.2 Study area

8.2.1 The following study areas have been used to gather information on ecological receptors that could be affected by the Proposed Scheme:

Table 8.1: Study area for ecological receptors

Ecological Receptor	Study Area
Internationally and nationally statutory designated nature conservation sites, including Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Ramsar (Wetlands of International Importance) Sites, National Nature Reserves (NNRs) and Sites of Special Scientific Interest (SSSIs).	2km
SAC's designated for bat populations.	30km
Statutory sites designated for bird interest.	10km
Non-statutory designated nature conservation sites including; Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and Royal Society for the Protection of Birds (RSPB) reserves.	2km
Habitat Suitability Index (HSI) assessments of waterbodies for Great Crested Newts *Triturus cristatus* (GCN).	500m
Preliminary Ecological Assessment (PEA) including Phase1 habitat survey, badger *Meles meles*, reptiles, polecat *Mustela putorius* and breeding birds.	100m
Water vole *Arvicola amphibius* and otter *Lutra lutra* survey.	250m
Aquatic invertebrates.	Wetland habitats directly impacted by the Proposed Scheme.

8.3 Existing and baseline knowledge

8.3.1 A number of nationally and locally designated sites occur within the study area, which are presented in Table 8.2.

Table 8.2: Summary of existing nature conservation baseline

Summary of Existing Baseline
• Norfolk Valley Fens SAC 15km upstream but hydrologically connected via River Yare • No SAC designated for bat populations are located within 30km of the Proposed Scheme • Eaton Chalk Pit SSSI is 1.5km to the east • Eaton Common LNR 1.4km to the east • Earlham Park Woods LNR 1.9km to the north east • Marston Marshes LNR 1.6km to the east • Meadow Farm County Wildlife Site (CWS) is adjacent to the Proposed Scheme • Intwood Carr CWS is 700m to the east • Foxburrow Meadow CWS 950m to the south • Softley Drive Meadow CWS 1.5km to the north east • Riding School Meadow CWS 1.2km to the east • Eaton Island CWS 1.3km to the east • Eaton Street Meadow CWS 1.2km to the east • Bluebell Marsh CWS 1.3km to the north east • Eaton Common CWS 1.6km to the east • Marston Marshes CWS 2km to the east • Eaton Chalk Pit CWS 2km to the east • The Carrs Woodland CWS 2.1km to the south • Swardeston Common CWS 2.4km to the south • The Heronry and Violet Grove CWS 2.5km to the north • UEA Marsh CWS 1.6km to the north east • UEA Butterfly Meadow CWS 1.7km to the north east • UEA Broad CWS 1.9km to the north east • Braymeadow CWS 1.4km to the north west • Ketteringham Hall Lake CWS 2.2km to the south west

8.3.2 The Thickthorn Stream which flows through the site is a tributary of the River Yare which is hydrologically linked to Eaton Common LNR and Marston Marshes LNR. There are no habitat or hydrological links between the Proposed Scheme and Earlham Park Woods LNR. These sites were scoped out of further assessment. However, given the links between the site of the Proposed Scheme and Eaton Common and Marston Marshes LNRs, these two sites have been scoped in for further assessment. With the exception of Meadow Farm Meadow and Intwood Carr CWS, all of the CWS were 700m or more from the Proposed Scheme and have been scoped out due to distance and lack of hydrological or habitat connectivity. Meadow Farm Meadow CWS is adjacent to the proposed Scheme whilst Intwood Carr is potentially ecologically linked to the site via a tributary of the River Yare and the habitats along the railway line and adjacent to the A47.

8.3.3 An Extended Phase 1 Habitat survey was undertaken by two suitably qualified ecologists in March 2016, in order to assess the ecological importance of the site and determine the requirement for more detailed Surveys. The full findings of the survey are discussed within the A47 Thickthorn Preliminary Ecological Appraisal (AECOM, 2016).

8.3.4 The survey work and desktop study identified suitable habitat for the following species:

- Bats
- Breeding birds
- Overwintering birds
- Great crested newts
- Badgers
- Reptiles
- Otters
- Water voles
- Polecat
- Terrestrial invertebrates
- Rare and scarce flora
- Invasive species, both terrestrial and aquatic

8.3.5 The main habitat types recorded within the study area were arable, semi-improved grassland, broadleaved woodland, including semi-natural and plantation, mixed plantation woodland, coniferous plantation, scrub, tall ruderal, standing water, buildings, marshy grassland, running water, hedgerows, veteran trees and hardstanding.

8.3.6 Surveys to date have taken place to support previous stages of design development and assessment. Surveys are also being carried out to inform the EIA, ultimately to inform production of the Environmental Statement. These have taken place in 2016 and 2017, as detailed in Table 8.3.

Table 8.3: Ecology surveys to date

Survey	Dates Undertaken	Study Area (including areas not surveyed)	Survey Methodologies (methods, frequencies etc.)
Phase 1 Habitat Survey / Preliminary Ecological Appraisal	March to July 2016	All accessible land within the footprint of the Proposed Scheme, plus a 50m buffer.	JNCC's Handbook for Phase 1 Habitat Survey - a technique for environmental audit. CIEEM's Guidelines for Preliminary Ecological Appraisal.
Phase 2 Botanical Surveys	May 2017	All accessible land within the footprint of the Proposed Scheme.	List of species using DAFOR scale (measures species abundance). Rodwell JS (2006). *National Vegetation Classification:*

Survey	Dates Undertaken	Study Area (including areas not surveyed)	Survey Methodologies (methods, frequencies etc.)
			Users' Handbook. JNCC, Peterborough.
Badgers	May 2016	All accessible land within the footprint of the Proposed Scheme, plus a 50m buffer.	Standard methodology [Harris et al (1989)]. Search for all field signs within the Study Area. Field signs include setts and other excavations, latrines, prints and paths, hairs, feeding evidence etc.
Bat Roost Appraisals	January 2017	All accessible land within the footprint of the Proposed Scheme, plus a 50m buffer.	All bat surveys have taken place in accordance with Collins, J. (ed.) (2016). Bat Surveys for Professional Ecologists: Good Practice Guidelines, 3rd edition, Bat Conservation Trust.
Bat Emergence/Re-Entry Surveys	May to September 2017	All accessible land within the footprint of the Proposed Scheme, plus a 50m buffer.	Emergence/Re-entry surveys for high habitat suitability/risk took place three times, for moderate suitability/risk two times, and for low suitability/risk once, in the period described.
Bat Activity Transect Surveys	September to October 2016 April to September 2017	All accessible land within the footprint of the Proposed Scheme, plus a 50m buffer.	All bat surveys have taken place in accordance with Collins, J. (ed.) (2016). Bat Surveys for Professional Ecologists: Good Practice Guidelines, 3rd edition, Bat Conservation Trust.
Birds - Breeding	May to June 2016 April to June 2017	All accessible land within the footprint of the Proposed Scheme, plus a 100m buffer.	Bibby *et al* (2000) and Gilbert *et al* (1998). Birds were recorded by walking, listening and scanning by eye and with binoculars. Birds were considered to be breeding if singing, displaying, carrying nest material, nests or young found, repetitively alarmed adults, disturbance displaying, carrying food or in territorial dispute.

Survey	Dates Undertaken	Study Area (including areas not surveyed)	Survey Methodologies (methods, frequencies etc.)
Birds - Overwintering	November 2016 to March 2017. Surveys were undertaken on a monthly basis i.e. three surveys were undertaken through the above period.	All accessible land within the footprint of the Proposed Scheme, plus a 100m buffer.	As the breeding bird survey above. As above, Birds were recorded by walking, listening, and scanning by eye and with binoculars. All birds were recorded, regardless of the activity/behaviour.
Reptiles	Reptile surveys commenced in May 2016, then in September and October 2016. Surveys re-commenced in April 2017, with further surveys undertaken in September/October 2017.	All accessible land within the footprint of the Proposed Scheme, plus a 50m buffer.	Froglife (1999) Advice Sheet 10 and the Herpetofauna Workers' Manual (1998). Use of refugia to attract reptiles on site, manual searches of suitable refugia present on site, checks for signs of reptile activity including sloughed skins, burrows, egg laying sites etc.; and sustained visual observation of banks/other suitable habitat within the site.
Water Vole and Otter	Spring surveys took place from April 2017 and continued until September 2017.	All accessible, suitable habitat within the footprint of the Proposed Scheme, plus a 250m buffer.	Standard water vole survey methodologies of Strachan et al. (2011) and Dean et al. (2016), searching for field signs including latrine sites, feeding stations, lawns, prints and runways. Standard otter survey methodology as identified in New Rivers and Wildlife Handbook, the Environment Agency's Fifth Otter Survey of England 2009-2010, and Monitoring the Otter, Chanin, (2003). Surveys involved searching for spraints, footprints, feeding remains, slides and haul-outs, couches and holts.
European Polecat Surveys	August to September 2017	All accessible, suitable habitat.	Presence / likely absence. Night vision cameras in suitable locations, Bated footprint traps
Terrestrial Invertebrate Surveys	August to September 2017	All accessible, suitable habitat.	

Survey	Dates Undertaken	Study Area (including areas not surveyed)	Survey Methodologies (methods, frequencies etc.)
Aquatic Invertebrate Surveys	August to September 2017	All accessible, suitable habitat.	Drake *et al* (2007).
Invasive Species surveys	No specific survey -invasive species have been identified during the PEA and as incidental sightings during other surveys.	All accessible, suitable habitat.	Environment Agency Guidelines on Managing Invasive plant species.

8.3.7 Protected species surveys are currently being undertaken for a number of species. Surveys have identified the presence of common reptiles including common lizard *Zootoca vivipara* and grass snake *Natrix natrix*. Several bat roosts have been found within trees and a common pipistrelle *Pipistrellus pipistrellus* day roost with two individuals was identified at a nearby dwelling.

8.3.8 Surveys have been completed for bats, water voles, otters, badgers, reptiles, breeding birds, overwintering birds, polecat and aquatic and terrestrial invertebrates.

8.3.9 HSI assessments indicated that there are five ponds within a 500m radius of the junction were potentially suitable for breeding great crested newt (GCN). However, subsequent eDNA surveys returned negative results. GCN are likely absent from the survey area and have been scoped out.

8.3.10 Bat surveys, including bat emergence and re-entry surveys of trees and activity surveys have confirmed one tree roost and one common pipistrelle day roost in a dwelling. These surveys have been completed in September 2017 and will inform the further surveys as well as the environmental assessment and mitigation.

8.3.11 Reptile surveys have confirmed the presence of a population of grass snake on site, with adults found in fields to the west of the A11. Common lizard has been found to the east of the A11.These surveys were completed in October 2017 and the results will inform the further surveys as well as the environmental assessment and mitigation.

8.3.12 Bird surveys have identified the Schedule 1 barn owl *Tyto alba* breeding close to Thickthorn Hall, approximately 500m to the west of the site. It is likely that the site is used by hunting barn owls. Red kite *Milvus* has been recorded on the site and kingfisher *Alcedo atthis* was recorded breeding at the fishing lake close to the rail line.

8.3.13 Badger surveys have found no evidence of badger activity to date. These surveys have been completed and will be used to inform further surveys as well as the environmental assessment and any mitigation required.

8.3.14 A dead European polecat was found approximately 1.5km north of the site along the A47. Polecat surveys during August and September 2017 have not found any evidence of presence and it is concluded that polecat is likely currently absent from the study area.

8.3.15 Water vole surveys have confirmed the presence of this species with extensive water vole activity along stream between A11 underpass and Cantley Lane. Evidence of otter *Lutra lutra* activity have also been found.

8.3.16 Surveys for terrestrial invertebrates recorded 596 species from seven survey visits. Four species of category Nationally Rare (Red Data Book) status were recorded; the ground beetle *Omophron limbatum*, the rove beetles *Cypha seminulum* and *Tachinus flavolimbatus* and the Five-banded Weevil-wasp *Cerceris quinquefasciata*. The last species is also a BAP Priority Species, covered under Section 41 of the NERC Act (2006). In addition, eighteen species of Nationally Scarce status were identified.

8.3.17 Noteworthy invertebrate assemblages were identified in the rabbit-grazed short sward grassland areas of the site. Other noteworthy fauna were also identified from smaller, less significant habitat-blocks in the survey such as the wetland areas and the hedge-lines. The plantation blocks, semi-natural woodland and improved grassland and pasture were found to be unexceptional for their invertebrate interest.

8.3.18 Overall, the site significance for invertebrates is only of local significance, but the presence of the scarce species assemblages and their associated habitats will be considered in the environmental assessment.

8.3.19 Scarce arable flora including corn spurrey *Spergula arvensis* and common cudweed *Filago vulgaris* have been found on site. Other rare/scarce flora potentially present in suitable woodland, grassland and wetland habitats. Botanical surveys were completed in summer 2017, the results will inform further surveys and the environmental assessment.

8.3.20 No invasive species have been found to date. A mature stand of Japanese knotweed *Fallopia japonica* and an area of giant hogweed *Heracleum mantegazzianum* are present just outside the study area. Invasive species surveys were completed in summer 2017.

8.3.21 A HRA Screening Report was undertaken to determine whether any adverse impacts on International or European Designated Sites (the Norfolk Valley Fens SAC via the River Yare). The HRA Screening concluded that there is not the potential for an adverse impact on the habitats and species which are a qualifying reason for selection of the European site due to distance from the Proposed Scheme. The HRA will be reviewed and updated.

8.4 Assumptions and limitations

8.4.1 It should be noted that the absence of certain protected or rare species from the Phase 1 Survey does not preclude their presence on a site. There is always the

risk of protected or rare species being over-looked, either owing to the timing of the survey or the scarcity of the species at the site.

8.4.2 Ecological surveys are ongoing and where undertaken field surveys were confined to locations where landowner permission has been obtained. Surveys will continue throughout 2018 with access sought to areas previously un-surveyed.

8.4.3 In-channel works will be required for the culvert extension and stream diversion, between the A11 and Cantley Lane south.

8.4.4 A number of the detailed surveys were started late in the season (mid-July), meaning that only half a season of data is available. To provide robustness to these surveys, it is intended to continue early season surveys in 2018 (as described below) to ensure that the sufficient surveys effort has been undertaken, and that surveys at the sensitive early part of the season are included for assessment.

8.4.5 The current programme is such that the surveys undertaken during the first half of 2018 will be used alongside those surveys already completed in 2016 and 2017, to inform the production of the ES. Surveys will continue through 2018 to inform a robust baseline against with future monitoring can take place, and to inform any European Protected Species (EPS) licences that would be required.

8.5 Guidance and best practice

8.5.1 Assessment will be undertaken in accordance with the following guidance, and targeted surveys for protected species will be necessary as part of this assessment:

- DMRB Volume 11 Section 3 Part 4 Ecology and Nature Conservation
- HA (2010) IAN 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2016) Guidelines for Ecological Impact Assessment in the UK, 2nd Edition
- CIEEM Sources of Survey Methods

8.6 Consultation

8.6.1 Detailed consultations have yet to be undertaken with various statutory and non-statutory bodies including Natural England, Environment Agency, Norfolk County Council, Norfolk Wildlife Trust and the RSPB. These organisations will need to be consulted fully during the environmental assessment process and their responses will be included in the associated reporting.

8.6.2 Consultation with other groups may also be required to fully develop robust mitigation measures, including:

- Local wildlife organisations and groups

- Landowners

8.7 Potential effects, including monitoring and mitigation measures

Both Option A and B

Construction

8.7.1 Due to the proximity of designated sites, including some partly with or immediately adjacent, to the Proposed Scheme (Appendix B), appropriate avoidance measures, mitigation and compensation will be assessed in detail with the final design.

8.7.2 There are eight international/European statutory designated sites within 30km of the site: Waveney & Little Ouse Valley Fens Special Area of Conservation (SAC); The Broads SAC; River Wensum SAC; Redgrave & South Lopham Fens Ramsar; Norfolk Valley Fens SAC; Broadland Special Protection Area (SPA) and Ramsar; Breydon Water SPA and Ramsar; and Breckland SAC and SPA. None of the SAC sites are designated for bats. There are however potential hydrological links between the Norfolk Valley Fens SAC and the site. This site is scoped in for assessment. There are no other effective pathways between the other International/European statutorily designated sites and the Thickthorn site. The other sites are scoped out from further assessment. The scale of this impact is not expected to be significant with control measures in place.

8.7.3 The Stage 2 Habitats Regulations Assessment (HRA) concluded that there were no likely significant effects upon International and European designated sites (Norfolk Valley Fens SAC). This assessment will be updated within the ES.

8.7.4 There is one nationally designated site located within 2km of the site; Eaton Chalk Pit Site of Special Scientific Interest (SSSI). The SSSI is located approximately 1.5km to the east of the site and is designated for its underground chalk caves providing a winter hibernation site for three bat species. Bats from this SSSI potentially use the Thickthorn site for summer roosting, commuting and foraging. Bat activity surveys will be undertaken during 2017 and the impact of any habitat loss, disturbance through construction and/or operation of the Proposed Scheme (e.g. lighting) will be considered in the Biodiversity and Landscape chapters of the ES. It is anticipated that impacts upon commuting and foraging bats will not be significant.

8.7.5 There are three Local Nature Reserves (LNRs) located within 2km of the Proposed Scheme; Eaton Common LNR, Earlham Park Woods LNR and Marston Marshes LNR. The River Yare is hydrologically linked to Eaton Common and Marston Marshes LNRs. Otter has been recently recorded at Marston Marshes LNR and is likely to be present at Eaton Common LNR. The site of the Proposed Scheme is within the home range of resident otters at these LNRs. Otter commuting and foraging may be disturbed by the Proposed Scheme. Otter surveys are on-going and appropriate mitigation, including pollution control, restriction of work at night, covering of trenches and a mammal friendly lighting scheme will minimise impact to the otters using these two LNRs.

8.7.6 Mitigation to avoid pollution will also prevent significant adverse impacts upon water vole, frogs and newts at Marston Marshes LNR. Marston Marshes LNR is beyond the zone of influence for amphibians and water voles therefore there should be no other potential impacts.

8.7.7 Desmoulins' whorl snail *Vertigo moulinsiana* has been recently recorded at Marston Marshes LNR. The snail is classified as 'rare' in the British Red Data Book and appears to need very humid conditions. It is found only at the edges of rivers, wet fens, swamps and around the swampy margins of ponds and ditches where the ground water is near the surface. For most of the warmer part of the year, Desmoulins' whorl snail lives on the leaves of tall wetland plants, such as reed sweet-grass *Glyceria maxima*, greater pond sedge *Carex riparia* and lesser pond sedge *Carex acutiformis,* common reed *Phragmites australis* and, at some sites, tussock sedge *Carex stricta* and saw sedge *Cladium mariscus*. The snail's distribution closely follows lowland rivers and floodplains. Nearly all its colonies are in the limestone or chalk areas of southern and eastern England.

8.7.8 There are no habitat links or hydrological links from Earlham Park Woods to the site. This site is scoped out of further assessment.

8.7.9 Direct impacts are anticipated on a non-statutory designated site (Meadow Farm Meadow CWS). These include habitat loss and increased levels of disturbance to protected species associated with the CWS. This may be characterised as of medium minor negative significance. The impact may be mitigated by measures such as:

- Habitat replacement and/or habitat improvement
- Timing of works to avoid sensitive periods for associated species

8.7.10 The Proposed Scheme is not anticipated to directly or indirectly impact any of the other CWS due to distance and limited ecological connectivity.

8.7.11 Appropriate mitigation and compensation for impacted habitats will be assessed in more detail with the final design and will be reported in the ES. However, mitigation is likely to include habitat replacement where priority habitat is directly impacted by land-take. Impacts on running water habitats and aquatic species may be mitigated against by adhering to pollution prevention measures identified in Chapter 13 Road Drainage and the Water Environment.

8.7.12 During the construction phase, vegetation clearance is likely to be required for Proposed Scheme. This could result in the loss of a number of veteran trees and directly reduce and fragment the available terrestrial habitat for species, such as badgers, reptiles, otters, bats, terrestrial invertebrates and breeding and overwintering birds. Removal of trees could result in the loss of at least one identified bat roost.

8.7.13 Construction will result in direct loss of woodland and scrub habitat that is used by a variety of common and widespread breeding species recorded during the surveys. It may also result in noise and other disturbance to species of

conservation concern. This is likely to result in a medium minor negative impact. However, Norfolk Valley Fens SAC qualifying species are unlikely to be impacted due to distance and habitats near to the junction are suboptimal for qualifying species.

8.7.14 There is unlikely to be a direct loss of habitats of great value to foraging and roosting birds in winter. These may be subject to increased noise disturbance during operation of the Proposed Scheme, although this is unlikely to be significant due to the availability of alternative suitable habitat in the area.

8.7.15 Specific bat mitigation will likely be required to some extent dependant on the final design and impacts, this may include creating, restoring or improving roosts (bat boxes, bat bricks in new or existing structures) or creating, restoring or enhancing habitat to facilitate foraging and/or commuting. Any loss of bat roosts will require appropriate mitigation and licensing from Natural England.

8.7.16 Development adjacent to Thickthorn Stream has the potential to impact water voles, otter, breeding and overwintering birds, aquatic and terrestrial invertebrates and fish. Specific mitigation for otter and water vole, including any licensing requirements, will be addressed in the ES.

8.7.17 Construction impacts may include increased risk of a pollution incident, such as contaminated land run off or spills/leaks of oils and fuels, and increased airborne pollutants into adjacent habitats which support these species. Changes in the drainage condition have the potential to have a negative impact upon aquatic vegetation fish, aquatic invertebrates, wildfowl, otters and water voles.

8.7.18 Any night-time works required may directly disturb nocturnal species such as bats and badgers as a result of increased lighting pollution, noise and vibration. This disturbance could potentially contribute to the displacement of this species from the area. During construction, if works are to take place during the night, any lighting required should be managed to avoid spill onto ecological features (note Appendix C – Lighting Impact Assessment Methodology). The impact can be minimised through the use of hoods, cowls or shields to prevent back spill. Additional best practice measures would also be included within and implemented through a CEMP so as to manage and minimise adverse construction stage effects. Measures could include the presence of an ecological clerk of works, toolbox talks, the sensitive timing of works and phased, supervised vegetation clearance. Licences granted from Natural England with respect to protected species may also be required.

Cantley Lane Option A

Construction

8.7.19 Option A would result in the direct loss of a range of habitats including broadleaved semi-natural woodland, mixed and coniferous plantation woodland, semi-improved neutral grassland, scrub and arable land. There would be the loss of several trees, including a veteran oak, and loss of sections of hedgerow. The loss of and disturbance to this range of habitat types would have a greater

impact upon breeding, overwintering, passage and foraging birds, including barn owls and raptors, than Option B.

8.7.20 There is the potential for Option A to result in a greater impact on bats than Option B due to the loss of a number of trees with bat roost potential and significant habitat loss and disturbance to bat foraging and commuting areas, including hedgerows and the Thickthorn Stream.

8.7.21 Construction would be close to the Thickthorn Stream which supports a population of water vole. Option A could result in significant damage or disturbance to the water voles or their habitat through direct damage or pollutants such as spillages or dust. Robust pollution control measures would be required. Damage to water voles or their habitat may require an agreed method statement and licencing by Natural England. Mitigation could involve establishment of alternative habitat and water vole translocation under licence. Impacts upon water vole are classified as high intermediate negative

8.7.22 There is also the potential for works in close proximity to the watercourse to impact otter. Whilst no otter holts, natal dens or couches have been found, signs of otter activity (spraints) are present and Thickthorn Stream is likely to be an otter commuting and foraging area. Construction could potentially impact otters through disturbance, disruption of commuting route or indirect impacts through pollution. Restriction on night working and lighting at night would reduce the potential impact on otters. Impacts upon otter are classified as medium/ minor negative.

8.7.23 The loss of areas of semi-improved grassland could have an adverse impact upon the notable terrestrial invertebrate communities at the site. These communities include a number of nationally rare species. Loss of key terrestrial invertebrate habitat is assessed as being of high intermediate negative significance**.**

Operation

8.7.24 Cantley Lane Option A would result in the permanent loss and severance of habitats including broadleaved semi-natural woodland, semi-improved grassland, veteran tree and hedgerows. In the absence of mitigation, the permanent loss of habitat suitable for protected species has the potential to adversely affect individual species and their conservation status.

8.7.25 Mitigation, as described in 8.7.29 would minimise the impact with the aim of ensuring no net loss of biodiversity and retaining habitat connectivity where possible.

8.7.26 In the absence of appropriate design and treatment of run-off and other potential pollutants, operational effects could include significant medium intermediate negative impacts upon water vole, otter, wildfowl and aquatic invertebrates.

Cantley Lane Option B

Construction

8.7.27 Option B would mainly result in the loss of arable land with small areas of plantation woodland, semi-improved grassland and hedgerow impacted. There would be some impact upon breeding, overwintering and foraging birds, and foraging and commuting bats, but these impacts are not considered likely to be significant.

8.7.28 There would be no impacts upon water vole or otter resulting from the construction of Cantley Lane Option B, neither would there be significant impacts upon terrestrial invertebrates as most of the land take would be arable land.

Operation

8.7.29 Once operational the Proposed Scheme would result in the permanent loss and potential severance of habitats of biodiversity value such as broad-leaved semi-natural woodland, semi-improved grassland, arable, and hedgerows. In the absence of mitigation, the permanent loss of habitat suitable for protected species has the potential to adversely affect individual species and their conservation status. As a result, it is anticipated that there is the potential for significant adverse effects upon nature conservation features once operational which warrants assessment and the development of mitigation measures. Such measures to minimise effects and to ensure that there is no net loss of biodiversity would be incorporated within the Proposed Scheme design and reported in the ES as appropriate. This could include the following measures:

- Habitat recreation and enhancement
- An appropriate ecological design
- An appropriate option design to ensure that irreplaceable features are avoided or fully compensated

8.7.30 There are also likely to be impacts during the operational phase as a result of any proposed new lighting or changes to existing lighting. This may result in adverse impacts upon potential bat roosts or foraging routes and otter or badger activity. The preliminary lighting design will conform to maximum allowable obtrusive lighting levels and will provide recommended luminaire types, mounting heights and angles for use within various areas of the Proposed Scheme. The scale of this impact is not expected to be significant with these measures in place.

8.8 Proposed level and scope of assessment

8.8.1 It is proposed that a number of protected species surveys will be undertaken, for the following reasons:

- Preparation of the Biodiversity chapter of the Environmental Statement

- To inform any necessary European Protected Species (EPS) licence applications (and preceding ghost EPS license applications to support the DCO application process)
- To inform the production of the HRA
- To inform the inclusion of suitable mitigation measures within the Proposed Scheme design
- To provide up-to-date ecological data on which construction-phase and post-construction monitoring can be based

8.8.2 Building on the information provided in Table 8.3, detailing completed and ongoing ecological surveys, it is proposed that the following surveys take place in 2018:

Phase 1 Habitat survey

8.8.3 This will take place to update existing survey data, to the geographical extents used to date. This will take place in spring 2018.

Badgers

8.8.4 This will take place to update existing survey data. Badgers are a mobile species, and there would be implications for careful consideration should they be found in the study area. This will take place in spring 2018.

Bats

8.8.5 A number of bat surveys will take place to update the existing survey data and monitor activity at the known roost sites. It is proposed that emergence/re-entry surveys would be carried out for high and medium potential trees, and high, medium and low potential buildings and structures. These surveys would take place between May and August 2018 and May and August 2019.

8.8.6 In addition, monthly transects and the associated static monitoring would take place, between May and September 2018.

8.8.7 All surveys will be to the BCT guidelines as detailed below as a minimum, with additional surveys proportional to the factors that the EPS Licence application will consider.

Overwintering birds

8.8.8 Overwintering bird surveys are proposed to take place over winter of 2017/18. They began in October 2017, taking place monthly for six months. The survey methodology (times, durations, survey locations, recording methods, acceptable weather conditions etc.) would replicate that used to date.

Breeding bird surveys

8.8.9 Breeding bird surveys will be undertaken from March 2018 to August 2018. Surveys undertaken in 2017 will only provide limited data as they started very late in the season. Surveys throughout the bird breeding season are proposed to inform mitigation. These would also replicate the survey methodology used to date.

Water voles and otters

8.8.10 The mobile nature of these species (particularly otter), the high levels of protection, and the need for dedicated mitigation and potential licensing means that surveys will be carried out from April to September 2018.

8.8.11 It is not proposed to carry out the following surveys:

- Phase 2 Botanical Surveys – survey data is unlikely to change. Limited flora communities, of low to moderate ecological value only.
- Aquatic invertebrate surveys – It is assumed that the survey data from the 2017 surveys will be sufficient to inform the environmental assessment unless the 2017 surveys indicate that additional surveys are required to monitor a protected, rare or endangered species. Communities not likely to change/move in any significant way.
- Hedgerow surveys – It is assumed that the survey data from the 2016 Phase 1 survey will be sufficient to inform the environmental assessment.
- Reptiles – It is assumed that the survey data from the 2017 surveys will be sufficient to inform the environmental assessment and allow accurate assessment of impacts to be made.
- Great crested newt surveys- eDNA results indicate that this species is likely absent.
- Terrestrial invertebrate surveys – as with the aquatic invertebrates, it is assumed that the survey data from the 2017 surveys will be sufficient to inform the environmental assessment so no further surveys are proposed unless the 2017 indicate that additional surveys are required to monitor a protected, rare or endangered species.
- Polecat surveys - surveys in 2017 indicate that polecat is likely absent.

Survey methodologies

8.8.12 All protected species surveys proposed for 2018 onwards will be to the standard methodologies as described of those that have already taken place, as described in Table 8.3.

8.8.13 In addition, and where relevant, surveys will draw on the Ecological Impact Assessment methodology set out in the Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater and Coastal, Second Edition (January 2016).

Evaluation of effects

8.8.14 Potential impacts arising from the Proposed Scheme will be addressed: direct or indirect, temporary, short term or long-term, and the effects of any environmental mitigation measures including alterations to the Proposed Scheme design will also be considered.

8.8.15 Impacts will be assessed for all ecological features (species, habitats and designated sites) identified during the assessment which are considered to be significant.

8.8.16 The significance of any impacts will be based on the consideration of the nature conservation value of the features (Table 8.4) and the magnitude of the impact on them (Table 8.5). These will be combined to give an overall appraisal category in the final ES (Table 1.2).

Table 8.4: Criteria for determining nature conservation value of features

Value	Criteria	Examples
Very High	High importance and rarity, international scale and limited potential for substitution	An internationally designated site or candidate site: • A viable area of a habitat type listed in Annex I of the Habitats Directive, or smaller areas of such habitat which are essential to maintain the viability of a larger whole. • Any regularly occurring population of an internationally important species, which is threatened or rare in the UK i.e. UK BAP, red data book species.
High	High importance and rarity, national scale, or regional scale with limited potential for substitution	A nationally designated site or a discrete area, which meets the published selection criteria for national designation, including: • Ancient woodland on Natural England register. • A viable area of a priority habitat identified in the UK BAP. • Any regularly occurring population of a nationally or regionally important species which is threatened or rare in the county (local BAP).
Medium	High or medium importance and rarity, local or regional scale, and limited potential for substitution	Any regularly occurring, locally and regionally significant population of a species listed as being nationally scarce: • Any County and other sites which the designating authority has determined meet the published ecological selection criteria for designation, including county wildlife sites. • A regularly occurring, locally significant number of a County and regional important species.
Low	Low or medium importance and rarity, local scale	• A diverse and/or ecologically valuable hedgerow network. • Local designated sites including Roadside Nature Reserves.
Negligible	Very low importance and rarity, local scale	Other sites, species or habitats with little or no local biodiversity and earth heritage interest.

Table 8.5: Criteria for determining magnitude of impact

Magnitude	Criteria
Major negative	The proposal (either on its own or with other proposals) may adversely affect the integrity of the site, in terms of the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the population levels of species of interest.
Intermediate negative	The site's integrity will not be adversely affected, but the effect on the site is likely to be significant in terms of its ecological objectives. However, if, in the light of full information, it cannot be clearly demonstrated that the proposal will not have an adverse effect on integrity, then the impact should be assessed as major negative.
Minor negative	Neither of the above apply, but some minor negative impact is evident. (In the case of Natura 2000 sites a further appropriate assessment may be necessary if detailed plans are not yet available).
Neutral	No observable impact in either direction.
Positive	Impacts which provide a net gain for wildlife overall.

8.8.17 The significance of the impacts will be ascertained using the criteria listed in Table 8.6.

Table 8.6: Description of the significance of effect categories

Significance category	Typical description of effect
Very Large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision making process. These effects are generally, but not exclusively, associated with sites or features of international importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Large	These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important, but are unlikely to be highly important to the decision-making factors. The cumulative effects of such factors may influence the decision making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
Slight	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or with the margin of forecasting error.

8.8.18 The significance of the impacts will be considered during the following phases of the project:

Construction phase

8.8.19 This will take account of the operations required to construct the Proposed Scheme including the potential sites for Contractors' compounds, haul routes as well as borrow and disposal areas.

Operational phase

8.8.20 This will look at the land take required to construct the project together with any drainage and other ancillary works. It will consider the impact of traffic and other related effects on the designated sites, habitat and species. The ongoing, long term maintenance requirements and actions will also be considered.

8.8.21 Assessments for the operational phase will include one for the opening year of the Proposed Scheme, and one for the design year, 15 years after opening. This will allow any changes in impacts to be identified. For example, this will consider the establishment of any habitat created as part of the Proposed Scheme, which is unlikely to be functioning at opening year, but by 15 years will be maturing well, and becoming well used by protected and other species.

8.8.22 Similarly, it is likely that traffic flows will change between opening year and design year, with a corresponding potential change in impacts. As with above, the two assessments will draw out any changes in the magnitude of impacts etc.

8.8.23 Table 8.7 provides a summary of potential construction and operational effects for biodiversity for the Proposed Scheme.

Table 8.7: Summary of potential biodiversity effects

Potential Construction Effects	Potential Operation Effects
Potentially significant direct and indirect impacts to protected species, designated sites and sensitive habitats.	Potentially significant direct and indirect impacts to protected species, designated sites and sensitive habitats.

8.8.24 The scope of the works and the potential significance of direct and indirect effects warrants assessment to a Detailed level, in accordance with IAN 130/10, as there is potential to cause disruption to protected species, designated sites and sensitive habitats as a result of the Proposed Scheme.

8.9 Proposed methodology including significance

8.9.1 The survey and assessment would be undertaken in line with best practice guidelines as recommended by the Chartered Institute of Ecology and Environmental Management (CIEEM), which coincide with the recommended approaches to survey methodologies detailed in the DMRB, Volume 11, Section 3, Chapter 7, parts 7.9-7.19. Exceptions may occur in circumstances where professional judgement is used to select an alternative methodology deemed to be more suitable for this particular site, if approved or suggested by the relevant consultees.

8.9.2 The published CIEEM guidelines (CIEEM, 2016) utilise an approach to valuing ecological features that involves the use of professional judgment, based on available guidance and information, together with advice from experts who know the area in which the study area sits and/or the distribution and status of the features that are being considered. Significance of effects would be

assessed in accordance with DMRB guidance, which also relies on professional judgment and the advice and views of appropriate statutory agencies and other consultees on local ecological status, in its approach to assigning value.

8.10 Conclusion

8.10.1 There is potential for significant direct and indirect effects to protected species, designated sites, and sensitive habitats as a result of the Proposed Scheme. Subsequently, this warrants further assessment to a Detailed level, in accordance with IAN 130/10.

8.10.2 This assessment will be presented within an ES.

9 Geology & Soils

9.1 Introduction

9.1.1 This chapter assesses the geology and soils issues (including contaminated land) which may impact, or may be impacted by, the construction and operation of the Proposed Scheme. This Chapter has been prepared in accordance with DMRB Volume 11, Section 2, Part 4, DMRB Volume 11, Section 3, Part 11, to a Scoping Level. The Proposed Scheme could have an impact upon both the geology and soils of the area, and constraints could be imposed on Proposed Scheme construction as a result of existing ground conditions. The potential requirement for assessment to either Simple or Detailed level will therefore be identified. Where required, this will be presented within the ES

9.1.2 The effects of the Proposed Scheme upon agricultural land have been assessed in Chapter 12 People and Communities and are not considered in this chapter.

9.2 Study area

9.2.1 The study area for this assessment considers all locations where physical works and ground disturbance would take place, and in addition extends to 1km beyond this in order to identify any past pollution incidents which may have affected soil within the works area.

9.3 Existing and baseline knowledge

9.3.1 Sources of information used in this Chapter include previous reporting, historical and geological mapping and online data sources. Key sources used include:

- Environmental Constraints Plan (refer to Appendix B).
- A47-A12 Schemes, Thickthorn Junction Improvements Preliminary Sources Study Report (PSSR) (Document Ref: HE551492-ACM-HGT-TJ-RP-CE-00001) (HAGDMS:29915).
- Envirocheck Report (Landmark, 2017).
- Unexploded ordnance preliminary threat assessment (HAGDMS:29967) (Landmark, 2017).

9.3.2 Baseline data for the Proposed Scheme can be found in Table 9.1.

Table 9.1: Baseline data

Aspect	Details	
Geology	**Solid Geology** - The solid geology comprises chalk of the White Sub-Group, formerly known as the Upper Chalk Formation. The BGS lexicon indicates that the sub-group includes the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation. The Chalk is exposed beneath the A47 route immediately to the north and south of the Breckland Railway (Norwich – Ely) railway line. The elevation of the Chalk rockhead varies from around 18mAOD at Thickthorn Interchange to 1mAOD immediately south-west of the A47 railway bridge. The existing boreholes around the A47 railway bridge indicate a difference in Chalk rockhead elevation north and south of the railway; to the north of the railway rockhead, is around 8.7mAOD whereas to the south, it varies from 1m to 5mAOD. There is, therefore, potential for variation in rockhead elevation over short distances. **Superficial Deposits** – The superficial geology consists of alluvium (locally present), glacial sand and gravel (Sheringham Cliffs Formation 5-6m in thickness) and glacial till (Lowestoft Formation approximately 8-10m in thickness). The BGS mapping indicates the interchange and an area extending approximately 350m to the south is underlain by the Lowestoft Formation. Further south and north of the interchange both the A11 and A47 are indicated to be underlain by the Sheringham Cliffs Formation. Alluvium comprising clay, silt, sand and gravel is present along the line of the watercourse (Cantley Brook) 700m south west of the interchange under the A11 and under the A47 to the south east. This tract of alluvium follows the course of Cantley Brook which flows alongside the Breckland Railway (Norwich – Ely) eastwards towards the River Yare.	
Sites of Geological Interest	Historic Quarrying	A gravel pit is shown on the historical OS maps east of Cantley Lane South and the current footbridge, immediately south of the A47. The pit is first identified on the 1993 1:2,500 map edition and although its footprint is shown on the 2000 1:10,000 map it cannot be identified on the 1999 or current aerial photography, suggesting that the pit is now infilled. As the time of operation of the gravel pit roughly coincides with the construction of the A47 it is thought that it may have been used as a borrow pit for the Proposed Scheme. A gravel pit is recorded on old OS plans north of Cantley Brook close to where it is culverted below the A11 adjacent to the eastern edge of the A11. This subsequently became a landfill site (see below).
	Local geological	There are no Sites of Special Scientific Interest (SSSIs) or sites of geological interest within 2km of Thickthorn junction. However, the proposed road works do fall into the wider SSSI Impact Risk Zones designated around a number of SSSIs mainly relating to chalk pits or ecological systems feeding from the Chalk aquifer.
	BGS Recorded	According to the Envirocheck report five BGS mineral sites have been recorded in the area of study. The status for all the mineral sites is given as ‘ceased’. It is considered that the workings exploited the glacial, Sheringham Cliffs Formation.

Aspect	Details
Hydrogeology	The study area is underlain by a Principal Aquifer (Chalk) which is highly permeable. This formation is overlain by low permeability drift deposits (glacial silt and clay) in the vicinity of Thickthorn Interchange and high permeability deposits (glacial sand and gravel) further to the north, east and south. The superficial deposits are designated a 'Secondary A Aquifer (Sheringham Cliffs Formation) and 'Secondary (Undifferentiated)' Aquifer (Lowestoft Formation). The Environment Agency classifies the Chalk bedrock as a Principal Aquifer i.e. a major aquifer that may support water supply on a strategic scale. The superficial deposits are classified as Secondary Undifferentiated and Secondary A aquifers i.e. minor aquifers where permeable layers may support local water supply or base flow to rivers. The area north-west of the A11 at Thickthorn Interchange is denoted as an Outer (Zone 2) Source Protection Zone whereas land south east of the A11 is outside the Source Protection Zone. The groundwater vulnerability maps show the area to be underlain by a Major Aquifer (Chalk) of intermediate vulnerability. The available borehole information indicates the groundwater table lies within the Chalk at approximately 15m AOD (16mbgl) at the Thickthorn interchange reducing to approximately 10m AOD (2mbgl) within the superficial deposits overlying the Chalk at the A47 railway crossing.
Hydrology	The south east flowing River Yare is located approximately 1.5km north east from the study area. The Yare valley divides Norwich and Cringleford. Cantley Brook, an east flowing tributary of the River Yare lies approximately 0.6km south of the junction This tributary includes a number of secondary and tertiary rivers, most notably to the east of the site, near Meadow farm drive and Cringleford Hall. See Chapter 12 Road Drainage and the Water Environment for more information.
Soil Survey	Land adjacent to the existing road network classifies as Grade 3 Agricultural Land. Some areas north of the A47 Thickthorn Interchange and east of the Norwich-Ely railway line have been mapped in more detail according to the new Agricultural Land Classification (ALC) system and have been classified as Grades 2, 3A and 3B, with Grades 1, 2 and 3A designated as Best and Most Versatile Agricultural Land.
Landfill Records	An historic landfill site is recorded on old OS plans and by the Environment Agency north of Cantley Brook close to where it is culverted below the A11 adjacent to the eastern edge of the A11(618,161.75E;304,971.25N). Cantley Lane landfill was operated between 1961 and 1969 receiving inert, industrial, commercial and household wastes. There are no details in the PSSR of any monitoring data or any details of environmental / pollution control measures (e.g. landfill liner or peripheral gas vent trench).

Aspect	Details
Current Land Use and Man Made Features	The greater area surrounding Thickthorn Junction is mainly agricultural, with parts occupied by residential and commercial structures. The area around Newmarket Road at the east of the site is mainly residential with agricultural land occupying the parts adjacent to the roundabout. South of the roundabout, between A11 and Cantley Lane Street, a number of cottages are present. East of the junction a large commercial complex exists. Two sites of antiquity ('Tumulus') are shown on OS mapping. These are situated at Cantley Wood.
Route History	The historical development of the area has been summarised from historical mapping contained within the Landmark Envirocheck Report. Prior to the construction of the A11 Wymondham to Cringleford improvement in the 1980's the area of Thickthorn Interchange was mixed farmland, traversed by the A11 Norwich Road and Cantley Lane. The improvement established the A11 on its current alignment as a dual carriage road, and also saw the construction of the Thickthorn Interchange allowing traffic to access local routes into Hethersett and to Cantley Road from the new dual carriageway. The construction of the Norwich Southern Bypass (A47) in the early 1990's saw the remodelling and enlargement of the interchange to accommodate the A47 embankment, overbridges and slip roads. A service area has been established for some time between the A11 northbound and B1172, immediately behind the cut slopes of the interchange circulatory. A Park and Ride facility is present adjacent to the service area which resulted in some remodelling of the B1172 approach to the interchange. The disused Cantley Lane landfill site is located in a former gravel pit at Cantley Wood and was in operation between 1961 and 1969. The Great Eastern Railway is shown on the earliest OS maps examined which date to 1887. This is now called the Breckland Railway (Norwich to Ely).

Aspect	Details
Potential Contamination Risks	No site-specific baseline land quality data has been obtained for the PSSR. Theoretical potential contamination risks to site users, construction workers and the wider environment including controlled waters include: **Option B –** The alignment between Ch.350 and 500 traverses an infilled former gravel pit which may be a former 'borrow-pit' for highway construction. The pit backfill material is, however, unknown. Depending on the nature of the infill material, the potential exists for short-term risks to ground workers, as well as long-term leachate generation and pollution of groundwater below the infilled pit which is a Secondary 'A' Aquifer. Cantley Brook is in close proximity and may be in hydraulic continuity. If this is the case then a second potential contaminant linkage may exist. **Option A** - The alignment between Ch.150 and 300 closely approaches the historical landfill site at Cantley Lane located within a former gravel pit. This is also the case for the proposed widening of the A11 at the proposed Cantley Lane overbridge. The landfill contains domestic, industrial, commercial and inert waste streams. It is likely that the landfill remains a significant source of gas and leachate given its age and waste composition. The potential exists for pollution of groundwater below the infilled pit which is a Secondary 'A' Aquifer. Cantley Brook is in close proximity and may be in hydraulic continuity. If this is the case then a second potential contaminant linkage may exist. The filling station at the services area is considered to be located remote from the proposed improvements work and, therefore, unlikely to represent a plausible risk.

9.4 Assumptions and limitations

9.4.1 The baseline information on the Proposed Scheme has been based on a desk study of currently available information at the time of writing.

9.4.2 To the extent that this Chapter is based on information supplied by other parties, it has been assumed that this information is complete and correct. All sources used have been listed within Section 9.3.

9.4.3 Reported baseline conditions from site walkovers have been assumed to be accurate, however owing to the dynamic nature of the environment, conditions may change during the construction and operational phases.

9.4.4 To the extent that this Chapter uses information obtained from a Ground Investigation (GI), persons using or relying on it should recognise that any such investigation can examine only a fraction of the subsurface conditions.

9.4.5 In relation to contaminated land, mapping and site walkovers may not always identify small areas of historic/hidden contamination and there is the potential for previously unidentified contamination to be encountered during the construction process.

9.4.6 A ground investigation will need to be undertaken to confirm the ground conditions in the vicinity of the Proposed Scheme and establish whether any contamination is present in near surface soils.

9.5 Guidance and best practice

9.5.1 The assessment will be undertaken in accordance with the published standards and guidance, with particular reference to:

- DMRB Volume 11 Section 3 Part 11 Geology and Soils
- Environmental Protection Act 1990 (as amended by the Environment Act 1995)
- Environmental Protection (Duty of Care) Regulations 1991 (as amended 2003)

9.6 Consultation

9.6.1 Consultation with the local authority and Environment Agency will be necessary to discuss the impact of the Proposed Scheme on the former Cantley Lane landfill site and vice versa. This consultation would be undertaken for the Preferred Scheme.

9.7 Potential effects, including monitoring and mitigation measures

Construction

9.7.1 Excavation works associated with the Proposed Scheme have the potential to directly damage any underlying geological features. However, since the Proposed Scheme is not located within a geologically protected site, and there are no important geological deposits present on site, it is anticipated that there would be no significant direct impacts upon geology during construction.

9.7.2 Option A is likely to disturb the former Cantley Lane landfill as the proposed earthworks directly encroach on the south-western extent of this historical landfill. This is also the case for the proposed widening of the A11 at the proposed Cantley Lane overbridge. The landfill contains domestic, industrial, commercial and inert waste streams. It is likely that the landfill remains a significant source of gas and leachate given its age and waste composition.

9.7.3 Further examination of the associated potential risks is recommended in accordance with good practice. Further work comprising site reconnaissance, intrusive investigation, sampling and analysis is necessary to support an environmental risk assessment. This will be incorporated into proposed ground investigation to supplement the existing geotechnical data for design purposes. There are several issues for further examination and investigation including:

- The performance and integrity of any gas/leachate system.
- The characterisation of waste for disposal.
- Extent, depth and composition of waste materials.
- Monitoring of landfill gases and vapours.
- Monitoring of groundwater / leachate quality and depth.
- Environmental risk assessment considering short-term and chronic risks to controlled waters, ecosystems and health and safety risks including odour and public nuisance issues.
- Design parameters for engineered remediation works to mitigate unacceptable risks, which may include a cover layer over residual waste with drainage to minimise infiltration, and in-ground cut-off / vent trenches.

9.7.4 Similar consideration will be provided regarding the infilled pit which underlies the Proposed Scheme with Option B, although associated risks are likely to be relatively low. This is based on the information currently available.

9.7.5 The findings of the environmental risk assessment would identify the requirement and scope of any necessary remediation works. The remediation strategy should examine feasible and sustainable options to manage, remove/dispose or treat identified contaminated material where it is cost effective and practicable to do so. These techniques could include a range of biological, chemical and physical treatments such as biopiles, air sparging or soil washing. Engineered remediation works to mitigate unacceptable risks, which may include a cover layer over residual waste with drainage to minimise infiltration, and in-ground cut-off / vent trenches may also be appropriate.

9.7.6 The strategy should also address any regulatory requirements under development control or environmental permitting and include proposals for managing any previously unknown contamination encountered during the works.

9.7.7 Where practicable, material should be re-used on site provided performance criteria are met with respect to chemical composition and geotechnical parameters. This may be managed under a Materials Management Plan prepared in accordance with the CL: AIRE Code of Practice.

9.7.8 In addition, the implementation of a Construction Environmental Management Plan (CEMP) would affect controls to ensure identified risks associated with contamination are appropriately managed and minimised. Mitigation measures within the CEMP would include best practice environmental management procedures and appropriate waste management, such as:

- Ensuring adequate space for storage of topsoil and subsoil which must be segregated during excavation
- Protection of watercourses from entry of polluting matter
- Stripping, storing and reinstating of soils using best practice measures to minimise the risk of degradation to soils
- Suppression of odour and dust using best practice measures.

Operation

9.7.9 It is anticipated that the operation of the Proposed Scheme would not give rise to any significant effects upon geology or soils.

Summary

9.7.10 Table 9.2 provides a summary of potential construction and operational effects for geology and soils for the Proposed Scheme.

Table 9.2: Summary of potential geology and soils effects

Potential Construction Effects	Potential Operational Effects
Potentially significant direct effects owing to direct encroachment of the Proposed Scheme on the former Cantley Lane landfill. This applies to widening of the A11 and the Cantley Lane Link (Option A).	No significant effects anticipated.

9.8 Proposed level and scope of assessment

9.8.1 The scope of the construction works and the potential significance of direct effects warrant further construction stage assessment for the Proposed Scheme. This would include the undertaking of a GI to further establish the baseline information of the Proposed Scheme area. Detailed investigation will examine the areas identified which encroach upon or are close to infilled ground / landfill. As detailed in Section 9.7.3, the investigation will identify the contaminants present. A remediation strategy will then be developed to consider the appropriate methods of treatment if necessary. Assessment would be undertaken to a Simple Level in the first instance.

9.8.2 The completed and operational Proposed Scheme is not expected to result in any significant direct adverse impacts upon geology and soils. As a result, it is considered that no further assessment of operational stage effects is required for the Proposed Scheme.

9.9 Proposed methodology including significance

9.9.1 The assessment method for Geology and Soils will take into consideration the guidance provided in the DMRB Volume 11, Section 3, Part 11.

9.9.2 The sensitivity of geological receptors will be determined according to Table 9.3.

Table 9.3: Scale for evaluation of the sensitivity of geological / soil receptors

Sensitivity	Criteria	Typical Examples
Very High	International Scale: Very high importance and rarity and very	Important on a European or global level: • Geology: World Heritage Sites. • Soils: Agricultural soils of Grade 1 quality. • Minerals: Energy minerals – minerals used to generate energy such as coal oil and gas.

Sensitivity	Criteria	Typical Examples
	limited potential for substitution	• Controlled Water: Groundwater vulnerability is classified as high; Principal aquifer providing a regionally important resource or supporting site protected under wildlife legislation; or source protection zone (SPZ) I. • Future site users: Very sensitive land uses proposed such as residential housing with gardens, allotments. • Built Environment: Sites of international Importance, World Heritage Sites.
High	National Scale: High importance and rarity, limited potential for substitution	Important in the UK: • Geology: Site protected under EU or UK wildlife legislation (SAC, SPA, SSSI, Ramsar site). • Soils: Agricultural soils of Grade 2 quality. • Minerals: Poor quality energy minerals or silica (industrial) sand for use in glass making. • Controlled Water: Groundwater vulnerability is classified as high; Principal aquifer providing locally important resource or supporting river ecosystem; SPZ II. • Future site users: Sensitive land uses proposed such as schools, residential housing without gardens, open spaces. • Built Environment: Listed buildings, Scheduled Monuments.
Medium	Regional Scale: Medium quality and rarity	Important in the context of the East: • Geology: Regionally Important Geological Sites (RIGS). • Soils: Agricultural soils of Grade 3 quality. • Minerals: Construction aggregates – minerals used in building and engineering or to manufacture building and engineering products such as concrete. • Controlled Water: Moderate classification of groundwater vulnerability; Secondary aquifer providing water for agricultural or industrial use with limited connection to surface water; SPZ III. • Future site users: Moderately sensitive land uses such as commercial developments and open spaces. • Built Environment: Sites with local interest for education or cultural appreciation.
Low	District Scale: Low quality and rarity	Important in the context of Norfolk: • Geology: Rock exposures. • Soils: Agricultural soils of Grade 4-5 quality. • Minerals: Poor quality materials suitable for us as general fill only. • Controlled Water: Deep Secondary aquifer with poor water quality not providing baseflow to rivers; Aquifer not used for water supplies (public or private). • Future Site Users: Low sensitivity land use such as Industrial Sites, highways and rail. • Built Environment: Infrastructure (e.g. Roads, railways, tramways).
Negligible	Local Scale: Very low importance and rarity	Important within and adjacent to site (~2km of site): • Geology: No rock exposures. • Soils: Urban classified soils.

Sensitivity	Criteria	Typical Examples
		• Minerals: No minerals. • Controlled Water: Non-aquifer. • Future Site Users: No sensitive land use proposed.

9.9.3 Magnitude of effect will be determined by the predicted deviation from the baseline conditions and the scale of impact. The methodology for determining the magnitude of an impact is shown in Table 9.4.

Table 9.4: Scale of magnitude of impact for geological / soil receptors

Magnitude of Effect	Geological Changes	Soils Including Waste	Human Health	Groundwater	Surface Water
Major	Disturbance or loss of geological features of interest e.g. change in condition status of geological SSSI or RIGS. Permanent impact on geological conditions. Sterilisation of 50% or more of mineral asset.	Generation of large volume of hazardous material for disposal off-site or treatment. Physical removal or degradation of a large area of soil. Remediation/ improvement of a large area of soil.	Site investigation data indicating severe contamination. Quantitative or qualitative risk assessment data estimating a significant likelihood of adverse/ beneficial impacts from exposure/ reduction in exposure to pollutants in the environment.	Significant change in groundwater quality with respect to Drinking Water Standards (DWS). Pollution/ treatment of potable source. Any pollution inside Zone 1 or a groundwater protection zone of special interest.	Significant change in water quality, impacting quality with respect to Environmental Quality Standards (EQS). Loss of attribute and/ or quality or function e.g. loss or extensive change to a fishery.
Moderate	Some disturbance or loss of geological feature. Temporary impact on geological conditions. Sterilisation of 15-50% of mineral asset.	Generation of hazardous/ non-hazardous material for disposal off-site or treatment. Physical removal or degradation of a moderate area of soil. Remediation/ improvement of a moderate area of soil.	Site investigation data indicating moderate contamination. Quantitative or qualitative risk assessment data estimating medium risk of adverse/ beneficial impacts from exposure/ reduction in exposure to pollutants.	Moderate changes insufficient to change water quality with respect to DWS.	Moderate changes insufficient to change water quality with respect to EQS. Moderate decline in the attribute quality or function.

Magnitude of Effect	Geological Changes	Soils Including Waste	Human Health	Groundwater	Surface Water
Minor	No disturbance or loss of geological feature. No permanent impact on geological conditions. Sterilisation of <15% of mineral asset.	Generation of inert/ non-hazardous waste materials which may be suitable for re-use on site. Physical removal or degradation of a minor area of soil. Remediation/ improvement of a minor area of soil.	Site investigation data indicating significant contamination is unlikely. Quantitative and qualitative risk assessment data estimating low likelihood of adverse/ beneficial impacts from exposure/ reduction in exposure.	Minor impact insufficient to impact on characteristics of water resource.	Measurable change in water quality but no change with respect to EQS or minor. Negligible decline in attribute quality or function.
Negligible	Physical removal, degradation (including loss of structure and contamination) or improvement of a very minor area of soil. Minimal impact on geological conditions and minerals assets.				
No change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.				

9.9.4 The likely severity of effects on geology and soils due to the construction and operation phases of the Proposed Scheme will be assessed using the matrix presented in Table 1.2.

9.9.5 A descriptive meaning for each of the five significance categories relevant to geology and soils is detailed in Table 9.5.

Table 9.5: Explanation of significance of effect for geological / soil receptors

Significance Category	Description and Examples		Significance
Neutral	**-**	• Minimal effect on geological condition. • Minor loss of urban soils. • No discernible negative effect to buildings / infrastructure.	**Not Significant**
Slight	**Adverse**	• Changes to Made Ground deposits only. • Moderate/major loss/degradation of Grade 4 or 5 soils. • Minor/moderate loss/degradation of Grade 3 soils. • Easily preventable, non-permanent health effects on humans. • Minor low-level and localised contamination of on-site soils. • Easily reparable damage to buildings/ infrastructure.	
	Beneficial	• Remediation of localised low levels of contamination. • Remediation of non-sensitive water resource • Contamination. • Minimal improvements to overall soil and water quality.	
Moderate	**Adverse**	• Superficial disturbance to near surface deposits. • Changes in geomorphology, large loss / degradation of Grade 3 soils. • Minor loss / degradation of Grade 1 or 2 soils. • Sterilisation of low quality mineral resources. • Easily preventable, permanent health effects on humans • Pollution of non-sensitive water resource or Low long-term risk of pollution to sensitive water resource. and, • Localised damage to buildings/infrastructure (on or off site).	**Significant**
	Beneficial	• Remediation of localised moderate levels of contamination. • Remediation of moderate, localised sensitive water resource contamination.	
Large	**Adverse**	• Moderate / large loss / Degradation of Grade 2 soils. • Moderate loss/degradation of Grade 1 soils. • Sterilisation of high quality mineral resource. • Medium / long-term (chronic) risk to human health. • Medium long-term risk of pollution of sensitive water resources. • Contamination of off-site soils.	

Significance Category	Description and Examples		Significance
	Beneficial	• Remediation of localised high levels of contamination; • Remediation of significant localised sensitive water resource contamination.	
Very Large	**Adverse**	• Loss of exposed designated geological feature or large loss/degradation of Grade 1 soils. • Short-term (acute) risk to human health. • Short- term risk of pollution of sensitive water resources. • Catastrophic damage to buildings / infrastructure.	
	Beneficial	• Remediation of significant, widespread elevated levels of soil contamination / sensitive water resource contamination.	

9.10 Conclusions

9.10.1 The scope of the construction works and the potential significance of direct effects warrant further construction stage assessment for the Proposed Scheme. This would include detailed investigation in order to examine the areas identified which encroach upon or are close to infilled ground / landfill. The investigation will identify the contaminants present and confirm extant ground conditions. A remediation strategy will then be developed to consider the appropriate methods of treatment if necessary.

Construction stage assessment to a Simple level in the first instance will be undertaken, and will be presented within the ES

9.10.2 The completed and operational Proposed Scheme is not expected to result in any significant direct adverse impacts upon geology and soils. As a result, it is considered that no further assessment of operational stage effects is required for the Proposed Scheme.

10 Materials

10.1 Introduction

10.1.1 This chapter assesses the potential impact on materials as a result of the Proposed Scheme, and has been prepared in accordance with DMRB Volume 11, Section 2, Part 4, to a Scoping Level. For the purposes of this Scoping Report, materials are defined as:

- The use of material resources
- The generation and management of waste

10.1.2 The potential requirement for assessment to either Simple or Detailed level will be identified. Where required, this will be presented within an ES.

10.2 Study area

10.2.1 Currently there is no guidance available for defining the study area to be used for materials assessments. As a result, the study area, which will be adopted in the ES, has been determined through professional judgement by the influence of the Proposed Scheme, rather than through a set geographical location.

10.3 Existing and baseline knowledge

10.3.1 There are no current estimates on material resource use and waste generation during the site remediation/preparation, demolition and construction phases. These shall be developed as the design is progressed.

10.3.2 Information on historic land uses and potential sources of land contamination is addressed in Chapter 9 Geology & Soils. Potential sources of contamination that are greater than 1km away from the Proposed Scheme has not been considered since these are unlikely to impact upon the Proposed Scheme given the distance and nature of the proposed construction.

10.3.3 Commercial construction and demolition (C&D) waste is identified as by far the most significant source of inert waste in Norfolk and there is the need for additional inert waste recycling infrastructure within the region. Capacity of regionally appropriate waste management facilities is an important consideration in the assessment and will be considered in the environmental assessment.

10.3.4 Further available information from the Defra, Environment Agency and Norfolk County Council on current waste generation and operational waste management facilities in Norfolk will be collated to provide the baseline for this assessment.

10.4 Assumptions and limitations

10.4.1 The potential impacts associated with material use and the production, movement, transport, processing and disposal of waste will be assessed once the type and quantify of materials and wastes have been estimated.

10.5 Guidance and best practice

10.5.1 The following legislation, standards and best practice guidelines are considered to be relevant to the Proposed Scheme which regulate the management of materials and waste:

- EU Waste Framework Directive 2008/98/EC
- Waste (England and Wales) Regulations 2011 (as amended 2012)
- Environmental Protection Act 1990, Part II, Section 34
- Hazardous Waste (England and Wales) Regulations 2005 (as amended, 2009)
- Environment Permitting (England and Wales) Regulations 2010 (as amended 2011 and 2012)
- Environment Agency (EA) (Standard Rules SR2015 No39: use of waste in a deposit for recovery operation
- CL:AIRE Definition of Waste: Development Industry Code of Practice Version 2, 2011
- DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, 2009

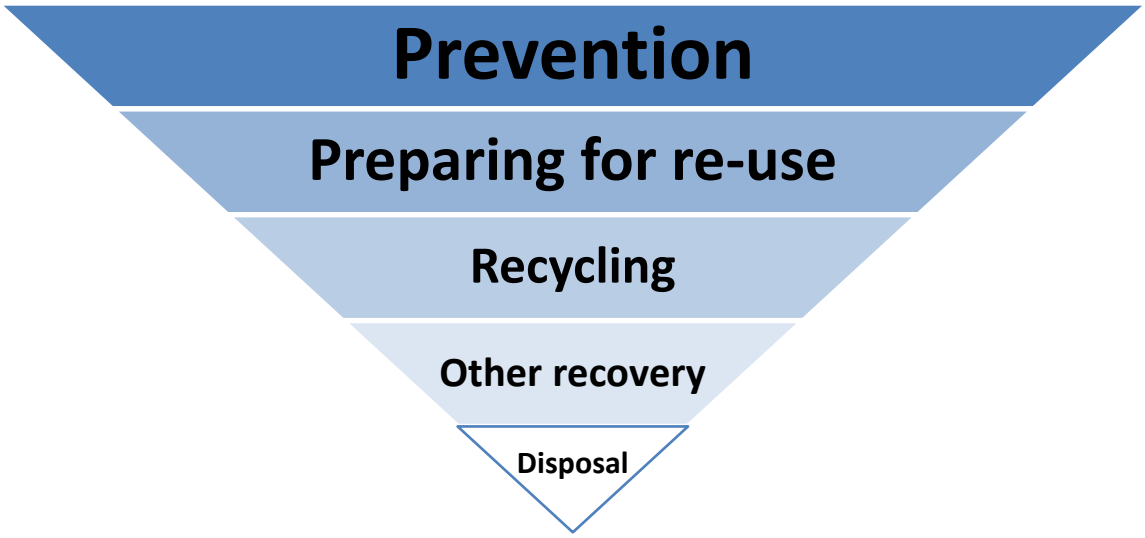
10.5.2 A Site Waste Management Plan (SWMP) is also an important tool for improving environmental performance, managing potential environmental impacts, meeting regulatory commitments and helping to reduce waste and therefore overall project costs. The SWMP aims to determine the waste types and amounts to be produced during design and construction and to identify appropriate waste management controls.

10.5.3 A Materials Management Plan (MMP) may also form part of the SWMP, where there is a need to demonstrate that any material re-use strategy does not pose any risk to human health or the environment and in accordance with ‘The Definition of Waste: Development Code of Practice’ Version 2 CLAIRE March 2011, is not a waste disposal activity.

10.5.4 The MMP documents how materials anticipated to be in the ground as part of the works are to be dealt with, including details on potential use, relative volumes, storage areas, intended final destination of the materials, protocols to track movements of these materials and any contingency arrangements (e.g. with regard to treatment of contaminated soils).

10.5.5 The waste hierarchy is a fundamental guidance to reduce waste generation at source and reduce the volume of waste to be sent to landfill (see Figure 10.1).

Figure 10.1 Waste hierarchy



Source: Guidance on applying the Waste Hierarchy, Defra 2011

10.6 Consultation

10.6.1 No specific consultation has been undertaken to date regarding materials and waste. Consultation and liaison with the Environment Agency will be ongoing, where relevant during the EIA process.

10.7 Potential effects, including monitoring and mitigation measures

10.7.1 Construction of the Proposed Scheme will involve the production, procurement, transport and use of material resources and the production of waste streams which have the potential to generate significant environmental effects, as summarised in Table 10.1.

Table 10.1: Summary of materials and waste that have the potential to generate significant environmental effects

Activity	Material use and potential to generate significant effects	Potential waste arisings and potential to generate significant effects
Site remediation / preparatory / earthworks	Potential direct effects associated with the import and use of materials, including: depletion of natural resources; noise and air emissions associated with their transportation; energy/fuel consumption through plant use and transportation; energy/fuel consumption through manufacture.	Potential direct effects associated with the generation of waste arisings (inert, non-hazardous, green and hazardous) including: demand on handling/disposal capacity of regional waste management facilities; release of contaminants to air, land or water; noise and air emissions associated with their transportation; energy/fuel consumption through plant use and transportation.
Demolition	N/A	Demolition waste from removal of surge chamber, footways and culvert modifications
Construction	• Road sub-base and surface materials • Concrete, steel and other structural materials • Pre-cast and prefabricated products (e.g. kerbs, gullies, barriers, manholes, drainage) • Signage, lighting columns and markings • Timber (e.g. for temporary use for shuttering) • Topsoil	• Non-reusable demolition material • Surplus earthworks • Surplus, damaged and 'cut-off' construction materials
Operation and maintenance	• Materials use expected to be minimal.	• Waste arisings generated expected to be minimal.

Construction

10.7.2 Specific quantities of materials and waste have not been quantified at this stage and will be estimated at a later stage as the design is progressed. Although there are no current cut and fill volume estimates, given the area of cutting compared with the area of embankment, there is likely to be surplus of excavated materials. An opportunity to re-use surplus material on other sections of the A47 where works are planned which would reduce the effects from the generation of waste arisings, as well as any other projects within the region.

10.7.3 The Proposed Scheme currently includes alternative options for Cantley Lane - Option A and Option B. Option B includes an access link route within the A47 underpass from the A11 to the east. Option A includes a link and A11 overbridge to the west, which presents more opportunities for the re-use of

excavated materials (where suitable) within the Proposed Scheme itself, e.g. within embankments.

10.7.4 There is the potential for significant adverse effects during construction due to the use of materials and generation of waste. Mitigation measures to further reduce the effects from the use of materials may be achieved through reducing the material requirements through design, re-use of site-won or recycled materials and use of materials with a high proportion of recycled content.

10.7.5 In accordance with the waste hierarchy, consideration will also be given to the re-use of waste on-site before waste is transported off-site for re-use or disposal. Where waste cannot be re-used either on or off-site, direct effects may result from the demands on the capacity of waste management facilities and landfills and impacts associated with transport.

10.7.6 The preparation of a SWMP and inclusion of mitigation measures with the appointed Contractor's Construction Environmental Management Plan (CEMP) would ensure that adverse effects associated with materials use, waste generation and required transport are managed.

10.7.7 Mitigation measures to be included in the SWMP and CEMP may include (but not limited to):

- Implementation of the waste hierarchy and avoiding generation of waste through design.
- Use of site-won or recycled materials as opposed to sourcing new materials.
- Where surplus materials cannot be re-used on-site, seek opportunities for re-use off-site, including other A47 schemes or other projects off-site (e.g. quarry restoration scheme).
- Encourage local and responsible resourcing of materials (e.g. through adoption of BES 6001) and efficiencies by minimal ordering of materials;
- Waste to be appropriately segregated and stored/stockpiled on-site by waste type, to ensure waste remains in a suitable condition to be re-used.
- Where waste must be taken to a recycling/disposal site, ensure these sites hold the appropriate permits.

Operation

10.7.8 Significant environmental effects from the use of materials and generation of waste are unlikely during the operation of the Proposed Scheme since there would be minimal requirements for materials, besides infrequent maintenance activities.

10.8 Proposed level and scope of assessment

10.8.1 There is a potential for significant volumes of earthworks and material used during construction, resulting in the need for potential off-site re-use and disposal of wastes generated. A Simple Level assessment is proposed at this stage for both the use of materials and generation of waste during the construction. This will be followed by a Detailed Level assessment, if considered necessary based primarily on the assessment and volume estimates.

10.8.2 No further assessment is likely to be required for material resource use and waste generation during operation, as no significant direct or indirect effects are anticipated.

10.9 Proposed methodology including significance

10.9.1 The Simple Level assessment will consider the following:

- The materials required for the project and where information is available, the quantities.
- The anticipated waste arisings from the project, and where information is available, the quantities and type (e.g. hazardous).
- The impacts that will arise from the issues identified in the scoping exercise in relation to materials and waste.
- The results of any consultation.
- A conclusion about whether this level of assessment is sufficient to understand the effects of the project or whether Detailed Level assessment is necessary.

10.9.2 Professional judgement will be used to provide an assessment of effects based on several factors, including:

- The availability/scarcity of the material resources.
- The type of materials required and their associated embodied carbon, e.g. primary/virgin materials, manufactured materials, recycled materials.
- The type of waste generated, e.g. inert, non-hazardous, hazardous.
- The capacity and availability of suitable facilities within close proximity to the Proposed Scheme to manage, treat or dispose of waste generated.
- Implementation of the waste hierarchy, i.e. where the generation of the waste is avoided through design in the first instance, then minimised, recycled, recovered or disposed of.

10.10 Conclusion

10.10.1 There is a potential for significant adverse effects from the use of materials and generation of waste. An initial Simple Level assessment is proposed, followed by a Detailed Level assessment if the environment impacts cannot be clearly identified by the Simple Level assessment. The requirement for a Detailed Level assessment shall be considered following completion of the Simple Level assessment.

10.10.2 The results of the assessment will inform development of a SWMP, MMP/ Materials Logistics Plan (MLP) which shall be prepared for the Proposed Scheme by the appointed Contractor. The SWMP and MMP/MLP shall consider the sourcing, procurement, transport, delivery, storage, handling, use and disposal of materials in a sustainable manner, in accordance with the waste hierarchy.

10.10.3 With implementation of a SWMP, MMP/MLP and other appropriate mitigation measures during construction as detailed in the CEMP, the use of materials and generation of waste is unlikely to result in significant direct or indirect effects, although an assessment to a Simple Level will be undertaken to confirm this conclusion.

10.10.4 No further assessment is required for the effects of the Proposed Scheme on material resources during operation, as significant direct or indirect effects are unlikely as there would be minimal requirements for materials and generation of waste.

11 Noise & Vibration

11.1 Introduction

11.1.1 This Chapter has been prepared in accordance with DMRB Volume 11, Section 2, Part 4, and DMRB Volume 11, Section 3, Part 7, to a Scoping Level. The construction and operation of the Proposed Scheme would have the potential to give rise to both temporary and permanent noise and vibration impacts at sensitive receptors in the area, which in turn could generate adverse or beneficial effects. This chapter identifies the key noise and vibration impacts, describes the study area and key receptors. The potential requirement for assessment to either Simple or Detailed level will also be identified. This will then be presented within an ES.

11.2 Study area

11.2.1 The DMRB Volume 11 Section 3 Part 7 HD213/11 Noise and Vibration (2011) provides the methodology for assessment of road projects within the UK.

11.2.2 For operational noise, the methodology requires that the study area is identified as an area within 1km of the physical works associated with the Proposed Scheme. Within this study area, road traffic noise predictions are performed at any sensitive receptor within 600m of a road where this is the possibility of a change of 1dB LA10, 18hr upon Proposed Scheme opening, or 3 dB LA10, 18hr in the long term**.**

11.2.3 For potential effects due to road traffic noise outside of the 1km area, the methodology requires that sensitive receptors are identified adjacent to roads where the change in received road traffic noise level would, as a result of the Proposed Scheme, increase or decrease by at least 1 dB LA10, 18hr on opening or 3dB in the long term. Consequently, the spatial extents of the assessment may extend beyond the physical works associated with the Proposed Scheme.

11.2.4 For construction noise, the study area is the same as that defined for assessment of operational noise impacts, although this may be extended to assess the impacts from construction traffic on the existing road network and from potential diversion routes. Within the study area the extent of the assessment will be limited to areas where total noise (calculated construction noise plus baseline noise) exceeds baseline noise levels.

11.3 Existing and baseline knowledge

11.3.1 The Proposed Scheme will provide improved links between the A47 and A11 at Thickthorn Junction. There are currently two options for achieving this objective.

Option A

11.3.2 Option A provides two new link roads for vehicles travelling east from A11 on to A47 and those travelling south from A47 on to A11. The eastbound link is largely within a cutting while the southbound link is largely at grade. There is an additional link road between Norwich Road and Cantley Lane. There are relatively few properties in the immediate area, principally confined to Cantley Lane and between Norwich Road and A11. There is a hotel in the service area adjacent to the existing interchange on the southwest side.

Option B

11.3.3 The design of Option B is similar to Option A with the exception of the link road between Norwich Road and Cantley Lane. This has been replaced by re-aligning Cantley Lane such that it forms a new link between Newmarket Road to the east of the interchange and Cantley Lane itself, adjacent to approximately 12 properties.

11.3.4 A review of noise-sensitive receptors and an initial noise survey was undertaken and in addition to residential receptors noted above the presence of a large number of properties in Cringleford, to the east of the A47, were considered.

11.3.5 Noise readings were reported at three locations, to the southwest of the A47adjacent to properties on Cantley Lane; to the north east of the A47 on Cantley Lane and on Newmarket Road east of Round House roundabout on the A11.

11.3.6 Background noise levels were noted as being dominated by traffic noise from the A47 and A11 at all locations, with some noise from occasional local traffic on Cantley Lane. Average LA10, 1 hour noise levels recorded at the locations adjacent to Cantley Lane were less than 60dB, while at the site nearest the A11 at Round House roundabout the average noise level was higher, as might be expected, at approximately 67dB.

11.3.7 Two Noise Sensitive Areas have been identified within the study area, both being located on the A11 to the north east of Round House roundabout. These are indicated on Figure A.1 and are as follows:

- IA_ID: 4965; Asset Owner Norfolk County Council
- IA_ID: 4966; Asset Owner Norfolk County Council

11.3.8 Table 11.1 identifies sensitive receptors, which includes typical examples identified in DMRB.

Table 11.1: Noise and vibration resources and receptors

Resource / Receptor	Description
Dwellings	Houses and any other building in residential use such as public houses, hotels etc.
Commercial premises	Shops, offices etc.
Community facilities	Libraries, public halls, sports centres, theatres, concert halls, places of worship etc.
Recreational facilities	Amenity areas, footpaths, sports grounds etc.
Educational establishments	Schools, university campus.
Designated sites	If relevant, environmentally sensitive areas and buildings sensitive to noise and vibration.
Other	Any other premises highly sensitive to noise and vibration such as laboratories etc.

11.3.9 Further surveys will be necessary and the following sources will be consulted prior to deciding locations:

- Noise mapping undertaken as part of the requirements of The Environmental Noise (England) Regulations 2006.
- OS mapping
- Consultation with the Local Authority
- Traffic flows
- Review of previous surveys and assessments

11.3.10 Surveys will comprise both long-term and short-term monitoring broadly in accordance with The Calculation of Road Traffic Noise (CRTN) methodology (HMSO, 1988).

11.4 Assumptions and limitations

11.4.1 There is currently no information on construction traffic movements, which is required to undertake an assessment of construction noise. Forecast traffic flows, speeds and percentage heavy goods data are currently unavailable. Discussion on potential impacts and effects within this Scoping Report have therefore been undertaken in the absence of this information. As design progresses and this information becomes available it will be incorporated into the assessment.

11.5 Guidance and best practice

11.5.1 The following legislation, standards and best practice guidelines are considered to be relevant to the Proposed Scheme:

- The National Planning Policy Framework 2012.
- The Noise Policy Statement for England 2010.
- The National Policy Statement for National Networks 2014.

- The Land Compensation Act 1973 Part 1.
- The Noise Insulation Regulations 1975 (amended 1988).
- Sections 60 and 61 of The Control of Pollution Act 1974.
- The Environmental Protection Act 1990.
- British Standard (BS) 5228-1:2009+A1:2014 ‘Code of practice for noise and vibration control on construction and open sites – Part 1: Noise’.
- BS5228-2:2009+A1:2014 'Code of construction practice for noise and vibration control on construction and open sites - Part 2: Vibration'.
- BS 7385:1993 ‘Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground-borne vibration’.
- Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 7 ‘Noise and Vibration’ (HD213/11 – Revision 1) 2011.
- Interim Advice Note 185/15 ‘Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into ‘speed bands’ for users of DMRB Volume 11, Section 3, Part 1 ‘Air Quality’ and Volume 11, Section 3, Part 7 ‘Noise’.
- Calculation of Road Traffic Noise (CRTN) 1988.
- Guidelines for Noise Impact Assessment, Institute of Environmental Management & Assessment (IEMA) 2014.

11.5.2 The above list is not exhaustive and further guidance will be referred to where necessary.

11.6 Consultation

11.6.1 Consultation with Environmental Health Officers will be progressed following any consultations undertaken to date. Discussion on methodology for the environmental assessment and proposed survey locations will form a key element of the consultation.

11.7 Potential effects, including monitoring and mitigation measures

Construction

11.7.1 During construction, both Proposed Scheme have the potential to directly alter the noise and vibration baseline for sensitive receptors for a temporary period. Impacts are likely to be restricted to areas where the existing baseline noise levels are exceeded. This would principally be in the vicinity of the Proposed Scheme envelope, although could extend along elements of the existing road network, depending on haul routes and the quantity of construction-related traffic. With strict adherence to mitigation including the shielding of noisy items of plant, the use of enclosures and the use of appropriate screening, to be included within the CEMP, construction noise would be managed to appropriate levels and is therefore not anticipated to have significant direct effects. However, at this stage with insufficient information on construction activities assessment will be needed to confirm this and to inform the mitigation strategy.

This will be undertaken based upon the requirements of BS5228 Parts 1 and 2 during the EIA process.

Operation

11.7.2 During operation, there is the potential for changes to traffic flows and road alignment to result in noise changes at noise sensitive receptors, including NIAs. However, with the implementation of appropriate mitigation, such as the provision of noise barriers/bunds and low noise road surfacing, potential adverse effects may be minimised. Nonetheless, it is considered that there is the potential for significant residual adverse effects to noise sensitive receptors which warrants assessment.

11.8 Proposed level and scope of assessment

11.8.1 The Proposed Scheme has the potential to directly alter the noise and vibration baseline for numerous sensitive receptors both temporarily (during construction) and permanently (during operation). Therefore, a quantitative assessment of both construction and operational noise and vibration is required in order to establish significant effects and to inform the mitigation strategy. The assessment will therefore be undertaken to a Detailed Level.

11.9 Proposed methodology including significance

11.9.1 The National Policy Statement for National Networks (DfT, 2014) requires that *'due* r*egard'* must be given to relevant sections of the NPPF, the Noise Policy Statement for England (Defra, 2010) and the associated National Planning Policy Guidance on noise (CLG, 2014a). In order to comply with these documents, it will be necessary to determine Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL) for noise impacts. The mitigation strategy will depend upon the magnitude of any impacts at sensitive receptors between LOAEL and SOAEL, in addition to exceedances of SOAEL, which will indicate the occurrence of significant adverse effects.

Construction noise

11.9.2 BS5228–1:2009+A1:2014 (BSI, 2014) does not define strict criteria to determine the significance of noise impacts, although examples of how limits of acceptability have been applied historically and some examples of assessing significance are provided. 'Example Method 2 – 5dB(A) change' (Annex E 'Significance of Noise Effects' Section E.3.3) will be adopted for the assessment of effects at sensitive receptors.

11.9.3 This approach considers the potential changes in ambient noise levels and more appropriately reflects conventional EIA methodologies compared with the use of fixed/absolute noise limits.

Construction vibration

11.9.4 BS5228 ‘Code of construction practice for noise and vibration control on construction and open sites – Part 2: Vibration’ (BSI, 2014) provides guidance on the effect of vibration and the likelihood they will cause complaint and cosmetic damage to buildings. BS 5228 does not indicate whether particular vibrations are significant. However, it does state that: “It is likely that vibration of... [1.0mm/s]...in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents”.

11.9.5 Generally, vibration from construction activities would be temporary and intermittent in nature. On this basis, in the assessment a Peak Particle Velocity (PPV) of 1.0mm/s or more would be considered to have the potential to result in a significant adverse impact.

11.9.6 BS 7385 provides guidance on the levels of vibration that would be necessary to cause structural damage to different types of buildings. The Standard indicates that continuous PPVs of more than about 7 mm/s would be required to cause structural damage to residential buildings. For residential buildings, limits will be placed based upon human response which are considerably lower than those at which building damage may occur.

Operational noise

11.9.7 DMRB HD213/11 describes the impacts of road traffic noise in terms of the noise descriptors conventionally used for assessing the impact of road traffic in the UK, i.e. the statistical noise level LA10,18h over an 18-hour period between 06:00 and 24:00 (the traffic noise index). The Calculation of Road Traffic Noise (CRTN) methodology (HMSO, 1988) will be followed in the calculation of road traffic noise, which will provide input to assessment of impact using the DMRB methodology.

11.9.8 The level of road traffic noise from the road network will be predicted using traffic data provided in terms of 18-hour Annual Average Weekday Traffic (AAWT) flow between the hours of 06:00 to 24:00, along with average vehicle speed and percentage heavy vehicles.

11.9.9 Calculations of the road traffic noise level will be undertaken for four scenarios:

- Do Minimum option in the baseline year
- Do Minimum option in the future assessment year
- Do Something option in the baseline year
- Do Something option in the future assessment year

11.9.10 In the above scenarios, 'Do Minimum' means traffic growth with committed development only. 'Do Something' means committed growth with the Proposed Scheme.

11.9.11 In accordance with DMRB HD213/11, for a Detailed Level of assessment, the assessment of road traffic noise impacts requires the following comparisons:

- The short-term change in road traffic noise upon Proposed Scheme opening (Do Minimum option in the baseline year vs. Do Something option in the baseline year).
- The long-term change in road traffic noise assuming the Proposed Scheme is built (Do Minimum option in the baseline year vs. Do Something option in the future assessment year).
- The long-term change in road traffic noise assuming the Proposed Scheme is not built (Do Minimum option in the baseline year vs. Do Minimum option in the future assessment year).

Operational vibration

11.9.12 Low frequency noise from vehicle exhausts may induce vibration (rattle) in light building elements such as windows i.e. airborne vibration. DMRB HD 213/11, para. A5.28 advises that vibration disturbance most closely parallels exposure to traffic noise levels, and that subject to professional judgement relating to conditions under which the research was undertaken, disturbance from vibration may be quantified along similar lines to nuisance from noise (the original research was restricted to properties within 40m of the carriageways where there were no noise barriers or other screening).

11.9.13 DMRB notes that traffic induced vibration is expected to affect a very small percentage of people at noise exposure levels below 58dB LA10.

Summary of proposed significance criteria

11.9.14 Environmental assessment regulations and the NPPF require that the assessment considers the significance of any impacts. These will be considered on the basis of magnitude and change. NPPF requirements regarding single objective noise-based measures will be based upon those adopted for other recent infrastructure Proposed Schemes.

11.9.15 Table 11.2 summarises proposed LOAEL and SOAEL values.

Table 11.2: Summary of potential noise and vibration effects

Time Period	Source	Adverse Effect Level	Noise Level
Day	Operational noise	LOAEL	Free-field 50dB $L_{Aeq,16hr}$
Day	Operational noise	SOAEL	Façade 67.5dB $L_{A10\ 18hr}$
Night	Operational noise	LOAEL	Free-field 45dB $L_{Aeq,\ 8hr}$
Night	Operational noise	SOAEL	Free-field 55dB $L_{night,\ outside}$
Day	Construction noise	LOAEL	Facade 50dB $L_{Aeq,16hr}$
Day	Construction noise	SOAEL	Façade 75dB $L_{Aeq,12\ hr}$
Night	Construction noise	LOAEL	Façade 45dB, $L_{Aeq,\ 8\ hr}$
Night	Construction noise	SOAEL	Facade 55dB $L_{Aeq,\ 8\ hr}$
	Construction vibration	LOAEL	PPV 0.14mm/s
	Construction vibration	SOAEL	PPV 1.0mm/s

11.10 Conclusion

11.10.1 During construction, the Proposed Scheme has the potential to directly alter the noise and vibration baseline for numerous sensitive receptors for a temporary period. Impacts are likely to be restricted to the vicinity of the Proposed Scheme with Option envelope, although could extend along elements of the existing road network. Mitigation will be key to minimising adverse impacts. Significant effects are unlikely with an appropriate CEMP and mitigation in place. Nonetheless, assessment in the form of a quantitative construction noise and vibration assessment is required to inform the mitigation strategy.

For operational noise and vibration effects, adverse effects from the introduction of a new noise source and changes to traffic flows would also be likely. As a result, assessment in the form of road traffic noise predictions is required for sensitive receptors, using available traffic data. Appropriate mitigation and enhancement would ensure that direct impacts are minimised**.**

12 People and Communities

12.1 Introduction

12.1.1 This chapter assesses the impacts of the Proposed Scheme on People and Communities. The DMRB topic 'People and Communities' is identified within Highways England's Interim Advice Note (IAN) 125/15. This new guidance replaces both the 'Effects on all Travellers' and 'Community and Private Assets' topics from IAN 125/09 and covers effects associated with:

- Non-Motorised Users (NMUs) (pedestrians, cyclists and equestrians)
- Amenity
- Motorised Travellers (MTs) Views from the Road
- Motorised Travellers (MTs) Driver Stress
- Community Severance
- Local Economy
- Community Land and Community Facilities
- Agricultural Land
- Individual Farm Business
- Development Land
- Demolition of Private Property and Associated Land Take

12.1.2 The potential requirement for assessment to either Simple or Detailed level will be identified, and where required, this will be presented within an ES.

12.2 Study area

12.2.1 No study areas for People and Communities are specified in DMRB Volume 11 Section 2 Part 4, and DMRB Volume 11 Section 3 Parts 6, 8 and 9, and therefore the study areas used for this chapter have been defined through professional judgement, based on the type and scale of the Proposed Scheme and the context of the surrounding area. These study areas are considered more than sufficient in terms of identifying the significance of effects in full.

12.2.2 The area within 250m of the Proposed Scheme boundary will be referred to as the Local Impact Area (LIA) and will be the primary study area for this topic. This LIA will be used to assess:

- **NMUs:** The study area will comprise all NMU facilities including Public Rights of Ways (PRoWs), footways, long distance walks and cycle routes within 250m of the Proposed Scheme.
- **Amenity:** The study area will comprise all NMU facilities within 250m of the Proposed Scheme.
- **MTs Driver Stress:** The study area will comprise all roads and connecting roads within 250m of the Proposed Scheme.

- **Community Severance:** The study area will include community facilities and connecting NMU routes within 250m of the Proposed Scheme.
- **Community Land and Community Facilities:** The study area will comprise community facilities and community land within 250m of the Proposed Scheme. Community facilities include schools, healthcare facilities and other community focussed resources. Community Land includes formal facilities such as parks, sports and recreation grounds, children's play areas, outdoor sports facilities, amenity spaces, allotments, cemeteries, and more informal facilities such as natural green spaces.
- **Demolition of Private Property and Associated Land Take:** The study area will consider impacts on private property within 250m of the Proposed Scheme. For this assessment, private property includes residential, industrial, and commercial properties including businesses such as independent shops.
- **Development Land:** The study area will consider unimplemented planning permissions and development allocations within 250m of the Proposed Scheme.
- **Agricultural Land and Individual Farm Business:** The study area will encompass land within 250m of the Proposed Scheme potentially required to accommodate infrastructure.

12.2.3 The study area for MTs Views from the Road considers views from the Proposed Scheme in operation only.

12.2.4 Wider social and community effects and effects on the local economy will be considered within a Wider Impact Area (WIA) which in this case will be the district of South Norfolk.

12.3 Existing and baseline knowledge

12.3.1 Thickthorn Interchange is located on the south-western edge of Norwich and provides access to the A47 via the A11 for Eaton, Cringleford and Wymondham. Connected to the west of the Interchange is a Park and Ride facility and a trunk road service area.

12.3.2 Table 12.1 summarises the existing baseline for all People and Communities topics, except for Local Economy, for the Proposed Scheme.

Table 12.1: Summary of existing people and communities' baseline

Topic	Summary
MTs: Driver Stress	Studies have identified the unsuitability of the current junction layout to accommodate the dominant movements through the junction on the A11 and between A11 northbound to A47 eastbound and the A47 westbound and A11 southbound carriageways. This leads to congestion during the peak periods resulting in medium levels of driver stress.

Topic	Summary
MTs: View from the Road	Existing views from the B1172, A11 and A47 are intermittent; partially screened by highway boundary vegetation and by tree cover within the wider surrounding landscape. The surrounding landscape typically comprises gently undulating arable land interspersed by small woodland blocks. To the east of the A47 the residential edge of Cringleford is visible on the Norwich suburbs. Park and ride and highway service facilities are visible to the west of Thickthorn interchange whilst a line of high voltage powerlines are notable skyline features along the A47 highway corridor. Cantley Lane and Cantley Lane South have restricted views enclosed by hedgerows.
NMUs	• A number of Public Rights of Way (PRoW) and other key routes have been identified within the study area. These routes provide an important means of access for local people to community facilities and the wider study area: • Cringleford FP4a which runs from Cantley Lane to a footbridge over the A47, providing a link to Cantley Lane South. • Cringleford BR5 (bridleway) which runs from Cantley Lane to Norwich Southern Bypass. • Cringleford FP1 runs from Cantley Lane to Newmarket Road. • Cringleford FP2 runs south from Cantley Lane to Langley Close. • Cringleford FP3 runs south west from Brettingham Avenue to Kedleston Drive. • Keswick BR5 runs to the east of the A47 at Intwood. • Hethersett FP6 which runs along Cantley Lane South parallel to Hethersett Bypass. • Norwich Circular via Saxlingham local cycle route. • Cringleford Cycle Route. • Cringleford to Sprowston Pedalway. • The Outer Circuit Pedalway • Kett's Country Local walking route from Cringleford to Wymondham and from Cringleford to Attleborough, which follows Intwood Road. • A shared-use footway on the northern side of the Interchange passing under the A47 alongside the gyratory carriageway. • The local cycle route at Cantley Lane and one Pedalway, namely Cringleford to Sprowston, are impacted by the Proposed Scheme but are of low sensitivity. • The footbridge over the A47 connecting Cantley Lane to Cantley Lane South is impacted by the Proposed Scheme but is of low to medium sensitivity. • Cringleford FP4a and Cringleford BR5 are impacted by the Proposed Scheme but are of low sensitivity. • NMU surveys were undertaken in the area of Thickthorn interchange, the A11/Round House Way roundabout and Cantley Lane/Cantley Lane South, in both the school term time and

Topic	Summary
	school summer holidays in 2017, to provide information on current usage. The surveys confirmed the most common routes for cyclists using the network and pedestrian demands at key crossing points in the area. They indicated that both pedestrians and cyclists make use of the Cantley Lane footbridge and they also observed that the equestrian route and associated Pegasus Crossing located on the A47 northbound northbound off-slip was not used by equestrians during either of the surveys.
Amenity	There is one crossing facility over the A47 for NMUs within the study area in addition to the facilities provided at the Interchange. This comprises the footbridge linking Cantley Lane South to Cantley Lane. Amenity varies per NMU facility depending on the barriers between people and traffic and at points where NMUs cross existing roads.
Demolition of Private Property and Associated Land Take	• Only a very small number of residential properties are located within the LIA, as the area is primarily made up of the road network and commercial land. Located to the north west of the junction, on the B1172, there is one set of terraced and one set of semi-detached properties. More properties are located slightly outside of the LIA. A large housing estate called 'Round House Park' is just under 500m north east of the junction. Cringleford itself is also east of the junction (approximately 585m), where a large number of residential properties are also located. • There are numerous businesses located in Thickthorn interchange LIA. These include two fast food restaurants, a hotel, a service station and a John Kemp car dealership.
Community Land and Community Facilities	• Thickthorn park and ride station and car park falls within the LIA to the west of the interchange. The station is accessed via the B172. There are no other community facilities within the LIA. • A nursery is also located outside the LIA to the west (approximately 585m), on the B1172. There is an area of woodland located within and around the interchange that may be used by the public for recreation such as dog walking. • Numerous community facilities are found in Cringleford, to the east of the interchange. Such facilities include Cringleford Church of England Voluntary Aided Primary School, Cringleford Primary School, Crackerjacks Pre School Playgroup, Cringleford GP Surgery, Cringleford Post Office, Clever Cloggs Childrens Nursery, First Class Learning and Cringleford Tennis Club.
Community Severance	No specific baseline information is available for community severance.
Development Land	• The Cringleford Neighbourhood Development Plan 2013-2026 shows that land within the LIA has been identified for future development. A large-scale planning application for approximately 650 residential properties, and other mixed-use

Topic	Summary
	development, is located directly to the east of the interchange. The development is set to spread across two sites: one to the north of the A11, east of the A47 and west of Round House Way, the other to the south of the A11, east of the A47 and west of Cringleford. • The development plan also highlights that permission has been approved for a drive thru restaurant with parking to be built on land at the Thickthorn roundabout. And, there is set to be an expansion of Thickthorn park and ride. • A 145m 'Landscape Protection Zone' has been allocated along Norwich Southern Bypass. However, this is outside of the LIA (approximately 770m south of the interchange).
Agricultural Land and Individual Farm Businesses	• The information has been taken from previous stages of design development and assessment and confirmed through the Natural England land capability for agriculture maps. No further desk study or site walkover has been possible. • The Proposed Scheme would require both temporary and permanent land-take of some Grade 3 (good to moderate quality) agricultural land. • The Proposed Scheme would also require land-take (temporary and permanent) of parcels of agricultural land from a number of individual farm businesses, this number and their locations are currently unknown.

Local economy baseline

12.3.3 South Norfolk has a population of 132,837, of whom 77,278 (58%) are of working age (16-64 years old). Children (aged under 16 years) make up 18% of the population, which is similar to the national average of 19%. Older people (over 65 years) comprise 24% of the general population, which is considerably higher than the national average of 18%.

12.3.4 The following table (Table 12.2) outlines the economically active population and, amongst them, those who are in employment and those who are unemployed. It shows there are proportionally more economically active people in South Norfolk than in England (85% compared with 78%). It also shows that unemployment is lower in South Norfolk at 2% (compared to 5% nationally). In Norfolk County, the economically active population is proportionally higher than the English average (80%) and the proportion of unemployed is slightly lower (4%).

Table 12.2: Employment and unemployment (April 2016 – March 2017)

All people	South Norfolk district*	South Norfolk district** (%)	Norfolk	Norfolk (%)	England (%)
Economically active	65,200	85	441,800	80	78
In employment	63,700	83	424,100	77	74
Unemployed	1,600	2	17,700	4	5

Source: ONS annual population survey
* Numbers are for those aged 16 and over
** % are for those aged 16-64

12.3.5 The English Indices of Deprivation 2015 are commonly used for the measurement and comparison of deprivation between neighbourhoods in England. In terms of deprivation, the neighbourhood that includes Thickthorn interchange is ranked 28,775 out of 32,844 Lower layer Super Output Areas (LSOAs) in England, with 1 being the most deprived LSOA. This indicates that Thickthorn interchange is within the 20% least deprived neighbourhoods in England.

12.4 Assumptions and limitations

12.4.1 This assessment will be reliant on desk based research, using publicly available information where available. This information includes strategic documents, Geographical Information Science (GIS) software, and information from previous stages of design and assessment.

12.4.2 Data used to define the baseline social and community conditions has been compiled from existing published sources. Assessments are based on the most recent data available for the LIA and WIA. The currency of data varies from dataset to dataset depending on how frequently information is collected. Dates for each dataset are noted in the baseline section where available.

12.4.3 In order to prevent double-counting of significant effects, effects relating to other environmental topics are not considered in detail as part of this social and community assessment.

12.4.4 Similarly, potential effects on human health are considered as part of those topics which are themselves determinants of health – namely noise, air quality, and, where relevant, within the social and community chapter. Any potential effects arising for human health are set out in Section 12.7.

12.4.5 The LIA is based on a 250m boundary from the outer limits of the Proposed Scheme, and not on distances via particular modes (such as walk times), by particular routes, or taking into account man-made and natural barriers (such as major roads, railway lines, or water courses).

12.4.6 The Construction Strategy for the Proposed Scheme has not yet been prepared so has not been used as part of this scoping exercise but, where stated, assumptions have been made as to its proposed or recommended content.

12.5 Guidance and best practice

12.5.1 People and Communities is identified as a DMRB topic within IAN 125/15 and the assessment will use this to guide the sub-topics considered and the approach to identifying the significance of potential effects.

12.5.2 Further guidance specific to the People and Communities is in development, and the assessment is cognizant of this, even where it is not directly used to inform the assessment approach itself. As a result, and pending new guidance, People and Communities will be assessed using guidance contained within DMRB Volume 11, Section 3 as follows:

- Part 6 – Land Use
- Part 8 – Pedestrians, Cyclists, Equestrians and Community Effects
- Part 9 – Vehicle Travellers

12.5.3 No specific published guidance currently exists for assessing the effects on social and community resources. The assessment approach will be conducted using previous professional experience of undertaking similar reviews on large scale transportation infrastructure.

12.6 Consultation

12.6.1 Assessment will be informed by the responses to the statutory public consultation that will be undertaken for the Proposed Scheme. In addition, consultation will be required with landowners who have land within the Proposed Scheme site boundary for assessment on agricultural and individual farm business.

12.7 Potential effects, including monitoring and mitigation measures

Construction

NMUs

12.7.1 The Proposed Scheme would have a direct impact on users of Cringleford FP4a as the existing footbridge over A47 would be removed and a minor impact on Cringleford BR5. The removal of the footbridge would result in increased journey times and lengths during the temporary construction period.

Amenity

12.7.2 Amenity is likely to be temporarily impacted for users of Cringleford FP4a, Cringleford BR5 and the existing facilities provided by the Interchange during construction through the presence of construction plant, machinery, materials, construction compounds and construction lighting, whilst there is also potential for barriers and traffic flows to change.

12.7.3 In addition, construction activities may cause indirect effects for NMUs, due to noise, dust and the presence of construction plant, materials, compounds sites

and machinery for a temporary period. The effects of such activities are discussed further in the Chapter 5 Air Quality, Chapter 7 Landscape and Chapter 11 Noise and Vibration.

MTs: Driver Stress

12.7.4 During construction works, it is possible that overnight working may be undertaken. This could cause temporary disruption for motorised users along the A47, A11 and adjoining side roads. Traffic management would be likely to result in temporary reduced speeds and potentially narrow lanes, which would increase journey times. This could temporarily increase stress for MTs and cause disruption for local communities. However, this would be managed through the implementation of a Traffic Management Plan and therefore temporary effects, whilst slight adverse, are unlikely to be significant.

Community Severance

12.7.5 The reconfiguration of the local road network, as well as an increase in construction traffic, could cause temporary severance for users of Thickthorn park and ride during the construction period. There may also be temporary severance for rail users as a result of the need to widen the existing bridge across the Breckland Railway Line, south of the interchange, as part of the Proposed Scheme.

12.7.6 The construction of the A11 and A47 underpasses are likely to cause severance for road users as a result of the need for the temporary implementation of vehicle diversions. Traffic management sequencing will be used to maintain traffic flows in the area, especially with the underpass construction. This will minimise disruption, and ultimately levels of severance.

12.7.7 With regards to Cantley Lane, two potential solutions are still currently under review (Figure 3.5). Option A would involve a new footbridge and Option B would involve a pedestrian and vehicle underpass. For both options, it is anticipated that works on Cantley Lane will involve a large amount of construction. Users of Cantley Lane are therefore likely to experience a considerable amount of temporary severance throughout the construction period.

12.7.8 Both options under review require extensive excavation works at Cantley Lane. This is scheduled to begin after the A11 underpass works are complete. Residents of Cantley Lane may experience some disruption and severance due to the construction work and presence of construction vehicles.

12.7.9 A pedestrian footbridge currently crosses the A47 just south of Cantley Lane. Both solutions within the Proposed Scheme require demolition of this structure which will involve a temporary closure of the A47.

12.7.10 An access route from the A47 to the Junction via the A11 will be permanently closed**.**

Community Land and Community Facilities

12.7.11 Thickthorn Park and Ride is likely to be impacted as a result of the construction works. Access to this facility for its users and the route of the buses could be temporarily affected.

12.7.12 Community facilities in Cringleford (see Table 12.1), although outside of the LIA, may be impacted during the construction period. Disruption to the local road network is likely to affect those accessing facilities in Cringleford (particularly those approaching Cringleford from the west). An increase in construction traffic, and possibly vehicles avoiding the interchange during the construction period, may also impact such facilities. This is due to the possibility of an increase in noise levels and a heavier flow of traffic in an area likely to be used by pedestrians (such as school children).

Development land

12.7.13 At this stage the extent of the land take is not yet know. This will be explored during the EIA. It is possible that the implementation of the Proposed Scheme may affect proposed future housing developments on adjacent land.

Demolition of private property and associated land take

12.7.14 The two options within the Proposed Scheme are likely to require both temporary and permanent land take. However private residential property is not likely to be affected.

12.7.15 Temporary land take will be required to accommodate construction compounds. A main compound with a satellite compound will be required for the duration of the works. The location of the main compound for both options is proposed to be to the west of the junction in an area of agricultural land. The satellite compound will be required to the east of the A47. A system of temporary haul roads will be required to provide HGV access to each area of the works.

12.7.16 Permanent land take will be required in the area to the east of and adjacent to the A47 to accommodate the expansion of the junction.

Local economy

12.7.17 The two options within the Proposed Scheme will require a construction workforce to deliver them, which may result in direct but temporary beneficial economic effects.

12.7.18 At present, however, no Construction Strategy is available. There is currently, therefore, no information on whether the workers required will be new or existing employees of the designated contractor (who is yet to be appointed), the skill levels likely to be required for delivery, and whether those workers can and will be drawn from the LIA or WIA. If the Proposed Scheme results in new employment in the area, then this could have a slight beneficial impact on employment rates. However, because of the size of the Proposed Scheme, this effect is unlikely to be significant.

12.7.19 For the duration of the construction phase, there will be construction workers on-site. It is anticipated that there would be a slight and indirect temporary beneficial impact on the local economy as a result of these workers using local hospitality and catering establishments, for example around mealtimes. This effect is also unlikely to be significant as any uplift would be minor for a scheme of this size.

Agricultural land and individual farm business

12.7.20 Temporary land-take can be defined as the land within the Proposed Scheme footprint required during the construction phase only (e.g. for access and construction compounds). Temporary land should be re-instated and restored to the baseline conditions and returned to the landowner before the Proposed Scheme becomes operational.

12.7.21 Permanent land-take can be defined as the land within the Proposed Scheme footprint required for the construction phase and retained for the operational phase of the Proposed Scheme.

12.7.22 The Proposed Scheme is likely to require both temporary and permanent land-take of some Grade 3 (good to moderate quality) agricultural land. Although Grade 3 is not classified as Best and most versatile (BMV) agricultural land, Sub-grade 3a is categorised as BMV land. Therefore, the land-take of Grade 3 agricultural land has the potential to have significant adverse effects during construction. Therefore, the permanent and temporary land-take of this land required for the construction phase of this Proposed Scheme has the potential to have significant adverse effects during construction.

12.7.23 The overall land-take, both temporary and permanent is currently unknown. For temporary land-take, the mitigation measures for agricultural land would require the re-instatement of the area to the same quality as measured pre-construction phase, before it is returned to the landowner. For permanent land-take, the mitigation measures for agricultural land would require the provision of alternative land or financial compensation. It is assumed that alternative means of access will be provided where existing access points are disrupted by the Proposed Scheme. It is also assumed that hedgerows, field boundaries, water supplies and existing field drainage infrastructure will be re-instated where effects are sustained as a result of operation.

12.7.24 The Proposed Scheme would also require land-take (temporary and permanent) of parcels of agricultural land from a number of individual farm businesses, this number and their locations are currently unknown. For temporary land-take, this would result in the potential for significant adverse impacts for landowners for a temporary period during the construction phase. For permanent land-take, this would result in the potential for permanent significant adverse effects for landowners. For individual farm businesses affected by permanent land-take (e.g. alterations in farm husbandry, field severance and changes in farm access), where possible, mitigation measures would include the provision of new agricultural land of the same classification with an alternative means of access, or financial compensation.

12.7.25 The construction footprint (site boundary) and the locations of the construction compounds are currently undefined, therefore the full extent of land-take (permanent or temporary) during construction is unknown at this stage. A definite figure will be available as the design stage progresses**.**

Operation

NMUs

12.7.26 The Proposed Scheme would have a direct impact on users of Cringleford FP4a as the existing footbridge over A47 would be removed and a minor impact on Cringleford BR5. At this stage, two potential solutions are being considered for local access to Cantley Lane South and for pedestrian movements across the A47. Option A includes the provision of a new footbridge spanning the A47 whereas Option B includes the provision of a new underpass structure for pedestrians and vehicles. Regardless of which option is progressed, there would be a negligible increase in journey times and lengths and crossing movements of the A47 would be maintained.

Amenity

12.7.27 The Proposed Scheme would result in a minor adverse effect for users of Cringleford FP4a should potential solution for Cantley Lane South Option B, namely the provision of an underpass of A47, be progressed.

MTs: Driver stress

12.7.28 Driver stress would be reduced as a result of the Proposed Scheme removing the dominant traffic movements from the junction leading to a reduction in peak hour congestion.

MTs: View from the road

12.7.29 At year 1 of operation, prior to the establishment of Proposed Scheme mitigation planting, there will be localised ‘open’ views from sections of the A11 and A47, but overall resulting in an ‘intermittent’ highway viewing experience. By year 15 of operation views will become more enclosed with establishment of highway boundary mitigation vegetation, but again balanced by potential for views through gaps in planting to maintain the baseline ‘intermittent’ nature of views. The nature of view from the road at year 1 of operation prior to the establishment of mitigation planting will include the apparent influence of Proposed Scheme highway infrastructure including highway surfacing, cutting and embankment landform and bridge structures. By year 15 of operation Proposed Scheme mitigation planting will have integrated the Proposed Scheme to a point whereby the appearance of highway components will be comparable to those experienced in the baseline.

12.7.30 In the outcome of implementation of potential solution for Cantley Lane South Option A, at year 1 of operation, a bridge structure associated with the highway link between Cantley Lane South and Norwich Road will locally accentuate the influence of highway infrastructure in views from the A11, whilst the link road

itself will afford new, ‘open’ views across the surrounding area. By year 15 of operation views from the Proposed Scheme Cantley Lane South to Norwich Road link road will become partially enclosed by mitigation planting resulting in a change to ‘intermittent’ views from the road.

12.7.31 In the outcome of implementation of potential solution for Cantley Lane South Option B, at year 1 of operation, users of the Cantley Lane South to Round House roundabout link road will experience a new road viewing experience of alternating open and closed views associated with the partial enclosure of cutting earthworks and the A47 underpass. By year 15 of operation mitigation planting will further contribute to the partial containment of views from the Cantley Lane South to Round House roundabout link resulting in an overall year 1 to year 15 operational ‘intermittent’ viewing experience.

Community severance

12.7.32 The existing footbridge over the A47 to the south of the interchange would be removed. The footbridge currently allows for NMU access across Cantley Lane, and is used to access services in Cringleford such as the GP surgery. The link road between the A47 and A11 would also be permanently removed.

12.7.33 Potential solution for Cantley Lane South Option A would involve a new footbridge over the A47 and an overbridge on the A11, compensating for the old footbridge.

12.7.34 Potential solution for Cantley Lane South Option B would involve a new underpass south of both the interchange and Cantley Lane, which would provide access for vehicle traffic between Cantley Lane and Cantley Lane South, and would be accessible for NMUs that would previously have used the footbridge.

12.7.35 While no traffic data is currently available on the proposed underpass, it may be less suitable for NMUs than the existing footbridge, and may put cyclists off of using it due to perceived safety concerns.

12.7.36 Similarly, the overall scheme itself is likely to lead to an increase in both traffic speed and traffic flow of the area. This could make the underpass unsafe for NMU use, creating an adverse impact. This increased risk would be greatest at night and on roads without adequate lighting.

12.7.37 The Cantley Lane underpass could also increase traffic flow in Cringleford, therefore causing further severance issues for communities here. Should the underpass become the main access route from south Norwich to Ketteringham, Cringleford could see increases in congestion and safety risks.

12.7.38 The linking of Cantley Lane and Cantley Lane South could also create severance for the owner of the land between Cantley Lane South, the A47 and the Breckland Railway line**.**

Community land and community facilities

12.7.39 It is not anticipated that there will be any permanent impacts on community land and community facilities. This will be explored in the EIA.

Development land

12.7.40 Implementation of the Proposed Scheme may affect proposed future housing developments on adjacent land, in particular, recreational space set to be provided between the proposed housing development and the A47.

Demolition of private property and associated land take

12.7.41 There will be no land take arising from the Proposed Scheme during the operational stage. Where land take is required, this will occur during the construction stage and is set out above (section 12.7).

Local economy

12.7.42 Direct operational employment is not expected to be created as a result of the Proposed Scheme. However, there are likely to be increased indirect employment opportunities related to reduced congestion and improved journey times. Alone these are likely to be minor, but may be significant when viewed cumulatively alongside other schemes being undertaken on the A47. These are likely to be felt throughout Norfolk.

Agricultural land and individual farm business

12.7.43 During the operational phase, the Proposed Scheme would require permanent land-take of some Grade 3 (good to moderate quality) agricultural land. Although Grade 3 is not classified as Best and most versatile (BMV) agricultural land, Sub-grade 3a is categorised as BMV land. Therefore, permanent land-take of Grade 3 agricultural land has the potential to have significant adverse effects during operation.

12.7.44 The effects and impacts to landowners caused by temporary land-take are alleviated during the operational phase of the Proposed Scheme, as the land is re-instated and returned to the landowner. The overall amount of permanent land-take required is currently unknown. For permanent land-take, the mitigation measures for agricultural land would require the provision of alternative land, or financial compensation. It is assumed that alternative means of access will be provided where existing access points are disrupted by the Proposed Scheme.

12.7.45 The Proposed Scheme would also require permanent land-take of parcels of agricultural land from a number of individual farm businesses, this number and their locations are currently unknown. The effects and impacts to landowners caused by temporary land-take are alleviated during the operational phase of the Proposed Scheme as the land is re-instated and returned to the landowner. For individual farm businesses affected by permanent land-take (e.g. alterations in farm husbandry, field severance and changes in farm access), where

possible, mitigation would include the provision of new agricultural land of the same classification with an alternative means of access, or financial compensation**.**

Summary

12.7.46 Table 12.3 provides a summary of potential construction and operational stage effects on people and communities for the Proposed Scheme.

Table 12.3: Summary of potential people and communities effects

Topic	Summary
NMUs	• Construction: The Proposed Scheme would have a direct impact on users of Cringleford FP4a as the existing footbridge over A47 would be removed and a minor impact on Cringleford BR5. The removal of the footbridge would result in increased journey times and lengths during the temporary construction period. • Operation: The Proposed Scheme would see the replacement of the footbridge over the A47 carrying Cringleford FP4a replaced with either a new footbridge or an underpass for pedestrians and vehicles. Regardless of which option is progressed, there would be a negligible increase in journey times and lengths and crossing movements of the A47 would be maintained.
Amenity	• Construction: Amenity is likely to be temporarily impacted for users of Cringleford FP4a, Cringleford BR5 and the existing facilities provided by the Interchange during construction through the presence of construction plant, machinery, materials, construction compounds and construction lighting, whilst there is also potential for barriers and traffic flows to change. With appropriate mitigation, these effects are not considered to be significant. • Operation: The Proposed Scheme would result in a minor adverse effect for users of Cringleford FP4a should potential solution for Cantley Lane South Option B, namely the provision of an underpass of A47, be progressed.
MTs: Driver Stress	• Construction: Driver stress for MTs would increase with changes in traffic flows and speeds, however these effects are not considered to be significant. • Operation: Driver stress would be reduced as a result of removing the dominant traffic movements from the junction leading to a reduction in peak hour congestion
MTs: View from the Road	• Operation: At year 1 of operation, prior to the establishment of Proposed Scheme mitigation planting, there will be localised ‘open’ views from sections of the A11 and A47, but overall resulting in an ‘intermittent’ highway viewing experience. By year 15 views will become more enclosed with establishment of highway boundary vegetation, but again balanced by potential for views through gaps in planting to maintain the baseline ‘intermittent’ nature of views. The nature of view from the road at year 1 of operation prior to the establishment of mitigation planting will include the apparent influence of Proposed Scheme highway infrastructure including highway surfacing, cutting and embankment landform and bridge structures. By year 15 of operation Proposed Scheme mitigation planting will have integrated the Proposed Scheme to a point whereby the appearance of highway components will be comparable to those experienced in the baseline.

Topic	Summary
Community Severance	• Construction: the reconfiguration of the local road network, as well as an increase in construction traffic, could cause temporary severance for users of Thickthorn park and ride during the construction period. There may also be temporary severance for rail users as a result of the existing bridge to be widened across the Breckland Railway Line, south of the interchange. The link road between the A47 and A11 would also be permanently removed. • Operation: it is not anticipated that there will be permanent community severance.
Community Land and Community Facilities	• Construction and Operation: Thickthorn park and ride is likely to be impacted as a result of the construction works. Access to this facility for its users and the route of the buses could be temporarily affected.
Development Land	• Construction and Operation: The permanent land take may affect proposed future housing developments on adjacent land. The land take means that recreational space set to be provided between the proposed housing development and the A47 is likely to no longer occur.
Demolition of Private Property and Associated Land Take	• Construction and Operation: a main and satellite compound will be required during the construction period, meaning that temporary land take will be required. Permanent land take will also be required to carry out the Proposed Scheme along the junction. The extent of this is not yet know and will be explored in the EIA. Permanent land take is likely to occur adjacent to the A47 in an easterly direction to allow for the expansion of the junction. The extent of which is not known yet.
Local Economy	• Construction: temporary employment could be generated in the local area, although due to the size of the Proposed Scheme this is unlikely to be significant. For the duration of the construction phase, there is also likely to by construction workers on-site who could slightly impact on the local economy through using local hospitality and catering establishments. • Operation: direct operational employment is not expected to be created as a result of the Proposed Scheme. However, there are likely to be increased indirect employment opportunities in reduced congestion and improved journey times.
Agricultural Land	• Construction: Both temporary and permanent land-take (Grade 3- good to moderate agricultural land) is required for the Proposed Scheme. Therefore, the Proposed Scheme has the potential to have significant effects on agricultural land. The full extent of land-take both permanent and temporary is currently undefined, therefore the extent of any effects to agricultural land are unknown.

Topic	Summary
	• Operation: The effects and impacts to landowners caused by temporary land-take will be alleviated during the operational phase of the Proposed Scheme as the land is re-instated and returned to the landowner. Permanent agricultural land-take would be required to accommodate the new road layout, and therefore the Proposed Scheme has the potential to have significant effects on agricultural land. The full extent of permanent land-take is currently undefined, therefore the extent of any effects to agricultural land are unknown.
Individual Farm Business	Construction: • Construction: Individual farm businesses would experience the permanent and temporary land-take of agricultural land of Grade 3 (good to moderate quality). Temporary land-take is required to accommodate construction compounds and access during the construction phase. Permanent land-take is required for the new road layout during the construction and operational phases. This land-take has the potential to have significant adverse effects. The full extent of land-take, both permanent and temporary is currently undefined, therefore the extent of any effects to landowners and agricultural land are unknown. The effects and impacts to landowners caused by temporary land-take will be alleviated during the operational phase of the Proposed Scheme as the land is re-instated and returned to the landowner. • Operation: Permanent land-take is required for the new road layout once the Proposed Scheme is operational. This land-take has the potential to have significant effects. The full extent of permanent land-take is currently undefined, therefore the extent of any effects to landowners and agricultural land are unknown.

12.8 Proposed level and scope of assessment

12.8.1 Assessment is required for NMUs, Amenity, MTs Driver Stress, Community Severance, Community Land and Community Facilities, Development Land, Demolition of Private Property and Associated Land Take, and Agricultural Land to a Simple Level during construction and operation, and MTs View from the Road during operation.

12.8.2 Further, Detailed Level assessment is required to determine the significance of the effects on the Local Economy during both construction and operation.

12.9 Proposed methodology including significance

NMUs

12.9.1 The assessment of effects of the Proposed Scheme on NMUs will be undertaken using the guidance contained within the DMRB Volume 11, Section 3, Part 8 Pedestrians, Cyclists, Equestrians and Community Effects and by applying professional judgement. The assessment will examine the likely detriment or improvement to NMU journeys, including changes to journey length and quality of a journey.

Amenity

12.9.2 Amenity is described as the “relative pleasantness of a journey” in DMRB 11.3.8. As such, the assessment will consider Cringleford FP4a and Cringleford BR5 within the study area. Changes to the degree and duration of people’s exposure to traffic, fear or safety for people or existing barriers between pedestrians and vehicle traffic, footpath width, distance from traffic and any crossing facilities within the study area will also be considered. Exposure to noise, dirt and air quality and impacts relating to visual intrusion are also relevant to amenity but will not be included in the assessment, as these impacts are appropriately covered in Chapter 5 Air Quality, Chapter 7 Landscape and Chapter 11 Noise and Vibration.

MTs: View from the road

12.9.3 DMRB 11.3.9 considers that the existence of a new road may enable more people to see the surrounding landscape than before or require people to pass through visually unattractive areas. Route selection has potential to allow travellers to appreciate the wider area and their location in relation to distinctive landscape features through new appropriate views, although characteristics of the new road that may also intrude on views. The view from the road assessment will provide a qualitative overview of the views afforded by the Proposed Scheme. A description will also be provided for traveller’s exposure to different types of scenery through which the routes pass, using the four categories as follows:

- No view - road in deep cutting or contained by earth bunds, environmental barriers or adjacent structures.

- Restricted view – frequent cuttings or structures blocking the view.
- Intermittent view – road generally at ground level but with shallow cuttings or barriers at intervals.
- Open view – view extending over many miles, or only restricted by existing landscape features.

MTs: Driver stress

12.9.4 The assessment of effects of the Proposed Scheme on driver stress will be undertaken using the guidance contained within DMRB Volume 11.3.9. DMRB considers that Driver Stress has three components: frustration, fear of potential accidents and route uncertainty. A qualitative overview will be provided for construction and operation periods applying the three-point descriptive scale (Low, Moderate or High) in line with DMRB 11.3.9.4. The construction driver stress assessment will consider the likely scope of works and will consider potential changes to traffic flows, speeds and congestion for roads within the study area, when compared with the baseline. The operational driver stress assessment will use the traffic forecasts and consider changes in traffic flows and speeds with or without the Proposed Scheme scenarios in the first 15 years after opening.

Community land and community facilities, community severance, development land, demolition of private property and associated land take, and local economy

12.9.5 Assessment will be undertaken in accordance with DMRB Volume 11.3.6 and 11.3.8, and will consider both direct and indirect effects arising as a result of the construction and operational of the Proposed Scheme. This involves identifying social and community resources in the study area, as well as receptors relevant to the topic, and then identifying the activities relating to the Proposed Scheme that could have an effect on those receptors and resources.

12.9.6 Social and community receptors include:

- Residents in the immediate area of the Proposed Scheme.
- Local employers and businesses in the area.
- Employees and job-seekers, particularly those who live locally.
- Users of community facilities in nearby villages, such as educational establishments, health facilities, recreational facilities, places of worship and public transport.

12.9.7 Social and community resources include existing and potential:

- Residential, business, community and development land affected by the Proposed Scheme, construction works, and compounds.

- Community facilities and services including, for example, public transport. Hospitals and community health facilities, primary and secondary schools, nurseries, places of worship and leisure and recreation services.

Agricultural land and individual farm businesses

12.9.8 Assessment will need to be undertaken in accordance with DMRB Volume 11, Section 3, Part 6 (amendment number one): 'Land Use', and will consider both direct and indirect effects arising as a result of the construction and operation of the Proposed Scheme. As outlined in the DMRB, MAFF has classified agricultural land in England and Wales by Grade according to the extent to which its physical or chemical characteristics impose long-term limitation on agricultural use for food production.

12.9.9 The quality of the agricultural land within the study area is classified as Grade 3 (good to moderate quality) agricultural land. This information has been taken from previous stages of design development and assessment and confirmed through the Natural England land capability for agriculture maps and shall be refined as part of the assessment work.

12.9.10 It should be noted that the maps provided by Natural England are not sufficiently accurate for use in assessment of individual fields or development sites, and should not be used other than as general guidance. They show only five Grades, as their preparation preceded the subdivision of Grade 3.

12.9.11 Based on the information above, it will be required to undertake an Agricultural land classification survey (ALC) and Soil resource survey (SRS). The methodology required to be followed for both are set out below.

12.9.12 The purpose of the ALC survey is to categorise the agricultural land at the site in accordance with the ALC for England and Wales (MAFF, 1988). This will determine whether it qualifies as the "best and most versatile" (BMV) land as defined in the National Planning Policy Framework (NPPF). The MAFF ALC system classifies land into five Grades numbers 1 to 5, with Grade 3 divided into Sub-grades; 3a and 3b. BMV agricultural land falls into Grades 1, 2 and Sub-grade 3a. This land ranges from excellent (Grade 1) to good quality (Sub-grade 3a) and is the most flexible, productive and efficient in response to inputs. Land in Sub-grade 3b is of moderate quality with lower yields, and / or a more restrictive cropping range. Grades 4 and 5 are poor and very poor quality respectively, with severe or very severe limitations. The survey work required for an ALC shall be conducted in accordance with DEFRA (2009) and British Standards (BS) BS3882:2015 and BS8601:2013. The survey requires an examination of the local topography, surface conditions and climatic data in addition to intrusive soil inspections, using a combination of hand augers and trial pits.

12.9.13 The purpose of the SRS is to further classify the soils of the site and to identify potential topsoil and subsoil resources present within the site boundary and assess their suitability for off-site sale, on-site re-use in landscaping and on-site re-use in the restoration of temporary areas of agricultural land required for the construction phase of the Proposed Scheme. The SRS component of this work shall be conducted in accordance with DEFRA (2009) section 2.1 paragraph 18 and section 4.1 and BS3882:2015 and BS8601:2013. This shall be based on existing field boundaries and differences in land-use and vegetation cover likely to influence soil properties.

12.9.14 The fieldwork required for an ALC and SRS survey shall be conducted at the same time, with a minimum density of one observation per hectare based on a rectilinear grid needed. A 0.07m diameter (Edleman) hand auger shall be used to log and sample these locations to a depth of 1.2m (or until an impenetrable layer is encountered after three attempts in a location). Soil material shall be brought to the surface in 0.2m auger segments for inspection and logging. Each excavated auger profile shall be photographed and horizon depths recorded to 0.1m accuracy.

12.9.15 Soil inspection pits allow the soil horizons identified by hand auger to be examined in greater detail and photographed. The frequency of the soil inspection pits would be related to the number of different soil types encountered in the auger profiles within the order of one pit per soil type being excavated. Where required, soil pits should be dug to a depth of 1.2m (or until an impenetrable layer is encountered).

12.9.16 Soil profile observations shall be supplemented by observation of field conditions (e.g. relief, vegetation cover) and desk study data. Soil properties shall be recorded in the field according to the Soil Survey Field Handbook (Hodgson, 1997) which provides the standard criteria for soil description. Soil matrix colour, mottles, organic matter, texture, stoniness, water state, structure, consistence and plant root characteristic shall be logged on-site for each horizon observed.

12.9.17 All auger holes and observation pits will be in-filled and re-instated immediately. Access shall be agreed with landowners in advance of any survey work.

12.9.18 Samples shall be collected in the field at each observation location for every soil profile in accordance with BS3882:2015 (topsoil) and BS8601:2013 (subsoil). These samples shall be submitted to a UKAS accredited laboratory for analyses according to BS3882:2015 and BS8601:2013. The analyses shall include:

- Soil texture
- Organic matter content
- Soil pH
- Plant nutrient content
- Electrical conductivity

- Potentially phytotoxic elements
- Visible contaminants; and
- Sharp contents

12.9.19 The combination of the field observations, soil profiles, climatic data and sample testing to BS3882:2015 and BS8601:2013 results allow for the land to be Graded to ALC Classifications and for the soil resources on-site to be identified. A report shall be produced identifying the ALC classification and soil resources of the site.

12.9.20 The results of the SRS shall inform the Soil management plan (SMP). DEFRA (2009) state: “A Soil Resource Plan (SRP) [or Soil Management Plan (SMP)] should be produced on all construction sites where re-usable reserves of topsoil and / or subsoil have been identified.”

12.9.21 The purpose of a SMP is to set out how soils are to be managed on-site, ensure the quality of the soil resources on-site are maintained during construction and ensure temporary land-take of agricultural land is restored satisfactorily upon return to the landowner. The SMP shall require site inspections throughout the construction phase to allow for observations of the soil management on-site.

12.9.22 The DMRB also outlines the assessment of effects on individual farm businesses. It considers land-take, changes in land quality, alterations in farm husbandry, field severance and changes in farm access likely to be imposed on individual farm businesses as a result of the Proposed Scheme. These are aspects which would be undertaken through an agricultural land questionnaire to specific identified farms. The assessment of effects on individual farm businesses will therefore be limited to the size and ALC grade of severed or potentially affected farms.

12.9.23 The assessment will be carried out by working directly with affected landowners, and their agents where appropriate. Questionnaires will be distributed to land users whose land is identified within the area of influence of the Proposed Scheme. These will be followed with direct communications, to discuss farm-specific operations, husbandry requirements and mitigation options. An ALC survey will also be conducted pre-construction to determine the quality and Grade of the effected agricultural land from the Proposed Scheme.

12.9.24 This information will be combined with local land registry data on the location and size of the land holdings to construct a profile of baseline agricultural conditions on each farm. The area of land-take (both temporary and permanent) will then be calculated for each farm business, both in absolute terms and as a percentage of the total area of land utilised by the farm.

Significance of effects

NMUs, amenity, and MTs

12.9.25 Criteria defining significance of effects are not outlined within DMRB Volume 11 Section 3 Part 6 or Part 8. However, DMRB Volume 11 Section 2 Part 5 provides an approach to determining significance of effects as outlined in Table 12.4. The significance of effects for each effect category have been assigned interpreting the guidance from DMRB and using professional judgement.

Table 12.4: Descriptors of the significance of effect categories

Significance Category	Typical Descriptors of Effect
Very Large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or features of local importance may also enter this category.
Large	These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision making if they lead to an increase in the overall adverse effects on a particular resource or receptor.
Slight	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the Proposed Scheme.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Source: DMRB Volume 11 Section 2 Part 5

12.9.26 Interpreting guidance from DMRB, the effect categories have been allocated the following significance (Table 12.5). All NMUs are highly sensitive to change and are considered to be highly valued. Therefore, the descriptors included in the magnitude of change table also correspond to the overall significance of effects for both NMUs (see Table 12.6) and amenity (see Table 12.7).

12.9.27 Views from the Road assessment only views from the new road in operation, and therefore, value, magnitude and significance of effects are not taken into account. A Low, Moderate and High descriptive scale is used to provide a description on driver stress changes from the baseline for motorised travellers in line with DMRB 11.3.9.4 (see Table 12.8 and Table 12.9).

Table 12.5: Value, magnitude and significance assigned to the effect categories

Effect Category	Value	Magnitude	Significance
Non-Motorised Users	High	Negligible, Minor, Moderate or Major (depending on the scale of severance)	Slight, Moderate, Large or Very Large (depending on value and magnitude)
Amenity	High	Dependant on changes to traffic flows and facilities (refer to Table 12.8)	Slight, Moderate, Large or Very Large (depending on value and magnitude)
Driver Stress	Low	Low, Moderate or high (considers change in stress on individual roads from the baseline)	Neutral, Slight or Moderate or Large (depending on overall change from baseline in study area)

Table 12.6: Impacts and magnitude of change on Non-Motorised Users

Description of impacts on non-motorised users	Magnitude
• Substantially improve NMU network through the provision of new amenities for NMUs where none existed previously. • Length of journeys decreased by over 500m.	Major Beneficial
• Improve existing NMU network through the provision of new amenities for pedestrians and cyclists where few or none existed previously. • Length of journeys decreased by 250-500m.	Moderate Beneficial
• Improve existing NMU network through the upgrading of existing amenities or provision of new amenities for NMUs where some already exist. • Length of journeys decreased by up to 250m.	Minor Beneficial
• Length of journeys not materially changed.	Negligible Beneficial
• No change to journey length.	No Change
• Length of journeys not materially changed.	Negligible Adverse
• Improvements to existing NMU amenities are not provided. • Length of journeys increased by up to 250m.	Minor Adverse
• Existing NMU facilities are degraded. • Length of journeys increased by 250-500m.	Moderate Adverse
• Closure/ removal of NMU amenities where they previously existed. • Length of journey journeys increased by over 500m.	Major Adverse

Source: Derived by professional judgement and based on DMRB 11.3.8 Chapter 6

Table 12.7: Impacts and magnitude of change on Amenity

Description of impacts on amenity	Magnitude
• Substantial improvement to NMU network through the provision of new amenities for pedestrians and cyclists where none existed previously.	Major Beneficial
• Improvement to a greater degree than Slight (determined through professional judgement) for the existing NMU network	Moderate Beneficial

Description of impacts on amenity	Magnitude
through the provision of new amenities for pedestrians and cyclists where few or none existed previously.	
• Improve existing NMU network through the provision of new amenities for pedestrians and cyclists where few or none existed previously.	Minor Beneficial
• No change in facilities	No Change
• Pedestrian at grade crossing of a new road carrying below 8000 vehicles per day (AADT) • A new bridge would need to be climbed or a subway traversed	Minor Adverse
• Pedestrian at grade crossing of a new road carrying between 8000 - 16000 vehicles per day (AADT) in the opening year	Moderate Adverse
• Pedestrian at grade crossing of a new road more than 16000 vehicles per day (AADT) in the opening year	Major Adverse
• Description of impacts on amenity	Magnitude
• Substantial improvement to NMU network through the provision of new amenities for pedestrians and cyclists where none existed previously.	Major Beneficial

Source: Derived by professional judgement and based on DMRB 11.3.8 Chapter 6

Table 12.8: Driver stress from traffic flow for single-carriageway roads

Average peak hourly flow per lane, in flow Units/1 hour	Average Journey Speed Km/hr		
	Under 50	50-70	Over 70
Under 600	Moderate (urban area)	Moderate	Low
600-800	High	Moderate	Moderate
Over 800	High	High	High

Source: DMRB 11.3.9, Table 3

Table 12.9 Driver stress from traffic flow for dual-carriageway roads

Average peak hourly flow per lane, in flow Units/1 hour	**Average Journey Speed Km/hr**		
	Under 60	**60-80**	**Over 80**
Under 1200	Moderate (urban area)	Moderate	Low
1200 – 1600	High	Moderate	Moderate
Over 1600	High	High	High

Source: DMRB 11.3.9, Table 2

Community severance, community land and community facilities, development land, demolition of private property and associated land take, and local economy

12.9.28 The sensitivity of these receptors and resources is governed by their capacity to absorb proposed changes arising from the Proposed Scheme. It ultimately reflects their vulnerability to the impacts of the proposed activities and their access to additional or alternative resources of a similar nature. If a resource is frequently used, if few alternatives exist, or if receptors have limited capacity to absorb the changes arising from the Proposed Scheme,

that receptor is considered to be sensitive to the changes. Criteria describing the sensitivity of receptors are identified Table 12.10.

Table 12.10: Socio-economic sensitivity criteria

Sensitivity	Description
High	• An already vulnerable receptor with very little capacity and means to absorb changes. • No alternative facilities, access arrangements or opportunities are available within an easily accessible distance. • A highly or frequently accessed resource.
Medium	• A non-vulnerable receptor with limited capacity and means to absorb changes. • A limited range of alternative facilities, access arrangements or opportunities are available within an easily accessible distance. • A moderately, or-semi-frequently accessed resource.
Low	• A non-vulnerable receptor with sufficient capacity and means to absorb changes. • A wide range of alternative facilities, access arrangements or opportunities are available within an easily accessible distance. • An infrequently accessed resource.

12.9.29 To assess the magnitude of an impact on these receptors and resources, each impact arising is assessed in terms of the following indicators

- Spatial scope – whether impacts are likely to be felt within the Proposed Scheme boundary, within the LIA or WIA (Great Yarmouth and Norfolk), or more widely;
- Extent – how many social and community resources and receptors are likely to be impacted;
- Duration – whether the impacts would be short or long-term; and
- Reversibility – whether the impact is permanent or temporary.

12.9.30 Taking these indicators into consideration, and also any mitigation measures that can be applied; the criteria are used as guidelines to assess the magnitude of each impact. This is described in more detail in Table 12.10.

Table 12.10: Socio-economic and community impact magnitude criteria

Magnitude	Criteria guidelines
Major	• Affects receptors within the WIA and beyond. • Affects the well-being of many receptors (or the well-being of a few receptors in an acute way for an extended period). • Affects receptors for an extended period (e.g. the majority of the construction period or is permanent). • Requires considerable intervention to return to the baseline.
Moderate	• Affects either the well-being of receptors beyond the site boundary into the LIA. • Affects the well-being of a moderate number of receptors.

Magnitude	Criteria guidelines
	• Continues over a number of years, but the baseline is re-established quickly. • May require some intervention to return to the baseline conditions.
Minor	• Affects the well-being of a small number of receptors. • Occurs exceptionally, mostly within the site boundary. • Does not extend beyond the life of the Proposed Scheme (the end of the construction period or first year of operation). • Baseline returns naturally or with limited intervention within a short timescale.
Negligible	• Localised to a specific location within the site. • Temporary or unlikely to result in detectable impact on the well-being of people or a socio-economic resource. • Considered to be a risk that is manageable with intervention. • Baseline remains consistent.

12.9.31 The significance of any potential effects is evaluated by combining the assessment of magnitude of each impact and the sensitivity of the receptor or resource; effects can be beneficial or adverse. Each type of effect is then determined to be either significant or not significant, as shown in Table 12.12.

Table 12.12: Evaluation of significance of effects

		Sensitivity of receptor		
		Low	Medium	High
Magnitude of impact	Negligible	Not significant	Not significant	Not significant
	Minor	Not significant	Not significant	**Significant**
	Moderate	Not significant	**Significant**	**Significant**
	Major	**Significant**	**Significant**	**Significant**

Agricultural land and individual farm businesses

12.9.32 Criteria defining significance of effects are not outlined within DMRB Volume 11 Section 3 Part 6 (amendment number one): 'Land Use'. The significance of effect for agricultural land and individual farm businesses have been assigned interpreting the guidance from DMRB and using professional judgement.

12.9.33 The significance of effects on agricultural land and individual farm businesses will be determined in accordance with Table 12.13.

Table 12.13: Significance of effects table: value, magnitude and significance assigned to the effect categories

Effect Category	Value	Magnitude	Significance
Agricultural Land	Dependent on Agricultural Land Classification (refer to Table 12.14).	Dependent on the area of land lost (refer to Table 12.15).	Slight, Moderate or Large (depending on value and

Effect Category	Value	Magnitude	Significance
			magnitude) (refer to Table 12.16).
Individual Farm Businesses	Dependent on area of land-take (refer to Table 12.17).	Dependent on the proportion of land lost to the business (refer to Table 12.18)	Slight, Moderate or Large (depending on value and magnitude) (refer to Table 12.19).

Source: Derived by professional judgement and based on DMRB 11.3.6 Chapters 6-10

Table 12.14: Value assigned to the assessment of agricultural land based on the ALC grading criteria

Value	Grade
High	1, 2 and 3a
Medium	3b
Low	4 and 5

Source: Derived by professional judgement and based on DMRB 11.3.6 chapters 6-10

Table 12.15: Magnitude of impact assigned to the assessment of agricultural land based on the ALC grading criteria and area of land-take

Grade	Land Take		
	>20ha	**<20ha**	**Indirect**
1, 2 and 3a	Major	Moderate	Minor
3b	Moderate	Minor	Minor
4 and 5	Minor	Minor	Minor

Source: Derived by professional judgement and based on DMRB 11.3.6 chapters 6-10

Table 12.16: Overall effect assigned to the assessment of agricultural land based on the ALC grading criteria and area of land

Value	Magnitude		
	Major	**Moderate**	**Minor**
High	Large adverse	Moderate adverse	Slight adverse
Medium	Moderate adverse	Slight adverse	Slight adverse
Low	Slight adverse	Slight adverse	Slight adverse

Source: Derived by professional judgement and based on DMRB 11.3.6 chapters 6-10.

Table 12.17: Value assigned to the assessment of individual farm businesses, which is based on the area of land-take

Value	Receptor
High	Total area <20ha and / or limited or highly specific range of high-value crops or livestock and low operational flexibility
Medium	Total area 20-50ha and / or some diversification or range of crop or livestock types
Low	Total area >50ha and / or highly diversified income and flexible management

Source: Derived by professional judgement and based on DMRB 11.3.6 chapters 6-10

Table 12.18: Magnitude of impact assigned to the assessment of individual farm businesses, which is based on proportion of land lost

Receptor	Magnitude		
	25% permanent land lost and / or access severely severed	**10-24% permanent land lost and / or access partially severed**	**Indirect 1-9% permanent land lost and / or minor access severed**
Total area <20ha and / or limited or highly specific range of high-value crops or livestock and low operational flexibility	Major	Moderate or Major	Minor or Moderate
Total area 20-50ha and / or some diversification or range of crop or livestock types	Moderate or Major	Moderate	Slight
Total area >50ha and / or highly diversified income and flexibility management	Minor or Moderate	Minor	Neutral or Minor

Source: Derived by professional judgement and based on DMRB 11.3.6 chapters 6-10

Table 12.19: Significance of effect from the value and magnitude assigned to the assessment of individual farm businesses, which is based on the area of land take and proportion of land lost

	Magnitude		
Value	**Major**	**Moderate**	**Minor**
High	Large adverse	Moderate or Large adverse	Slight or Moderate adverse
Medium	Moderate or Large adverse	Moderate adverse	Slight adverse
Low	Slight or Moderate adverse	Slight adverse	Neutral or Slight adverse

Source: Derived by professional judgement and based on DMRB 11.3.6 chapters 6-10

12.10 Conclusion

NMUs, amenity and MTs

12.10.1 Assessment is required to a Simple Level in the first instance for Non-Motorised Users and Amenity for the Proposed Scheme, during both construction and operation. This will be undertaken in accordance with the DMRB Volume 11, Section 3, Part 9 'Vehicle Travellers' and Part 8 'Pedestrians, Cyclists, Equestrians and Community Effects' respectively.

12.10.2 Assessment is also deemed necessary for Motorised Travellers Driver Stress, for the Proposed Scheme to a Simple Level initially, as there would be the potential for significant effects associated with the Proposed Scheme. This will be undertaken in accordance with DMRB Volume 11, Section 3, Part 9 'Vehicle Travellers'.

12.10.3 Whilst the assessment of Views from the Road does not directly associate with a measure of significance of effect, as defined in preceding sections above, the scale and nature of change associated with the Proposed Scheme merits assessment in the ES. Assessment is therefore required for Views from the Road to a Simple Level during construction and operation. The significance of visual effect experienced by road users as a result of the Proposed Scheme will be represented within Chapter 7 Landscape of the ES.

Community severance, community land and community facilities, development land, demolition of private property and associated land take, and local economy

12.10.4 The Proposed Scheme is likely to result in a number of effects on social and community receptors during construction.

12.10.5 Construction of the Proposed Scheme may result in users of Thickthorn park and ride experiencing temporary access restrictions. Where impacts are likely to arise, these can be managed through construction management processes such as the implementation of a Construction Environmental Management Plan (CEMP).

12.10.6 Permanent land take is likely to be required to allow for the junction expansion to go ahead, giving rise to potentially significant adverse effects.

12.10.7 There are also likely to be a number of beneficial effects during construction and operation including the creation of temporary construction employment and the potential for a contribution to significant economic benefits arising from the overall programme of work scheduled for the A47 of which the Proposed Scheme is a part.

12.10.8 The Proposed Scheme has two potential solutions for Cantley Lane South and both options are likely to have significant effects. Consequently, the assessment of the social impacts is scoped in for assessment. The components that are scoped in are severance, property and land take, community facilities and community land, development land, and economics during the construction stage. During the operation stage, severance and community facilities and community land and economics have also been scoped in to explore the effects of the new bridge or underpass (depending on the preferred option).

Agricultural land and individual farm businesses

12.10.9 The Proposed Scheme is also likely to impact on agricultural land and individual farm businesses during construction and operation. In particular, permanent and temporary land-take will be required from the Grade 3 agricultural land, which shall also impact on individual farm businesses. It should be noted that the maps provided by Natural England are not sufficiently accurate for use in assessment of individual fields or development sites, and should not be used other than as general guidance.

The land-take of Grade 3 agricultural land shall require assessment in the forms of ALC and SRS survey work informing the SMP and Farm viability assessment. Work shall be undertaken in accordance with the DMRB Volume 11, Section 3, Part 6 (amendment No 1): 'Land Use'.

12.10.10 Assessment is therefore required for agricultural land, including individual farm businesses during construction and operation as there is potential for significant effects to result from the Proposed Scheme.

Summary of assessment requirements

12.10.11 Table 12.20 outlines the level of assessment required for each sub-topic of People and Communities.

Table 12.20: Level of assessment required

People and Communities Sub-Topic	Level of Assessment Required
NMUs	Simple
Amenity	Simple
MTs Driver Stress	Simple
MTs View from the Road (Operation only)	Simple
Community Severance	Simple
Community Land and Community Facilities	Simple
Development Land	Simple
Demolition of Private Property and Associated Land Take	Simple
Local Economy	Detailed
Agricultural Land and Individual Farm Business	Simple

13 Road Drainage and the Water Environment

13.1 Introduction

13.1.1 This chapter considers existing environmental baseline information for Road Drainage and the Water Environment alongside the proposed scope of assessment and assessment methodologies. This chapter also addresses the potential effects as a result of the construction, demolition and operation of the Proposed Scheme on the Road Drainage and the Water Environment topic. It has been prepared in accordance with DMRB Volume 11, Section 2, Part 4, and DMRB Volume 11, Section 3, Part 10, to a Scoping Level. The topic incorporates surface water and groundwater, water resources and flood risk. This chapter identifies the key impacts, describes the study area and key receptors. The potential requirement for assessment to either Simple or Detailed level will be identified. Where required, this will be presented within the Environmental Statement.

13.2 Study area

13.2.1 The study area encompasses a number of water features within a 1km area around the Proposed Scheme. This is extended where there are features that may be affected by pollutants transported down-gradient of the Proposed Scheme, and therefore these features would be included in the assessment as appropriate.

13.3 Existing and baseline knowledge

13.3.1 This chapter has been completed based on the information from previous stages of design development and assessment, plus the following sources of information:

- British Geological Survey 1:50,000 and 1:625,000 superficial and bedrock geological map and available borehole logs (British Geological Survey, 2017)
- Defra Magic map (Defra, 2017)
- Environment Agency (EA) data (EA, 2017a, 2017b, 2017c, 2017d, 2017e)
- Highways Agency Drainage Data Management System (HADDMS), Drainage Data Management System v5.12.0
- Highways England (2017). A47 Corridor Improvement Programme. Stage 2 Buildability Summary Report

13.3.2 The information in Table 13.1 summarises the relevant waterbodies within the study area for the Proposed Scheme as well as any water dependent designated conservation sites. Figure 13.1 shows the surface water features and flood zones within the study area, Figure 13.2 shows the groundwater

bodies, Figure 13.3 shows the surface water flood risk and Figure 13.4 shows groundwater flooding in the vicinity of the Proposed Scheme (see Appendix D).

Table 13.1 Summary of existing road drainage and the water environment baseline

	Summary of Existing Baseline
Surface Water	• Ordnance Survey (OS) mapping and HADDMS indicates the area of the Proposed Scheme has an elevation of 20 to 33mAOD. The surrounding land is generally flat or undulating which falls from the existing roundabout to the west, east and north. • The study area comprises areas within two Water Framework Directive (WFD) catchments: o The Yare (Tiffey to Wensum) catchment (WFD WBID: GB105034051281) which is located in the northern half of the study area, and; o The Intwood Stream catchment (WFD WBID: GB105034051240) which is located in the southern half of the study area. • The Yare (Tiffey to Wensum) water body (WBID: GB105034051281) itself passes through the study area at the far north-eastern corner. It is designated as a heavily modified water body and lies within the Anglian River Basin District, the Broadland Rivers management catchment and the Yare operational catchment. It is partially protected under the Nitrates Directive (397 and 400) and the Urban Waste Water Treatment Directive (River Tiffey and Yare). • The Intwood Stream water body (WBID: GB105034051240) passes through the study area at the far eastern edge of the study area. It is designated as a heavily modified water body and lies within the Anglian River Basin District, the Broadland Rivers management catchment and the Yare operational catchment. It is partially protected under the Nitrates Directive (400). • The Proposed Scheme lies within the River Yare Nitrate Vulnerable Zone (NVZ) for surface water. • An additional Ordinary watercourse passes through the Proposed Scheme area and beneath both the A11 and A47. This watercourse is known as Thickthorn Stream or Cantley Stream and joins the Intwood Stream WFD water body close to the eastern edge of the study area and is located within the Intwood Stream catchment (Figure 13.1). • A smaller unnamed Ordinary watercourse is located on the extreme northern edge of the study area within the Yare (Tiffey to Wensum) catchment (Figure 13.1). • OS Open Raster mapping indicates a number of ponds in the vicinity of Thickthorn Stream both upstream and downstream of the Proposed Scheme that may constitute

	Summary of Existing Baseline
	potential receptors of road run-off. Two notable ponds are located west (upstream) of the A11 and a further two ponds are located between the A11 and A47 on the north bank of Thickthorn Stream. • A pond of area approximately 5,000m^2 is located southeast of the existing roundabout. The pond appears to be 'offline' from the watercourse but is within the floodplain. A further pond is located to the north of the A11 Newmarket Road roundabout. This pond appears to be an attenuation SuDS feature serving a recent residential development to the north of the A11. • There are no surface water abstractions within 1km of the Proposed Scheme.
Water Quality	• All watercourses are located in the in the Yare Operational WFD Catchment within the Broadland Rivers Management Catchment part of the Anglian River Basin District. • The current Anglian River Basin Management Plan (RBMP), as shown by the Environment Agency's Catchment Explorer (EA, 2017a) shows that the Yare (Tiffey to Wensum; GB105034051281) water body classifies the current ecological and chemical quality of the water body as 'Moderate' potential and 'Good' status, respectively. The ecological potential is limited by supporting elements (surface water) mitigation measures assessment (linked to surface water and groundwater abstractions) and biological quality elements (macrophytes) not supporting 'Good' potential. The overall water body status is classified as 'Moderate' with an objective for 'Good' potential by 2027. • The Anglian RBMP classifies the current ecological and chemical quality of Intwood Stream (GB105034051240) as 'Moderate' potential and 'Good' status, respectively. The ecological potential is limited by physico-chemical quality elements (phosphate linked to the water industry and agriculture) not achieving 'Good' potential. The overall water body status is classified as 'Moderate' and is not expected to obtain 'Good' potential due to it being disproportionately expensive. • Both water bodies are protected under the Nitrates Directive (EA, 2017a). The entire study area is within the Yare Surface Water Nitrate Vulnerable Zone (NVZ) (S400) and the majority of the study area is also within the Norwich Crag and Gravels Groundwater NVZ (G79). The River Yare is also partially protected by the Urban Waste Water Treatment Directive.

	Summary of Existing Baseline
	• No assessment of pollution impacts from routine run-off to surface waters has been undertaken using the Highways Agency Water Risk Assessment Tool (HAWRAT) • The Broadland Rivers Chalk and Crag groundwater body (GB40501G400300) has 'Poor' chemical and quantitative status (2016 cycle 2). The quantitative status is limited by the Groundwater Dependent Terrestrial Ecosystems (GWDTE) test which scored poorly due to agricultural abstractions lowering the natural flow and levels of the groundwater. The objective is to achieve 'Good' quantitative status by 2021. The chemical status is limited by the Chemical Drinking Water Protected Area criteria, which scored poorly due to suspect data. Objectives are to achieve 'Good' chemical status by 2027 by natural recovery. The Broadland Rivers Chalk and Crag groundwater body is linked to areas protected under the Nitrates Directive listed. • Option A crosses a historical landfill site between Ch.200 to 250. More details on the historical landfill may be found in Chapter 9 Geology and Soils. • There are four consented discharges to surface water within the study area of the Proposed Scheme which consist of the following: o One contaminated site drainage to a balancing pond from a waste collection/ treatment/ disposal/ materials recovery commercial premises at OS National Grid Reference (NGR) TG 17296 03981 (ref EPRKB3690NY); o One treated effluent discharge to the small Ordinary watercourse close to the A11 from a commercial premise at OS NGR TG 16931 04275 (ref PRENF19656), and; o One treated effluent discharge to the Ordinary watercourse to the north of the Proposed Scheme from an educational facility at OS NGR TG 17715 05529 (ref EPREB3397RL), and; o One treated effluent discharge to Intwood Stream to the south east of the Proposed Scheme from a commercial premise at OS NGR TG 19580 04310 (ref PRENF16384).
Groundwater	• The bedrock and superficial geology within the study area is described in detail in Chapter 9 Geology and Soils and summarised below. • The superficial geology mainly comprises Lowestoft Formation (Diamicton), classified as a Secondary (Undifferentiated) aquifer. The Sheringham Cliffs Formation Sand and Gravels and Alluvium superficial deposits are

	Summary of Existing Baseline
	also present within the study area and are classified as Secondary A aquifers. The Sheringham Cliffs Formation Sand and Gravel is overlain by the Lowestoft Formation (Diamicton) and may be present across the whole site. This will be determined by ground investigations (see Figure 13.2). • Existing boreholes beneath the Proposed Scheme recorded the superficial deposits as dry and the Chalk to have a rest water level of 14m AOD (18 m below ground level (bgl)). To the south of the study area, near Thickthorn Stream, groundwater levels are recorded in the Sheringham Cliffs Formation Sand and Gravels at a maximum of 1.1m bgl (BGS, 2017). • The Proposed Scheme is within a groundwater Nitrate Vulnerable Zone (NVZ) where directly underlain by Sheringham Cliffs Formation Sand and Gravels superficial deposits. • The bedrock geology underlying the study area comprises undifferentiated formations within the White Chalk Subgroup, a Principal Aquifer. This aquifer has a Major Aquifer Intermediate vulnerability classification. This means the overlying superficial deposits provide some protection but there is still the potential for leaching to groundwater (see Figure 13.2). The groundwater within the study area is part of the Broadland Rivers Chalk and Crag WFD groundwater body (GB40501G400300). • The Chalk is present under the Proposed Scheme at an elevation of approximately 18m AOD (14m bgl), which reduces to 5m AOD to the south of the study area, near Thickthorn Stream. The Proposed Scheme partially overlies a Source Protection Zone (SPZ) 2 (Outer Zone) associated with groundwater abstractions for public water supply in Norwich, 5km to the east. However, there is no corresponding licensed abstraction for potable water supply shown on the EA's website (EA, 2017f). The shape of the SPZ suggests that groundwater flow is predominantly to the east. A SPZ 2 is located in the north of the 1km study area and relates to public water supply abstractions 3km to the north of the Proposed Scheme (see Figure 13.2). • Five licensed groundwater abstractions were identified within 1km of the Proposed Scheme, used for agricultural and domestic water supply purposes. • Four private water supply points were identified within the study area; all supply water for domestic purposes and are located south of the railway line.

	Summary of Existing Baseline
	• There are two consented discharges to soakaway within the study area of the Proposed Scheme which consist of the following: o One treated effluent discharge to ground to the south of the A11 from an Engineering Depot at OS NGR TG 17250 03850 (ref PRELF13102), and; o One treated effluent discharge to ground to the south of the A11 from a single domestic property at OS NGR TG 17147 03915 (ref NPSWQD002134). • There is one consented discharge to land within the study area of the Proposed Scheme which consists of the following: o A sewage discharge (final/treated effluent) to land from a single domestic property (likely septic tank with drainage field) at OS NGR TG 19600 04900 (ref PR4NF921). It is underlain by Sheringham Cliffs Formation Sand and Gravels.
Flood Risk	• According to the EA's Flood Map for Planning (EA, 2017b), the majority of the study area is located within Flood Zone 1 (all areas outside of Flood Zones 2 and 3 in Figure 13.1) which is associated with a low risk of flooding from fluvial and coastal sources (an annual probability of less than 1 in 1,000 (0.1%) of river and sea flooding. • Where Thickthorn Stream passes beneath the A11 to the west there are localised areas of Flood Zone 2 and Flood Zone 3a. Beneath the A47 to the east, there are localised areas of Flood Zone 2, and Flood Zone 3b. • The Flood Zones are defined as; o Flood Zone 2 consists of land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. o Flood Zone 3 is split into two separate zones; 3a and 3b; o Flood Zone 3a comprises of land assessed as having a 1 in 100 or greater annual probability of river flooding; or land having a 1 in 200 or greater annual probability of sea flooding. o Flood Zone 3b comprises as land where water has to flow or be stored in times of flood. • In addition, the study area intersects at the eastern edge, Flood Zones 2 and 3b associated with Intwood Stream and the River Yare although these are remote from the Proposed Scheme itself.

	Summary of Existing Baseline
	• The A47 is sufficiently raised above the floodplain and the EA Flood Map for Planning (EA, 2017b) shows the carriageway itself not to be at risk of flooding. • The A11, however, is not raised sufficient above the floodplain and the EA Flood Map for Planning (EA, 2017b) does indicate the carriageway as being at risk from flooding. • There are no flood defences, areas benefitting from defences or flood storage areas with the study area. • The EA's Historic Flood Map does not indicate any areas of previous flooding within the study area. • The Norfolk County Council Norfolk Local Flood Risk Management Strategy (Norfolk County Council, 2015) indicated that 10 residential properties in Cringleford to the east of the Proposed Scheme are at risk of flooding and 20 residential properties in Hethersett to the west of the Proposed Scheme are at risk of flooding. • The EA's Risk of Flooding from Surface Water map (EA, 2017c) shows the majority of the study area is at very low and low risk of flooding (as identified in Figure 13.3), meaning there is an annual risk of less than 0.1% and between 0.1% and 1% respectively. • There are localised areas of medium and high risk of surface water flooding, especially associated with the floodplains of Thickthorn Stream and the smaller watercourse to the north and areas on the A47/A11 junction roundabout. The map appears to indicate an area of surface water ponding to the west (upstream) of the A47 where the smaller watercourse passes beneath the carriageway. The map also indicates a medium risk surface water flow path across the A11 to the south of Thickthorn Stream. • The EA Flood Risk Map from Reservoirs (EA, 2017c) indicate the study area and Scheme are not at risk of flooding due to reservoir failure. • HADDMS identified a number of instances of historic flooding on the A47 within the study area: o One low severity (0-2) incident of carriageway flooding on the A47 near Thickthorn Stream in 2009. o Three low severity (0-2) incidents of flooding on the carriageway at the A11/A47 junction roundabout in 2012, 2016 and 2017. o Six low severity (3-4) incidents of flooding on the carriageway at the A11/A47 junction roundabout between 2013 to 2017 due to blocked gullies and heavy rainfall.

	Summary of Existing Baseline
	○ Two medium severity (5-6) incidents of flooding on the A47 carriageway in 2016 and 2017 due to blocked gullies and heavy rainfall. ○ One low severity (1-2) incident of carriageway flooding on the A47 near the unnamed watercourse to the north due to blocked gullies. • Currently there is no information from Anglian Water regarding sewer flooding.
Groundwater Flood Risk	• The Proposed Scheme crosses zones of potential for groundwater flooding to surface and below surface structures between Ch.0 and 200 and potential for groundwater flooding for below ground structures at Ch.650 for Option A. Option B crosses a zone of potential for groundwater flooding to below ground structures at Ch.275 (see Figure 13.4).
Drainage	• HADDMS identifies a number of outfalls within the study area: ○ Six outfalls discharging run-off from the A11 to Thickthorn Stream all classified as Category D Priority Outfalls (low pollution risk): ▪ TG1704_8886a and TG1704_8987a to the west of the A11 and ▪ TG1704_9081a, TG1704_9384a, TG1704_9585b, and; TG1704_9686a to the east (downstream) of the A11 ○ Sixteen outfalls discharging run-off from the A47 to Thickthorn Stream all classified as Category D Priority Outfalls (low pollution risk): ▪ TG1804_9884b, TG1904_0186a, TG1904_0285a, TG1904_0285b and TG1904_0681a to the west of the A47, and; ▪ TG1904_1084a, TG1904_0084b, TG1904_1185a, TG1904_1185b, TG1904_1186a, TG1904_1386b, TG1904_1387a, TG1904_1686c, TG1904_1686d, TG1904_1886b and TG1904_1886d to the east of the A47 ○ In addition, five outfalls were identified on the northern boundary of the study area which receive drainage flow from the Proposed Scheme area running north along the A47. The outfalls discharge to an unnamed Ordinary watercourse within the Yare (Tiffey to Wensum) water body catchment: ▪ TG1706_8136a, TG1706_8136b, TG1706_8136c and TG1704_8136d to the west of the A47, and; ▪ TG1706_8441a to the east of the A47 which outfalls to a detention pond (TG1706_8542a).

	Summary of Existing Baseline
	• HADDMS suggests that the majority of the existing drainage within the study area ultimately discharges to Thickthorn Stream with the area of the A47 north of Thickthorn Junction ultimately discharging to the smaller unnamed Ordinary watercourse to the north. • HADDMS also identified 19 soakaways (all classified as Category D, low pollution risk to groundwater) within the study area, these receive run-off from the A47/A11 junction roundabout and the A47 itself between the roundabout and Thickthorn Stream. • HADDMS identified an interceptor (TG1704_9383a) located prior to the outfall from the A11 to Thickthorn Stream. This interceptor and outfall receive drainage run-off from the A11 to the south of Thickthorn Stream. • The Proposed Scheme lies within a partly urbanised catchment, particularly to the east of the A47 where surface water drainage is governed by Local Authority (Norfolk County Council) highways drainage and Anglian Water's sewerage drainage network. Subject to the outcome of the drainage survey, the Proposed Scheme drainage does not appear to connect to the local network. • The HADDMS and other available information on highway drainage arrangements and outfalls is relatively limited and a drainage survey is required to confirm outfall locations and sizes, receptors and the existence of any water pollution control systems. • Part of the Proposed Scheme (Intwood Stream catchment (GB105034051240)) lies within the boundary of the Norfolk Rivers Internal Drainage Board (IDB). The IDB drainage district does not cover its full watershed catchment area, and the boundary is based on the principles of the 1933 Medway Letter which sought to set boundaries for low lying areas which requires close attention to manage and reduce the risk of flooding (Broads, 2006).
Aquatic Ecology	• Through potential impacts on the water environment, the Proposed Scheme has the potential to impact on the aquatic ecology in the study area. • Intwood Stream is classified as ‘Good’ potential for invertebrates with no classification for fish and an objective to maintain ‘Moderate’ overall ecological potential. • River Yare (Tiffey to Wensum) is classified as ‘Good’ potential for fish and ‘Moderate’ potential for macrophytes and phytobenthos with an objective to maintain ‘Good’ overall potential. • Water Voles have been confirmed under the A11 Bridge and signs of Otter activity were observed within the study

	Summary of Existing Baseline
	area. Any appropriate assessment and mitigation for these features would be outlined in Chapter 8 Biodiversity. • There are no Ramsar sites, Special Areas of Conservation (SAC), Local Nature Reserves (LNR) or National Nature Reserves (NNR) within the study area. • Downstream and outwith the study area, the River Yare is hydrologically linked to Eaton Common LNR and Marston Marshes LNR. Desmoulins' whorl snail, Otters and Water Voles have been recently recorded at Marston Marshes LNR. Otters are likely to be present at Eaton Common LNR. The site of the Proposed Scheme is within the home range of resident otters at these LNRs. Otter commuting and foraging may be disturbed by the Proposed Scheme. • There are five Priority Habitat sites located within the study area along Thickthorn Stream: o There is a Coastal and Floodplain Grazing Marsh Priority Habitat located to the south west of the study area along Thickthorn Stream; o Downstream of this, between the A11 and Cantley Lane South, lies a Good Quality Semi-Improved Grassland; o A Lowland Meadow Priority Habitat is located within the south-east of the Proposed Scheme boundary along Thickthorn Stream. o South of this a Lowland Fen Priority Habitat is located along Thickthorn Stream. Lowland Fens receive water and nutrients from the underlying soil, rock and groundwater. At this location, the fen is underlain by Alluvium and may be in hydraulic continuity with the underlying Secondary A and Principal Aquifers, where groundwater levels from existing borehole logs are at a maximum of 1.1m bgl. o A second Lowland Fen Priority Habitat is located within the study area, a further 0.5km east along Thickthorn Stream. At this location, the fen is also underlain by Alluvium. • Further information on sensitive species and aquatic ecology is available in Chapter 8 Biodiversity.
Recreation and Human Health	• There are no surface water abstractions within the Proposed Scheme or study areas. • The watercourses within the study area are predominantly minor Ordinary watercourses and are unlikely to be used for recreation activities such as navigation or fishing. However, there are some amenity green spaces surrounding the watercourses which are publicly accessible providing a space for recreation and dog walking, for example.

	Summary of Existing Baseline
	• Intwood Stream and the River Yare are both classified as Main Rivers within the study area although neither are used for navigation. • A number of licensed and unlicensed groundwater abstractions used for potable water supply have been identified within the study area. In addition, Option A crosses a SPZ 2 (Outer Zone) at its northern extent. This SPZ is associated with groundwater abstractions for public water supply 5km to the east, in Norwich. A SPZ 2 is located in the north of the 1km study area and relates to public water supply abstractions 3km to the north of the Proposed Scheme. The current status of these licences require verification, however.
Climate Change	• The associated online climate change allowance (EA, 2017d) states that to allow for residual uncertainty in assessing the impacts of climate change on future flood risk, fluvial flow rates should be increased by 65% which refers to the 'Upper End' categories for the Anglian Region and a time horizon of 2080s (2070 to 2115), as the Site is classed as 'essential infrastructure' partly lying in Flood Zone 3b. • The Met Office regional climate summary for Eastern England (Met Office, 2016) indicates the current climate baseline to be: o Mean annual temperatures ranging from 9.5°C to around 10.5°C in the low-lying areas with mean daily minimum temperatures of 1°C in winter and mean daily maximum temperatures of 20°C to 23°C in summer. o Average annual sunshine durations over Eastern England range from over 1600 hours in Norfolk Suffolk and Essex to less than 1450 hours in the east Yorkshire and Lincolnshire. o Eastern England has a more even annual distribution of rainfall when compared with the rest of the UK with an average of 30 rain days in winter and less than 25 days in summer o The average number of days with snow falling is about 20 per year in low lying areas. o Eastern England is one of the more sheltered parts of the UK in terms of wind
Major Accidents and/or Disasters (Events)	• Norfolk County Council Local Flood Risk Management Strategy (Norfolk County Council, 2015) identified historic flooding events in Norwich with the largest in 1912 with an estimated return period of 800-years. Fifteen flooding events were reported between 2001 and 2009 with the most significant in 2008.

	Summary of Existing Baseline
	• No further information was available on major accidents, disasters or pollution events/spills within the study area. • Further consultation will be required with Norfolk County Council, South Norfolk District Council and Anglian Water to fully understand the extent of extreme historical flooding in the study area.

13.4 Assumptions and limitations

13.4.1 This scoping exercise has been prepared using publicly available information and with reference to previous assessments carried out and through the use of HAGDMS and HADDMS. The assessment presented is based on a desk study and no site visit was undertaken at the time of writing. Considering the nature of the Proposed Scheme, it is not considered that the data limitations introduce any significant uncertainties with respect to surface water, groundwater and flood risks.

13.4.2 Information on the existing drainage Proposed Scheme, including outfall locations, is currently limited and will be verified as part of a drainage survey to be undertaken during design development.

13.4.3 There are currently no details of the Proposed Scheme drainage design.

13.4.4 It is assumed that significant in-channel works and stream re-alignment will be necessary on Thickthorn Stream where the culvert will be extended, and east of this where the Cantley Lane South route diversion is to be located should that route option be preferred.

13.4.5 It is assumed that temporary watercourse crossings will be required as part of the Proposed Scheme.

13.5 Guidance and best practice

13.5.1 The scope, level of assessment and methodologies listed in Sections 13.8 to 13.9 represent the approach required to meet the following statutory and non-statutory requirements:

- National Planning Policy Framework (DCLG, 2012) and its associated Technical Guidance (DCLG, 2016)
- Highways (Environmental Impact Assessment) Regulations 2007 (EIA Highways Regulations 2007)
- Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (2000), more commonly known as the Water Framework Directive

- Water Environment (Water Framework Directive) (England and Wales) Regulations 2000
- The Groundwater (Water Framework Directive) (England) Direction 2016
- Groundwater protection guides covering: requirements, permissions, risk assessments and controls (EA, 2017e), previously covered by: Groundwater protection: principles and practice (GP3) (EA, 2013a)
- Land Drainage Act 1991 and 1994
- Flood and Water Management Act (2010)
- Environment Agency environmental permitting guidance
- The Environmental Permitting (England and Wales) Regulations (2010) which replaces the Water Resources Act (1991) as the key legislation for water pollution in the UK
- The Greater Norwich Development Partnership (2014) Joint Core Strategy for Broadland, Norwich and South Norfolk
- The South Norfolk Local Plan (2015-2026)
- The Environment Act (1995)
- The Water Act (2014)

13.5.2 The Road Drainage and Water Environment assessment will be undertaken in accordance with Highways England's technical guidance provided in DMRB Volume 11, Section 3, Part 10 (HD 45/09, HA, 2009).

13.6 Consultation

13.6.1 Consultation with the following organisations will be required throughout the environmental assessment:

- Environment Agency
- Norfolk County Council as Lead Local Flood Authority (LLFA)
- Norfolk Rivers IDB
- South Norfolk District Council
- Anglian Water

13.6.2 It is proposed to initiate consultations with the organisations listed in Section 13.6.2 regarding clarifications on approach and other issues relating to water quality and WFD status, flooding, drainage and groundwater. The outcomes of the relevant consultation will be detailed in the ES.

13.7 Potential effects, including monitoring and mitigation measures

Construction and demolition

13.7.1 A main compound with a satellite compound will be required for the duration of the works, the location of the main compound for both options is proposed to be to the west of the junction in an area of fields. A satellite compound will

be required to the east side of the A47 in the location of the tie in and a system of haul roads will be required to provide HGV access to each area of the works. An alternative location of the main compound would be to the north of the B1172 adjacent to the existing roundabout, this option is currently under review (Highways England, 2017).

13.7.2 The construction phase has the potential to impact upon the water environment (including groundwater) through mobilisation of sediments and contaminants due to earthworks, construction dewatering, vehicular movements, plant and vehicle washing and alterations to ground levels. The impacts of this would be mitigated by best practice construction measures to be included within the Construction Environment Management Plan (CEMP) in accordance with Construction Industry Research and Information Association (CIRIA) Guidelines (CIRIA C543, 2002; CIRIA C648, 2006; and CIRIA C741, 2015).

13.7.3 Any permeable horizons present within the superficial deposits, particularly the alluvium or Sheringham Cliffs Formation Sand and Gravel deposits, may act as pathways for the migration of near-surface groundwater or contaminants. Any pilings or foundations could create preferential pathways for the migration of pollutants to the underlying aquifers. Pilings and foundations may also have the potential to act as groundwater dams. This is of particular concern where construction works may occur within SPZ2 (Option A). If any construction works presents a significant risk to groundwater within SPZ 2, the EA may require a programme of groundwater monitoring to be installed to give early warning of any developing groundwater contamination or development of harmful disturbance of groundwater flow (EA, 2017g). Disturbance of groundwater flows may also impact on the Lowland Fen (Priority Habitat) located within the study area.

13.7.4 The Proposed Scheme lies within the River Yare NVZ for surface water and the majority of the Proposed Scheme lies within the Norwich Crag and Gravels groundwater NVZ. Where construction activities have the potential to mobilise nitrate during, for example, earthworks in areas of agriculture, there is a potential to increase nitrate concentrations within the Yare or to groundwater, including the SPZ and Lowland Fens (Priority Habitat). The risk of nitrate mobilisation will be managed by the implementation of best practice construction measures through the CEMP and, if appropriate, would include water quality monitoring, prior to, and during the construction period.

13.7.5 Construction activities for the Proposed Scheme could increase the risk of a pollution incident at the site of works, associated with accidental spillages or leakages of fuel, chemicals, wastewater, cement and admixture. This could adversely impact on the principal aquifer, SPZ and associated public water supply abstraction, other local abstractions and the downstream Eaton Common and Marston marshes LNRs. However, due to the temporary nature of these impacts, and with appropriate best practice working measures implemented through the CEMP, the risk is considered to be mitigated.

13.7.6 Where works will lead to temporary changes in the surface water run-off regime by the alteration of ground elevations and overland flow pathways for example, by earthworks or proposed structures, a temporary surface water drainage strategy would be developed for the Proposed Scheme and incorporated into the CEMP to ensure that there will be no increase in run-off and flood risk during the construction phase. SuDS would be implemented where appropriate.

13.7.7 The culvert extension where the A11 crosses Thickthorn Stream and the associated river re-alignment (both option A and B), plus the realignment of Thickthorn Stream associated with the proposed raised embankment structure from Cantley Lane South across the A11 (Option A only) is likely to require temporary construction works within the floodplain and river channel. This has the potential to mobilise sediment and contaminants, impacting on the water quality and aquatic ecology downstream. Appropriate mitigation measures would be implemented through the CEMP and, if appropriate, would include water quality monitoring, prior to, and during the construction period.

13.7.8 The construction of the raised embankments and other earthworks within the Thickthorn Stream floodplain will lead to a loss of floodplain storage altering flood flow pathways and could increase in flood risk downstream. This can be mitigated through the provision of compensatory storage and will be considered as the preliminary design progresses and the requirements are confirmed.

13.7.9 The construction phase has the potential to effect recreational users of, and the aquatic ecology within, the watercourses due to increased pollution during construction. Due to the temporary nature of these impacts, and with appropriate best practice measures implemented through the CEMP, these risks are likely to be mitigated.

13.7.10 Given the requirements for construction activities within the Thickthorn Stream watercourse and its immediate floodplain, to enable the new watercourse crossings to be constructed, it is likely that water quality monitoring will be required prior to and during the construction phase.

13.7.11 Any construction activities on or near a main river, on or near a flood defence structure or in the flood plain of a main river, would require a flood risk activity permit from the EA.

13.7.12 Any construction activities on or near an Ordinary watercourse or IDB watercourse would require consent from the Lead Local Flood Authority (Norfolk County Council) or the IDB (Norfolk Rivers IDB) as appropriate.

13.7.13 The requirements for demolition are yet to be confirmed as part of the preliminary design. Potential demolition activities include the removal of side roads where they are no longer required.

Operation

13.7.14 The potential effects of Proposed Scheme operation on the water environment will be assessed and mitigated through the Proposed Scheme design.

13.7.15 Sections of the A11 and A47 carriageway and side roads are within Flood Zones 2 and 3, although majority of the Proposed Scheme area lies within Flood Zone 1. The effect of an increase in impermeable area could result in an increase in peak flow rates and volumes which could, in turn, increase flood risk, particularly within areas of Flood Zones 2 and 3. Appropriate mitigation by attenuation would be required to ensure there is no increase in surface water run-off peak flow rate resulting from the Proposed Scheme. This mitigation may take the form of SuDS, where appropriate. SuDS features should be designed in accordance with the SuDS Manual (CIRIA, 2007).

13.7.16 The proposed raised embankments and other earthworks associated with the Thickthorn Stream floodplain (including the Cantley Lane link road embankment – option A) will lead to a loss of floodplain storage in Flood Zone 3, altering flood flow pathways and could increase fluvial flood risk upstream and downstream. Compensatory flood storage would be required to mitigate this impact.

13.7.17 The Proposed Scheme requires the widening of the existing A11 Thickthorn Stream culvert and its approaching embankments and the widening of the existing A47 railway overbridge and its approaching embankments. Should Option A progress, the Proposed Scheme would also require the culverting of Thickthorn Stream downstream of the A11 to accommodate the new Cantley Lane link road. The Proposed Scheme also requires the re-alignment of Thickthorn Stream where the culvert will be extended under the A11, and, for option A only, potentially east of this where the Cantley Lane South route diversion would also result in the re-alignment of Thickthorn Stream. This has the potential to adversely affect the status of the watercourse including the hydrological and geomorphological regime, and the quality of in-stream and riparian habitat. Detailed assessment will be required to ensure the design of the widened structures does not cause an adverse impact and aims to enhance the overall condition of Thickthorn Stream, where possible. Appropriate hydrological and hydraulic modelling of impacts on flooding will be required. Furthermore, appropriate mitigation will be required to ensure the widened structures do not increase flood risk upstream or downstream of the Proposed Scheme and do not result in a deterioration of the WFD status.

13.7.18 Any underground structures, such as foundations or underpasses, have the potential to act as groundwater dams, potentially resulting in mounding of groundwater up-gradient of the structure and a reduction of groundwater availability down-gradient of the structure.

13.7.19 Any cuttings transecting permeable strata may result in seepage through the cutting face, resulting in additional flows to the drainage system. Seepage volumes will be calculated to inform the drainage design, however.

13.7.20 The increase in impermeable surface area is unlikely to reduce recharge to underlying groundwater bodies, due to the surface area of the new hardstanding relative to the overall surface area of the aquifer.

13.7.21 The proposed sections of lane widening and additional slip and link roads, along with the potential associated increase in the volume of traffic may result in an increase in pollutant loads in highway run-off, resulting in long term increase in diffuse pollution and subsequent deterioration in water quality of surface water and groundwater. Any potential impact would be mitigated using SuDS measures (CIRIA, 2007).

13.7.22 Appropriate mitigation/attenuation would be required to ensure no increased surface water run-off peak flow rate or volume and/or reduction in flood plain storage results from the Proposed Scheme. This mitigation may take the form of SUDS, where appropriate and subject to suitable ground conditions. Permanent SUDS features should be designed in accordance relevant DMRB Standards (Highways England, 2016a; 2016b) and the SUDS Manual (CIRIA, 2007).

13.7.23 Should Option A be progressed discharge locations for SuDS features may require careful consideration to avoid discharges to groundwater occurring within the SPZ 2. Where this is unavoidable, the EA may require the provision of suitable treatment or pollution prevention measures.

13.7.24 A possible deterioration in water quality may result in a detrimental impact on the aquatic ecology and the health of humans who participate in recreational activities in or adjacent to the watercourses.

13.7.25 There is a risk of pollution to groundwater or surface water resulting from accidental spillages or pollution incidents. This risk is likely to increase with the potential increase in the volume of traffic. This may result in short term impacts on water quality and aquatic ecology without mitigation in the form of pollution control devices and SuDS treatment measures.

13.7.26 Any construction activities on or near a main river, on or near a flood defence structure or in the flood plain of a main river, would require a flood risk activity permit from the EA.

13.7.27 Any construction activities on or near an Ordinary watercourse or IDB watercourse would require consent from the Lead Local Flood Authority (Norfolk County Council) or the IDB (Norfolk Rivers IDB) as appropriate.

13.7.28 Monitoring the impacts of Proposed Scheme operation on the water environment is not considered necessary provided that appropriate measures are implemented to mitigate any impacts. The only exception to

this is the monitoring for the post construction impacts of the Thickthorn Stream realignment.

13.8 Proposed level and scope of assessment

Surface Water

13.8.1 Thickthorn Stream, the smaller unnamed Ordinary watercourse to the north and the pond on the north bank of Thickthorn Stream will be considered as part of the assessment. These are part of the wider River Yare catchment. These water bodies are hydrologically connected to the Proposed Scheme and are likely to receive the highway drainage from the Proposed Scheme. Assessment would be undertaken to a Simple Level in the first instance.

Groundwater

13.8.2 The assessment will consider both groundwater level and quality impacts in accordance with the requirements of the WFD. Consideration will be given to the potential changes to water flow, volumes and quality during both the construction and operation phases. Consideration of conveyance of flow to indirect receptors, such as the SPZ, licensed abstractions, Intwood Stream and the River Yare. Additional information collected as part of the ground investigation, including groundwater level monitoring, will be used to inform the assessment. Potential impacts are likely to be covered by the CEMP and drainage design, however.

13.8.3 It is not known at this stage whether groundwater will be discharged to soakaway during either construction (dewatering activities) or operation (road drainage) phases. If required, assessments relating to these will be undertaken. Assessment would be undertaken to a Simple Level in the first instance.

Water Framework Directive and Water Quality

13.8.4 As noted previously, the Proposed Scheme has the potential to impact on surface water bodies and groundwater bodies during construction, operation and demolition through direct construction impacts and from potential run-off or spills during operation. This could potentially damage aquatic ecosystems and human health.

13.8.5 It is proposed to assess the impact of routine run-off and spillages on water quality on the receiving water bodies through a Simple and if required for routine run-off, a Detailed assessment. A HAWRAT Assessment has not been undertaken to date, this will be undertaken during the next stage of assessment.

13.8.6 The entire study area is within the Yare surface water NVZ and the majority of the study area is also within the Norwich Crag and Gravels Groundwater NVZ. It is anticipated the Proposed Scheme will not impact upon these protected areas during construction, demolition and operation due to

mitigation within the design and through the implementation of best practice construction measures described in the CEMP.

13.8.7 A preliminary WFD compliance assessment will be carried out as part of the assessment, in consultation with the EA, to screen if the Proposed Scheme has the potential to have an effect on the WFD status of the water bodies within the study area. Any potential significant adverse impacts on these water bodies will trigger a standalone detailed WFD compliance assessment report.

13.8.8 The design of the Proposed Scheme is ongoing, however, it is anticipated that a number of in-channel structure modifications, channel diversions and a section of new culvert will be required in Thickthorn Stream. Therefore, a detailed WFD compliance assessment is anticipated for these proposals. A geomorphological survey and impact assessment of Thickthorn Stream would be required to support the WFD assessment. The WFD assessment would identify opportunities for enhancement measures.

13.8.9 Other works within the floodplain and over channel will be required as part of the Proposed Scheme construction, any potential impacts are likely to be mitigated by measures outlined in the CEMP.

Licensed Abstractions and Potable Water Supply

13.8.10 Further information on licensed and unlicensed private water supplies will be identified in consultation with the EA and the local authority. This will include confirmation of the licensed abstraction relating to the SPZ.

13.8.11 Should any groundwater abstractions be identified within the Proposed Scheme area, it is not anticipated that the construction, demolition and operation of the Proposed Scheme will result in an impact on licence holder's ability to abstract groundwater, as resource availability is unlikely to be affected by any increase in impermeable area or diversion of groundwater flows, and contamination risks are to be mitigated through the CEMP and the design. However, this assumption will be reviewed once further information has been received. Assessment would be undertaken to a Simple Level in the first instance.

Consented Discharges

13.8.12 It is considered that the construction, demolition and operation of the Proposed Scheme will result in a minor impact on the dilution of existing consented discharges as any change in run-off from the Proposed Scheme, in terms of volume and pollutant load, is likely to be minimised through the CEMP or in-design mitigation. This will be assessed following the confirmation of the proposed drainage discharge rates and volume, outfall locations and type (groundwater or surface water). Assessment would be undertaken to a Simple Level in the first instance.

Road Drainage

13.8.13 A drainage strategy will be developed for the Proposed Scheme, which will include an assessment of the impact of the proposed drainage on discharge rates and volumes entering receiving surface water or groundwater bodies using a detailed hydraulic drainage model. Any unavoidable discharges to groundwater within the SPZ 2 will be discussed and agreed with the EA. Assessment would be undertaken to a Simple Level in the first instance.

Flood Risk

13.8.14 A Flood Risk Assessment (FRA) will be undertaken, to comply with the National Planning Policy Framework (NPPF) (CLG, 2012) and the supporting online Planning Practice Guidance (PPG) (CLG, 2016) for Flood Risk and Coastal Change. This will focus on the surface water drainage implications associated with the creation of additional impermeable surfaces as well as the potential impact of the Proposed Scheme on fluvial flood risk associated with Thickthorn Stream**.**

13.8.15 The extent of the work involved with the FRA at this stage will be discussed and confirmed in consultation with the Environment Agency, Norfolk County Council (as LLFA), Anglian Water and Highways England. The FRA will require the hydraulic modelling of the Thickthorn Stream to assess the flood risk impacts of the Proposed Scheme including the culvert modification, channel re-alignments and the loss of floodplain storage. The hydraulic model will assess the any mitigation proposed as part of the Proposed Scheme design. Assessment would be undertaken to a Simple Level in the first instance.

Groundwater Flooding

13.8.16 Potential for groundwater flooding is considered to be low and is unlikely to impact on the Proposed Scheme. This will be confirmed by ground investigations. If identified as an issue, the potential for groundwater flooding will be included in the FRA. Assessment would be undertaken to a Simple Level in the first instance.

Aquatic Ecology

13.8.17 The assessment will review potential impacts on water quality and status of the receiving surface water bodies. Any consequential impact on the aquatic ecology will be considered under Chapter 8 Biodiversity.

Recreation and Human Health

13.8.18 It is considered that impacts of the Proposed Scheme on human health will be considered indirectly through the water quality impact assessment and the impacts of the proposed drainage strategy on flood risk in the receiving watercourses.

Climate Change

13.8.19 To account for climate change, the latest 2016 guidance (Environment Agency, 2017d) will be adopted to assess fluvial flood risk to the Proposed Scheme, which is a 65% increase in peak river flow ('Upper End' allowance in the 2080s for Anglian region) and this should be used to assess the culvert performance and potential flood risk implications for Thickthorn Stream.

13.8.20 In addition to this, the current DMRB guidance will be adopted when considering climate change within the drainage design; this is a 20% allowance for an increase in peak rainfall intensity. A sensitivity assessment will be undertaken for the drainage design using the climate change allowance from the 2016 guidance (Environment Agency, 2017d) which can be up to a 40% increase in peak rainfall intensity depending on the Flood Zone it impacts.

Events

13.8.21 The impact of Climate Change and the occurrence of a Major Event or Disaster will be considered as part of the FRA principally in terms of the residual risk of flooding following the adoption of any mitigation measures. It is considered that the occurrence of an extreme flooding event is the primary major natural event to impact the Proposed Scheme.

13.9 Proposed methodology including significance

13.9.1 The proposed methodology for the assessment will follow the methodology and guidance provided in DMRB Volume 11, Section 3, Part 10 HD 45/09 'Road Drainage and the Water Environment' (Highways Agency, 2009) for assessing the significance of effects of proposed road schemes on the road drainage and the water environment. The procedures and the appropriate methods that must be used when assessing the potential impacts from road projects on the water environment are described in Section 5.3 and Annex I of the DMRB document.

13.9.2 The following proposed methods will be adopted:

- The potential ecological impacts of routine run-off on surface waters will be re-assessed using Method A (HAWRAT), as advised in section 5.6 of HD 45/09 (Highways Agency, 2009). The assessment will use existing drainage information, updated Annual Average Daily Traffic (AADT) forecast data and the proposed preliminary drainage design to establish potential impacts of pollutants in routine highway run-off from the Proposed Scheme upon the watercourses within the study area and the requirement for mitigation measures to adequately reduce the risk. It is anticipated that a site survey and flow gauging will be required to confirm the channel characteristics and magnitude of low flows respectively.

- If required, and dependent on the results of the HAWRAT assessment, Method B - Detailed assessment of pollution impacts from routine run-off will be undertaken.
- It is not known whether any discharges to groundwater will be incorporated in the design. If incorporated, a groundwater assessment will be completed in line with Method C (Assessment of Pollution Impacts from Routine Run-off on Groundwaters) as detailed within Annex I of the DMRB HD 45/09 (Highways Agency, 2009).
- An assessment of pollution impacts on surface waters from accidental spillages will be undertaken in line with Method D detailed within Annex I of the DMRB HD 45/09 (Highways Agency, 2009). Predicted AADT data for the Proposed Scheme is required to inform this assessment.
- A hydrological assessment of Design Floods for Thickthorn Stream will be undertaken in line with Method E detailed within Annex I of the DMRB HD 45/09 (Highways Agency, 2009).
- A hydraulic assessment of Thickthorn Stream including existing and proposed hydraulic structures (i.e., culverts), together with the channel re-alignments, will be undertaken in line with Method F detailed within Annex I of the DMRB HD 45/09 (Highways Agency, 2009).

13.9.3 A detailed FRA will be undertaken to address the risk from all forms of flooding and the potential impacts of the Proposed Scheme on flood risk. The FRA will be undertaken in accordance with the requirements of the NPPF (DCLG, 2012; 2016), and the EA's climate change allowances (EA, 2017d).

13.9.4 The FRA will incorporate the findings of the drainage strategy and from the hydrological and hydraulic assessments of the Proposed Scheme.

13.9.5 The extent of the work involved in the FRA will be discussed and confirmed in consultation with the Environment Agency, Norfolk County Council as LLFA, Anglian Water and Highways England. The proposed scope of work required for the FRA is as follows:

- Undertake a desk based review of existing flood risk information available from the consultees including output from any existing hydraulic models for the Thickthorn Stream.
- Using information from consultees, surface water flood risk will be investigated to assess whether surface water overland flow will impact the Proposed Scheme.
- The requirement for compensatory storage will be assessed where the Proposed Scheme lies within Flood Zone 3.
- If an existing Environment Agency model is not available or suitable for use, then a hydraulic model will need to be developed for Thickthorn Stream. This will require undertaking a topographical survey of the existing river channel and structures to an extent agreed with the EA and Norfolk County Council.
- The hydraulic model, together with the 2016 guidance on climate change allowances for fluvial flood risk, will be used to assess the fluvial flood

risk impacts of the modified structures and channel re-alignments and assess the performance of flood risk mitigation measures such as compensatory storage.
- The FRA will incorporate the findings and any mitigation proposed as part of the drainage strategy in line with DMRB guidance (HA, 2009).

13.9.6 A drainage strategy will be prepared for the Proposed Scheme which will detail outfall locations, any attenuation requirements and the inclusion of SuDS features, where appropriate. The results of the drainage strategy will be used to inform the assessment and the FRA.

13.9.7 The construction, operation and demolition stages could result in potential adverse direct effects on water bodies classified under the WFD and therefore a WFD assessment will be required, which will include a geomorphological survey and impact assessment and scour impact assessment focussed on the culvert \ structure extensions and channel re-alignments. The WFD assessment will be undertaken, to the appropriate level, as part of the assessment, in consultation with the EA and Norfolk County Council. The WFD assessment will be carried out in accordance with Planning Inspectorate Advice Note Eighteen: The Water Framework Directive (Planning Inspectorate, 2017).

Assessment of magnitude of impacts and significance of effects

13.9.8 The conservation value of water resources is in part defined by legislation which protects all controlled waters in England and Wales and, in effect, protects all water bodies (surface water or groundwater). Therefore, there cannot be any water feature which has negligible value. The value of controlled waters can be defined by taking into account the use and conservation importance of the water body. The value / importance of water environment attributes within the study area are defined in Table 13.2, based on the definitions provided in Table A4.3 of Annex IV in DMRB HD 45/09 (HA, 2009).

13.9.9 Definitions for the magnitude of impact are given in Table 13.3 and are based on values set out in Table A4.4 of Annex IV of DMRB HD 45/09 (HA, 2009). The overall significance of effect is determined using the matrix presented as Table 2.4 in HA 205/08 (HA, 2008) and the definitions provided in Table 13.4. Effects can be beneficial or adverse. Effects that are moderate, large, or very large, are considered significant effects. Effects that are slight or neutral are not significant.

13.9.10 These tables are based on the guidance given in DMRB HD 45/09 (HA, 2009), although additional criteria have been added, where appropriate to Table 13.3 to meet the requirements of WFD, for which guidance on the assessment of compliance became available after the publication of DMRB HD45/09.

Table 13.2: Criteria for estimating the importance of water environment attributes

Value	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on a regional or national scale.	**Surface Water**: Site protected under EU wildlife legislation (SAC, SPA, or Ramsar site); WFD high status water bodies. **Groundwater**: Principal aquifer providing a regionally important resource or supporting site protected under EU wildlife legislation; Source Protection Zone 1 (SPZ1); international scale and very limited potential for substitution, or more than 100 residential, commercial, or industrial properties, which may be affected by changes to the groundwater regime. **Flood Risk**: Receptor is at high risk from flooding (FZ3b); or floodplain or defence protecting more than 100 residential properties from flooding.
High	Attribute has a high quality and rarity on a local scale.	**Surface Water**: Site protected under UK wildlife legislation (SSSI); WFD status (or potential) is currently 'good' or has a target of good. **Groundwater**: Principal or Secondary aquifer providing locally important resource or supporting site protected under UK wildlife legislation; SPZ2; national scale, and limited potential for substitution, or between 10 and 100 residential, commercial, or industrial properties, which may be affected by changes to the groundwater regime. **Flood Risk**: Receptor is at high risk from flooding (FZ3a); floodplain or defence protecting between 10 and 100 residential properties or industrial premises from flooding.
Medium	Attribute has a medium quality and rarity on a local scale.	**Surface Water**: Site protected under Local wildlife legislation (SNCI), Local Natural Reserve (LNR)); WFD status (or potential) is moderate. **Groundwater**: Secondary aquifer which is of limited value because the water quality does not allow potable or other quality sensitive uses, exploitation may be for agricultural or industrial use but is not extensive; limited connection to surface water and may provide some support to local site of nature conservation interest; SPZ3; regional scale, limited potential for substitution, or 10 or fewer residential, commercial or industrial properties, which may be affected by changes to the groundwater regime. **Flood Risk**: Receptor is at moderate risk from flooding (FZ2); floodplain or defence protecting 10 or fewer industrial properties from flooding.
Low	Attribute has a low quality and rarity on a local scale.	**Surface Water**: WFD status (or potential) is poor, or water body is not classified under the WFD. **Groundwater**: Unproductive strata, with no known past or existing exploitation and not providing baseflow to rivers or supporting a site of nature conservation interest; and no residential, commercial, or industrial properties that may be affected by changes to the groundwater regime. **Flood Risk**: Receptor is at low risk from flooding (FZ1); floodplain with limited constraints and a low probability of flooding of residential and industrial properties.

Table 13.3: Estimating the magnitude of an impact on an attribute

Magnitude	Criteria	Example
Major adverse	Results in loss of attribute and/or quality and integrity of attribute	Failure of soluble and sediment bound pollutants in HAWRAT (Method A, Annex A) and compliance failure with EQS values (Method B). Calculated risk of pollution from a spillage >2% annually (Spillage Risk Assessment, Method D, Annex 1). Loss of, or extensive change to, a designated site or aquifer. Potential high risk of groundwater pollution from routine run-off – risk score >250 (Groundwater Assessment, Method C, Annex 1). Reduction in status of a WFD 'high' or 'good' status or potential water body Increase in peak flood level (1% annual probability) of >100mm.
Moderate adverse	Results in effect on integrity of attribute, or loss of part of attribute	Failure of soluble and sediment bound pollutants in HAWRAT (Method A, Annex A) but compliance with EQS values (Method B). Calculated risk of pollution from a spillage >1 and <2% annually (Spillage Risk Assessment, Method D, Annex 1). Partial loss of, or change to, a designated site or aquifer. Potential medium risk of groundwater pollution from routine run-off – risk score 150-250 (Groundwater Assessment, Method C, Annex 1). Reduction in status of a WFD 'moderate' status or potential water body Increase in peak flood level (1% annual probability) of >50mm.
Minor adverse	Results in some measurable change in attribute's quality or vulnerability	Failure of either soluble or sediment bound pollutants in HAWRAT (Method A, Annex A). Partial change to an aquifer. Calculated risk of pollution from a spillage >0.5 and <1% annually (Spillage Risk Assessment, Method D, Annex 1). Potential medium risk of groundwater pollution from routine run-off – risk score <150 (Groundwater Assessment, Method C, Annex 1). Reduction in status of a WFD 'poor' status or potential water body. Increase in peak flood level (1% annual probability) of >10mm.
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	No risk identified by HAWRAT. Risk of pollution from spillages <0.5%. No impact on aquifer and risk of groundwater pollution from spillages <0.5%. Negligible change in peak flood level.
Minor beneficial	Results in some beneficial effect on attribute or a	HAWRAT assessment of either soluble or sediment bound pollutants becomes Pass from baseline of Fail.

Magnitude	Criteria	Example
	reduced risk of negative effect occurring	Calculated reduction in existing surface and groundwater spillage risk of 50% or more (when existing risk is <1% or more). Increase in status of a WFD 'poor' status or potential water body. Reduction in peak flood level (1% annual probability) of >10mm.
Moderate beneficial	Results in moderate improvement of attribute quality	HAWRAT assessment of both soluble and sediment bound pollutants becomes Pass from baseline of Fail. Calculated reduction in existing surface and groundwater spillage risk of 50% or more (when existing risk is >1% or more). Increase in status of a WFD 'moderate' status or potential water body. Reduction in peak flood level (1% annual probability) of >50mm.
Major beneficial	Results in major improvement of attribute quality	Removal of existing polluting discharge to a watercourse or an aquifer or removing the likelihood of polluting discharges occurring. Recharge of an aquifer. Increase in status of a WFD 'good' status or potential water body. Reduction in peak flood level (1% annual probability) of >100mm.

Table 13.4: Definitions of overall significance of effect

Significance	Examples
Very large adverse	Surface water: Potential failure of both soluble and sediment bound pollutants in a High or Good watercourse. Groundwater: Potential high risk (score >250) of pollution in the Groundwater Assessment (Method C, Annex 1) to a principal aquifer providing a regionally important resource or supporting a site protected under habitat legislation. Flood risk: An increase in peak flood levels (1% annual probability) >100mm increasing the risk to >100 properties.
Large adverse	Surface water: Potential failure of both soluble and sediment bound pollutants in a High or Good watercourse. Groundwater: Potential high risk (score >250) of pollution in to a secondary aquifer providing water for a small number of dwellings agricultural/industrial use or supporting a LNR. Flood risk: An increase in peak flood levels (1% annual probability) >50mm increasing the risk to >100 properties or an increase in peak flood levels (1% annual probability) >100mm increasing the risk to 1-100 properties.
Moderate adverse	Surface water: Potential failure of either soluble or sediment bound pollutants in a High or Good watercourse.

Significance	Examples
	Groundwater: Potential medium risk (score 150-250) to a secondary aquifer providing water for a small number of dwellings agricultural/industrial and/or supporting a LNR. Flood risk: An increase in peak flood levels (1% annual probability) >10mm increasing the risk to >100 properties or an increase in peak flood levels (1% annual probability) >500mm increasing the risk to 1-100 properties.
Slight adverse	Surface water: Potential failure of either soluble or sediment bound pollutants in a Moderate or Poor watercourse. Groundwater: Potential low risk of pollution (score <150) to a secondary aquifer with limited agricultural use and connectivity to surface waters and local ecology. Flood risk: An increase in peak flood levels (1% annual probability) >10mm increasing the risk to <10 industrial properties.
Neutral	Surface water: No risk identified by Method A or method B assessment (soluble and sediment bound). Calculated risk of spillage <0.5% annually. Groundwater: No predicted change in quality of any type of aquifer and/or its use as a resource. Flood risk: Negligible change in peak flood (1% annual event) <+/- 10mm.
Slight beneficial	Surface water; Method A assessment of either soluble or sediment bound pollutants becomes Pass from previous Fail condition for existing discharges. Groundwater: Reduction by 50% or more in existing pollution risk from spillages into an aquifer (when existing spillage risk is <1%). Flood risk: A reduction in peak flood levels (1% annual probability) >10mm resulting in reduced flood risk to 1-100 residential properties.
Moderate beneficial	Surface water: Method A assessment of both soluble and sediment bound pollutants becomes Pass from previous Refer or Fail condition for existing discharges. Groundwater: Recharge of aquifer through provision of treated discharges to ground resulting in measurable improvements to a connected site/habitat (LNR). Flood risk: A reduction in peak flood levels (1% annual probability) >10mm resulting in reduced flood risk to >100 residential properties.
Large beneficial	Surface water: Removal of an existing polluting discharge through provision of pollution prevention measures, or any other measure, affecting a site/habitat protected under EC or UK legislation. Groundwater: Removal of an existing polluting discharge within SPZ 1 or 2 and/or a principal aquifer. Flood risk: A reduction in peak flood levels (1% annual probability) >50mm resulting in reduced flood risk to >100 residential properties.

13.10 Conclusion

13.10.1 The following water receptors have been identified that could be impacted by the Proposed Scheme:

- Thickthorn Stream
- A smaller unnamed Ordinary watercourse to the north of the Proposed Scheme
- River Yare (Tiffey to Wensum) (GB105034051281)
- Intworth Stream (GB105034051240)
- An off-line pond adjacent to the north bank of Thickthorn Stream
- Broadland Rivers Chalk and Crag groundwater body (GB40501G400300) and associated abstractions

13.10.2 The potential for the Proposed Scheme to affect these water receptors will be assessed using the appropriate methodologies outlined in DMRB Volume 11, Section 3, part 10 (HD45/09).

13.10.3 A preliminary WFD assessment will be undertaken alongside the above assessments to establish the potential for effects on WFD water body status. It is considered that a detailed WFD assessment will be required, which will include a geomorphological survey and impact assessment and scour impact assessment focussed on the culvert \ structure extensions and channel re-alignments on Thickthorn Stream. The WFD assessment will be undertaken as part of the environment assessment and in accordance with the relevant advice from the Planning Inspectorate.

13.10.4 A FRA will assess the impact to, and of, the Proposed Scheme on flood risk with a focus on Flood Zones 2 and 3 associated with Thickthorn Stream. This will consider any mitigation proposed as part of the drainage strategy and Proposed Scheme design. Detailed, site-specific hydrological and hydraulic assessments will be required to assess the impacts of the Proposed Scheme on flood risk. Mitigation will be designed in accordance with relevant DMRB guidance (Highways England, 2016a; 2016b) and the SuDS Manual (CIRIA, 2007).

13.10.5 The above assessments will be presented within the ES.

14 Climate

14.1 Introduction

14.1.1 It has been established that as a result of rising concentrations of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere, climate change is expected to have significant implications for infrastructure assets, particularly those with long operational lifetimes. This requires them to be resilient not only to the climate at the time of their construction, but also to climate variations over the decades of their use.

14.1.2 The Climate Change Act was passed in November 2008 which set ambitious, legally binding targets for reducing the UK's CO_2 emissions by 34% by 2020 and 80% by 2050, relative to the 1990 baseline. The EIA Directive (2014/52/EU) and subsequent updates to UK EIA regulations (of which the Infrastructure Planning (EIA) Regulations 2017 are of relevance to Nationally Significant Infrastructure Schemes (NSIPs)) also now outline the requirement to assess the impact of projects on climate and their vulnerability to climate change, as presented within this chapter.

14.1.3 This chapter has been prepared following guidance provided by Highways England. This section presents the outcomes of the scoping assessment for the climate change related topics. To align with the requirements of the IP EIA Regulations 2017 and the National Policy Statement for National Networks (NNNPS) 2014, it has been divided into two separate aspects:

a) Greenhouse gas (GHG) impact assessment – effects on climate change of GHG emissions arising from the Proposed Scheme, including how the project will affect the ability of Government to meet its carbon reduction plan targets (in accordance with NNNPS paragraph 5.17).

b) Climate change resilience assessment – the resilience of the Proposed Scheme to climate change impacts, including how the proposal will take account of the projected impacts of climate change (in accordance with NNNPS paragraph 4.40 and the IP EIA Regulations 2017).

14.1.4 The potential requirement for further assessment will be identified. Where required, this will be presented within an ES.

14.2 Study area

Effects on climate

14.2.1 The 'effects on climate' assessment will consider the greenhouse gas emission potential throughout the lifecycle of the Proposed Scheme for both

construction and operation (the latter for the design life of the Proposed Scheme).

Vulnerability of the proposed scheme to climate change

Spatial scope

14.2.2 The assessment will identify the key climate change effects on Proposed Scheme design elements such as structures or technological assets, as well as environmental receptors identified within this Scoping Report that may be affected by the Proposed Scheme.

14.2.3 There may be interrelationships between the assessment of potential effects on climate and other disciplines. Therefore, please refer to the following Chapters:

- Chapter 5: Air Quality
- Chapter 6: Cultural Heritage
- Chapter 7: Landscape
- Chapter 8: Biodiversity
- Chapter 9: Geology and Soils
- Chapter 10: Materials
- Chapter 12: People and Communities
- Chapter 13: Road Drainage and the Water Environment

Temporal scope

14.2.4 The assessment of vulnerability to climate change will consider construction and operational effects. Climate change effects on construction have the potential to be scoped out depending on the construction duration. The operation assessment will be informed by the design life of key elements of the Proposed Scheme and availability of UK Climate Projections.

14.3 Existing and baseline knowledge

Effects on climate

14.3.1 Existing carbon emissions will be considered from a variety of sources in the Local Authority area relevant to the Proposed Scheme (e.g. Norwich City Council and Norfolk County Council), including those from transport infrastructure.

14.3.2 Norwich City Council reported a carbon footprint of approximately 6,000 tonnes of CO_2e in 2016, measured in accordance with national indicator NI185 (Norwich City Council, 2017), although it is noted that this figure reflects emissions specifically associated with the Council's operations (e.g. owned and contractor-operated buildings, vehicle fleet, etc.) rather than the

wider local authority region. In 2015, total end-user CO_2 emissions from transport in Norwich were reported as approximately 135,600 tonnes (Department for Business, Energy & Industrial Strategy, 2017b).

14.3.3 Norfolk County Council reported total emissions for the 2015-16 year to be approximately 99,147 tonnes of CO_2e for Local Authority operations (Norfolk County Council, 2016), and the Council has committed to reducing emissions by 50% by 2020, relative to 2009-10 levels. Most recent figures released in 2015 indicated total transport emissions for the wider Norfolk County area (including all relevant Districts) to be approximately 1,953,000 tonnes of CO_2 (Department for Business, Energy & Industrial Strategy, 2017b).

14.3.4 In 2015, UK net CO_2 emissions were estimated at 403.8 million tonnes, a decrease of 3.8% in comparison to 2014 levels (Department for Business, Energy & Industrial Strategy, 2017a). Furthermore, 24% of UK greenhouse gas emissions in 2015 originated from the transport sector with emissions of 120mtCO_2e.

Vulnerability of the proposed scheme to climate change

14.3.5 A current climate baseline for the project area has been compiled through the use of Met Office (2016) regional climate data for the Eastern England region, which comprises the counties of Bedfordshire, Cambridgeshire, Norfolk, Suffolk, Lincolnshire, the East Riding of Yorkshire and parts of Essex and Hertfordshire. High-level climate observations for the region over a 30-year averaging period (1981-2010) are presented in Table 14.1.

Table 14.1: Historic climate baseline for Eastern England

Climate Variables	Climate Observations
Temperature	Mean daily minimum temperatures can range from 0°C to 2°C in winter, whilst summer daily maximum temperatures are in the region of 22°C.
Rainfall	Eastern England includes some of the driest areas in the country, with the majority of the region receiving less than 700mm of rainfall annually, distributed fairly evenly throughout the year. On average, the region experiences approximately 30 rain days during the winter months (December – February) and under 25 days during the summer period (June – August). Despite generally low levels of precipitation, the area has encountered a number of severe storms which can contribute significantly to total annual rainfall and may also result in the occurrence of hail.
Wind	Eastern England is one of the more sheltered parts of the UK, however the winter months are when the strongest winds are experienced. Wind direction is fairly consistent across the region, however speeds are generally greater in coastal locations than inland, and gusts exceeding 90 knots have been recorded in East Anglia. The frequency of tornadoes is

Climate Variables	Climate Observations
	greatest in eastern England relative to other parts of the UK, nevertheless, the intensity of these events remains minor.
Sunshine	Average annual sunshine in the wider region ranges from approximately 1450 hours over Lincolnshire and East Yorkshire, to over 1600 hours in east Norfolk, Suffolk and Essex.
Air Frost	The average number of days with air frost ranges from less than 30 (coastal) to 55 (inland) per year.

Source: Met Office (2016) Regional Climate Data

14.4 Future projections

Effects on climate

14.4.1 The transport sector is a key driver in projected UK carbon emissions increases with road transport emissions projected to rise by 28 $MtCO_2e$ over 2023-2027 (the fourth carbon budget period) (Department for Business, Energy & Industrial Strategy, 2017c).

Vulnerability of the proposed scheme to climate change

14.4.2 The UK Climate Projections provide regional climate information, for which the project area is included within the East of England Administrative Region. The East of England region is predicted to experience changes in temperature, rainfall, and frequency of extreme weather events as a consequence of climate change. These changes are predicted to occur under all three emissions scenarios (i.e. low, medium, and high greenhouse gas emissions), which are incorporated into the climate change models produced by the Met Office Hadley Centre. The general trend for the region is warmer, drier summers and warmer, wetter winters.

14.4.3 Under the high emissions scenario for the 2080s, estimated changes in climatic conditions are as outlined in Table 14.2.

Table 14.2: Future climate projection data for the 2080s

Climatic Conditions	Climate Observations
Temperature	The average summer temperature is estimated to increase by 4.5°C under the central estimate, which represents 'as likely as not' probability of change (50th percentile), and average winter temperature is estimated to increase by 3.7°C (50th percentile).
Rainfall	The average summer rainfall rate is estimated to decrease by 27%, whereas the average winter rainfall rate is estimated to increase by 26% (in the 50th percentile or central estimate for both).
Wind	Climate projections for wind are more uncertain than those for temperature and precipitation, due to inherent difficulty in modelling future wind conditions. However, overall an increase in extreme weather including wind is projected (Committee on Climate Change, 2017).

Source: UKCP09 Climate Projections

14.1.1 It should be noted that climate projection data corresponding to the 2080s (2070-2099) under a high emissions scenario have been selected in line with NPS paragraph 4.41, which states:

"Where transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the UK Climate Projections 2009 (UKCP09) high emissions scenario (high impact, low likelihood) against the 2080 projections at the 50% probability level."

14.5 Assumptions and limitations

14.5.1 Information on the climate baseline and future projections are based on available information from third parties, including the historical meteorological variables recorded by the Met Office and the UK Climate Projections (UKCP09) developed by the Met Office.

14.5.2 Climate projections are not predictions or forecasts but simulations of potential scenarios of future climate under a range of hypothetical emissions scenarios and assumptions. The results, therefore, from running the climate models cannot be treated as exact or factual, but projection options. They are representations of how the climate may evolve in response to a range of potential scenarios and their reliability varies between climate variables. Projections exclude outlying 'surprise' or 'disaster' scenarios in the literature and any scenario necessarily includes subjective elements and is open to various interpretations. Generally global projections are more certain than regional, and temperature projections more certain than those for precipitation. The degree of uncertainty associated with all climate change projections increases for projections further into the future.

14.5.3 The climate projections have previously been independently verified and will not be reviewed for this report.

14.5.4 It should also be noted that at present, there is no single accepted methodology for the assessment of climate change (mitigation or adaptation) within Environmental Impact Assessments (EIAs). A qualitative methodology for assessing the vulnerability of the Proposed Scheme to climate change will be produced in line with DMRB Volume 11 Section 2 Part 5. This will be updated as and when consolidated methodology or practice for this topic is published.

14.6 Guidance and best practice

14.6.1 The climate change assessment will be prepared guidance provided by Highways England and in accordance with the National Networks National Policy Statement (2014). In addition, the following guidance documents have been used to inform the assessment:

- Climate Adaptation Risk Assessment Progress Update (Highways England, 2016)
- IEMA Environmental Impact Assessment guide to Climate Change Resilience and Adaptation (IEMA, 2015)
- IEMA's Guidance on Assessing the GHG Emissions and Evaluating their Significance (IEMA, 2017)
- TAG Unit A3 Environmental Impact Appraisal (DfT, 2015) Chapter 4 Greenhouse Gases
- PAS 2080:2016 Carbon Management in Infrastructure

14.7 Consultation

14.7.1 To date, no topic-specific consultation has been undertaken. For scheme-wide consultation refer to Chapter 4.

14.8 Potential effects, including monitoring and mitigation measures

Construction

Effects on climate

14.8.1 The duration of the construction works for the Proposed Scheme is anticipated to be approximately 26 months. Embodied carbon emissions from the use of construction materials are the main contributor to climate change, with additional greenhouse gas emissions arising from the use of plant and transport of materials. As outlined in Sections 5.7 and 10.7, mitigation measures to be included in the Construction Environmental Management Plan (CEMP) such as the reduction of raw material usage, recycling, the use of local suppliers and ensuring vehicle engines and plant motors are switched off when not in use, would limit emissions as far as practicable. Further assessment appraising the greenhouse gas emissions

of the Proposed Scheme will be carried out in accordance with TAG Unit A3 Chapter 4.

Vulnerability of the proposed scheme to climate change

14.8.2 During the temporary construction period, climate change is not expected to bring about a change in the risk of severe weather between now and the start of the period of construction. Despite this, the construction site may be vulnerable to extremes of weather, leading to the risk of delay in activities. However, adaptation measures included in the CEMP such as ensuring construction materials are covered when stored and pro-active planning would minimise adverse effects. Therefore, climate change effects are not expected to impact on Proposed Scheme construction.

Operation

***Effects* on climate**

14.1.2 Over the design life of the Proposed Scheme, its operation has the potential to result in an increase in local CO_2 emissions due to changes in vehicle distributions and speeds. An appraisal of greenhouse gases for the Proposed Scheme opening year and design year, to derive the change in carbon dioxide equivalent (CO_2e) emissions, will be assessed in accordance with TAG Unit A3 Chapter 4.

Vulnerability of the proposed scheme to climate change

14.8.3 Changes in climate as outlined in Table 14.2 are anticipated in the Study Area over the design life of the Proposed Scheme. This has the potential to pose a risk to the Proposed Scheme assets such as deformation and deterioration of asphalt surfacing associated with temperature increase and changes in precipitation affecting the foundation strength and deterioration of the road surface, with the potential to lead to an increased flood risk. A Flood Risk Assessment (FRA) will be carried out and, will take into account the Environment Agency's 'Climate change allowances for planners' NPPF supporting guidance. Higher temperatures and increased precipitation may increase the frequency of maintenance required for gantries. In addition, higher wind speeds could pose a risk to gantries. Further assessment as outlined in Section 14.10 will be undertaken during the EIA and presented within the ES.

14.8.4 Changes in climate also have the potential to pose risks to the environmental receptors detailed throughout this Scoping Report. For example, increased precipitation may affect the foraging habits of bats and more frequent rainfall events resulting in higher runoff could increase pollutant concentrations within the receiving water. These will be assessed in further detail and reported within the ES.

Summary

14.8.5 A summary of the potential effects on climate as a result of the Proposed Scheme is presented in Table14.3.

Table 14.3: Summary of potential climate effects

Potential Construction Effects	Potential Operation Effects
Potential for increased CO_2 emissions. The construction site has the potential to be vulnerable to extremes of weather, although significant climate change is not expected during the construction period.	Potential for increased CO_2 emissions. Changes in climate have the potential to pose a risk to the Proposed Scheme assets and environmental receptors.

14.9 Proposed level and scope of assessment

14.9.1 The Proposed Scheme has the potential to contribute to climate change and be directly affected by climate change over its lifetime. Therefore, further assessment is required to inform relevant mitigation and adaptation measures.

14.9.2 The spatial and temporal scopes of the assessment have been outlined above in Section 14.2.

14.10 Proposed methodology including significance

14.10.1 The assessment methodology presented in this chapter will be undertaken in accordance with Highways England guidance.

Effects on climate

14.10.2 The assessment will include:

- The greenhouse gases emitted through the materials used to construct the Proposed Scheme, and the significance of the effects of this (the assessment and significance methodology is outlined in Chapter 10 Materials of this Scoping Report).
- The greenhouse gases and significant carbon dioxide emitted during the lifecycle of the Proposed Scheme using the Mott MacDonald Carbon Portal which is PAS 2080 compliant.
- Comparison of greenhouse gas emissions for both construction and operation in relation to the baseline and compared to regional (if available) and UK emissions predictions.
- Opportunities for mitigation in the Proposed Scheme design.
- A conclusion about whether this level of assessment is sufficient to understand the effects of the project or whether further assessment is necessary. This will be completed in accordance with the findings in

the Air Quality and Materials assessments (Chapters 5 and 10 of this Scoping document).

14.10.3 In line with the National Policy Statement for National Networks (2014), significance of impacts will be assessed by comparing estimated GHG emissions arising from the Proposed Scheme with UK carbon budgets, and the associated reduction targets.

Vulnerability of the proposed scheme to climate change

14.10.4 There is at present no single accepted methodology for the assessment of climate change within EIA. A qualitative methodology for assessing the vulnerability of the Proposed Scheme to climate change will be produced in line with DMRB Volume 11 Section 2 Part 5. In line with IP EIA Regulations 2017 Schedule 4 Part 5, a description of the likely significant effects of the development on the environment, resulting from the vulnerability of the project to climate change, will be provided.

14.11 Conclusion

14.11.1 During construction and operation, the Proposed Scheme would increase CO_2 emissions, therefore further assessment appraising the greenhouse gas emissions of the Proposed Scheme is required.

14.11.2 During construction, works may be vulnerable to extremes of weather, however adaptation measures included in the CEMP would address potentially adverse effects. During the operation of the Proposed Scheme, changes in climate have the potential to impact scheme assets and environmental receptors.

14.11.3 Further assessment of construction and operational effects, both on and as a result of climate change, is therefore required for the Proposed Scheme. This assessment will be presented within the ES.

15 Combined and Cumulative Effects

15.1 Introduction

15.1.1 Combined and Cumulative effects result from multiple actions on receptors over time and are generally additive or interactive (synergistic) in nature. They can also be considered as effects resulting from incremental changes caused by other past, present or reasonably foreseeable actions together with the project, identified as:

- Combined effects from a single project (the interrelationship between different environmental factors)
- Cumulative effects from different projects (with the project being assessed)

15.1.2 DMRB Volume 11, Section 2, Part 6 states that, in general, cumulative assessment will be most successful when the assessment of all other environmental effects of the project is complete. The previous chapters presented in this report have identified that assessment is required for a number of environmental topics, which would be prepared and presented within the ES. As a result, no assessment of combined and cumulative effects has currently been made within this report. Instead, this chapter provides an overview of the baseline, potential effects, and methodology of assessment for combined and cumulative effects, with assessment recommended to be included within the ES.

15.2 Study area

Combined effects

15.2.1 The study area for the assessment of combined effects, for both construction and operation, would be defined by the study areas identified within the relevant environment topic chapters of this EIA Scoping Report.

Cumulative effects

15.2.2 The search area for the identification of ‘other developments’ for inclusion in the assessment of cumulative effects would reflect a 2km Zone of Influence (ZOI) around the boundary of the Proposed Scheme, for both construction and operation. This 2km ZOI is large enough to cover the proposed developments likely to contribute to cumulative effects, whilst being proportionate to the scope and scale of the Proposed Scheme. DMRB Volume 11, Section 2, Part 5, states that the study area for the assessment of cumulative effects should be defined on a case-by-case basis reflecting the Proposed Scheme in question and the area over which significant effects can be reasonably be considered to have the potential to occur from both the Proposed Scheme and in combination with other developments. As such, a 2km search area is deemed appropriate for this Proposed Scheme.

15.2.3 The study area used to identify the ZOI for environmental receptors included within the cumulative assessment, during both construction and operation, will reflect the individual ZOIs of the topic chapters.

15.3 Existing and baseline knowledge

15.3.1 The baseline for the combined effects is described in the individual environmental topic chapters that precede this chapter.

15.3.2 The baseline for the cumulative effects will include the proposed major developments identified within the study area, once confirmed. The proposed major developments will be identified from the traffic Uncertainty Log and committed developments to be confirmed with South Norfolk Council.

15.4 Assumptions and limitations

15.4.1 At this stage of assessment, the proposed other major developments within the area have not been identified. Therefore, the environmental effects that would result from the other development have not been identified. The assessment of potential effects is therefore limited at this stage, and has focused on some of the main receptors that could be affected as a result of both combined and cumulative effects. The likely residual effects and proposed mitigation for each of the other developments would be identified and incorporated into the cumulative effects assessment of the ES.

15.5 Guidance and best practice

15.5.1 This chapter draws upon the following guidance:

- The Planning Inspectorate's 'Advice Note Seventeen: Cumulative Effects Assessment'
- DMRB Volume 11 Section 2 Part 5 'Assessment and Management of Environmental Effects

15.6 Consultation

15.6.1 Consultation with South Norfolk Council as the Local Planning Authority will be undertaken in advance of the production of the ES, to agree a list of proposed developments to be included within the cumulative effects assessment.

15.7 Potential effects, including monitoring and mitigation measures

Combined effects

15.7.1 During construction and operation, there is the potential for combined effects to all receptors including geology and soils, landscape/townscape, cultural features, communities, vehicle travellers, water environment, biodiversity, climate, and material resources, as a result of the Proposed Scheme due to the potential effects reported in Chapters 5 to 14. However, during construction, effects would be temporary in nature and best practice mitigation measures

included in the CEMP would ensure that combined effects are reduced as far as possible. Combined effects during operation, although may be permanent, would be reduced as far as possible through best practice mitigation, enhancement measures would be developed as part of the Proposed Scheme design, and any monitoring requirements would be specified.

Cumulative effects

15.7.2 During construction, there would be the potential for cumulative effects on all receptors as a result of the Proposed Scheme with any of the other developments, where the construction stages overlap. However, effects would be temporary in nature and it is assumed that best practice measures would be included in a CEMP for each of the other developments, reducing the likelihood of significant cumulative effects.

15.7.3 Once operational there would be the potential for cumulative effects to receptors, including (but not limited to) habitats, protected species, agricultural land, noise and air quality. However, it is assumed that mitigation would be provided by the other developments to offset any significant environmental effects, and monitoring of residual effects would also be in place for those other developments that have gone through the statutory EIA process, which would reduce the likelihood of significant cumulative effects during operation.

15.7.4 The likely residual effects and proposed mitigation for each of the other developments would be identified and incorporated into the cumulative effects assessment of the ES.

Summary

15.7.5 A summary of the potential effects from combined and cumulative interactions as a result of the Proposed Scheme is presented in Table 15.1.

Table 15.1: Summary of potential climate effects

Potential Construction Effects	Potential Operation Effects
During construction and operation, there is the potential for combined effects to all receptors including geology and soils, landscape/townscape, cultural features, communities, vehicle travellers, water environment, biodiversity, climate, and material resources.	Combined effects during operation, although may be permanent, would be reduced as far as possible through best practice mitigation, enhancement measures would be developed as part of the Proposed Scheme design, and any monitoring requirements would be specified.
During construction, there would be the potential for cumulative effects on all receptors as a result of the Proposed Scheme with any of the other developments, where the construction stages overlap.	For cumulative effects there would be the potential for cumulative effects to receptors, including (but not limited to) habitats, protected species, agricultural land, noise and air quality.

15.8 Proposed level and scope of assessment

15.8.1 The assessment for combined and cumulative effects within the ES will be undertaken for the Proposed Scheme during both construction and operation.

15.9 Proposed methodology including significance

Combined effects methodology

15.9.1 The assessment methodology for combined effects would involve the identification of impact interactions associated with the Proposed Scheme upon separate environmental receptors, to better understand the overall environmental effect of the Proposed Scheme.

15.9.2 The significance of construction and operational phase environmental effects would be brought forward from the preceding chapters of the ES into matrices, providing an overview of the potential effects on individual receptors. The assessment considers adverse effects, after mitigation has been taken into account. The significance of combined effects upon each environmental receptor group would then be made based upon the balance of scores and using professional judgement.

15.9.3 The methodology for the assessment of combined effects would follow DMRB Volume 11 Section 2 Part 5: Assessment and Management of Environmental Effects. For the purposes of the assessment, combined effects of Moderate, adverse or beneficial, and above would be considered significant.

Cumulative effects methodology

15.9.4 The assessment methodology for cumulative effects would involve the identification of incremental changes likely to be caused by potential 'other developments' together with the Proposed Scheme.

15.9.5 The assessment of cumulative effects would follow Advice Note Seventeen: Cumulative Effects Assessment (The Planning Inspectorate, 2015) with the four stages of assessment:

- Stage 1: Establish the Nationally Significant Infrastructure Project's (NSIP's) Zone of Influence (ZOI) and identify a long list of 'other developments'.
- Stage 2: Identify shortlist of 'other developments' for the cumulative effects assessment.
- Stage 3: Information gathering.
- Stage 4: Assessment.

15.9.6 The ES will set out the methodology recognising the requirements of the NNNPS and advice on development of threshold criteria in PINS Advice Note Seventeen: Cumulative Effects Assessment, giving particular regard to the size and spatial influence of developments on the proposed project.

15.9.7 Rather than reporting every interaction, the methodology for the assessment of cumulative effects concentrates on the main significant effects, and will aim to differentiate between permanent, temporary, direct, indirect and secondary effects, positive or negative.

15.9.8 Where significant cumulative effects, beyond those identified as residual effects of the Proposed Scheme in isolation, have been identified, additional mitigation measures will be developed to avoid significant effects.

15.9.9 The significance of cumulative effects upon each environmental resource would then be based on the balance of scores and using professional judgement. An on-balance approach would also be taken when identifying the overall cumulative effect for the Proposed Scheme in conjunction with the other proposed major developments.

Significance criteria

15.9.10 The assessment of significance of the combined and cumulative effects would be determined in accordance with the significance criteria contained in Table 15.4 of DMRB Volume 11, Section 2, Part 5 (HA 205/08), which is described in more detail in Section 1.6 of this EIA Scoping Report. Typically, the greater the environmental sensitivity or value of the receptor or resource, and the greater the magnitude of impact, the greater the effect. In this way, the consequences of a highly value resource suffering a major detrimental impact would be a very large adverse effect, as shown in Table 1.2 contained in Chapter 1 of this EIA Scoping Report, and outlined in DMRB Volume 11, Section 2, Part 5 (HA 205/08).

15.9.11 For the purposes of this cumulative effects assessment, the value of a resource and magnitude of impact is determined according to the criteria set within the preceding chapters of this EIA Scoping Report. The significance of effect is then carried forward from preceding chapters to enable an on-balance assessment of combined significance upon environmental receptors, as well as to identify the significance of cumulative effects with other developments. Typical descriptors of cumulative significance are included within Table 15.2, which reflects this on balance approach. Overall significance is determined with mitigation included, as shown in Table 1.2.

15.9.12 Significance descriptors have also been aligned with the considerations included within PINS ‘Advice Note Seventeen: Cumulative Effects’. Accordingly, where impacts are likely to be temporary, the overall significance of effect is considered to be reduced from a permanent impact on a receptor of the same value. Equally, localised and infrequent impacts are likely to be of lower magnitude than those that cover a greater geographical scale and / or regularly occur, resulting in a reduced significance of effect. Effects can be additive (such as the loss of 2 pieces of woodland of 1ha, resulting in 2ha cumulative woodland loss) or synergistic (two discharges combining to have an effect on a species not affected by discharges in isolation).

15.9.13 Where an effect is Moderate or above, adverse or beneficial, it is deemed to be significant.

Table 15.2: Combined and cumulative significance criteria

Significance Category	Definition
Very Large (Adverse or Beneficial)	Where the combined effects of the Proposed Scheme or cumulative effects of the Proposed Scheme in association with other existing or more than likely / near certain future major development upon an individual or collection of environmental receptors would be highly significant. Effects would be: • Permanent and far reaching for receptors of very high value
Large (Adverse or Beneficial)	Where the combined effects of the Proposed Scheme or cumulative effects of the Proposed Scheme in association with other existing or more than likely/ near certain major future developments upon an individual or collection of environmental receptors would be highly significant. Effects would be: • Permanent and far reaching for receptors of high value • Localised for a receptor of very high value • Temporary for a receptor of very high value
Moderate (Adverse or Beneficial)	Where the combined effects of the Proposed Scheme or cumulative effects of the Proposed Scheme in association with other existing or more than likely/ near certain major development upon an individual or collection of environmental receptors would be significant. Effects would be: • Permanent and far reaching for receptors of medium value • Localised for receptors of high value • Temporary for receptors of high value
Slight (Adverse or Beneficial)	Where the combined effects of the Proposed Scheme or cumulative effects of the Proposed Scheme in association with other existing or more than likely/ near certain future major developments upon an individual or collection of environmental receptors would be noteworthy but not significant. Effects would be: • Permanent and far reaching for receptors of low value • Localised for receptors of medium value • Temporary for a receptor of medium value
Neutral	Where the combined effects of the Proposed Scheme or the cumulative effects of the Proposed Scheme in association with other existing or more than likely/ near certain future major developments would balance.

Source: Based on DMRB Volume 11 Section 2 Part 5 and professional judgement

15.10 Conclusion

15.10.1 The baseline and methodology for the assessment of combined and cumulative effects has been considered within this chapter. The assessment for combined and cumulative effects will be undertaken and presented within an ES.

15.10.2 The assessment will draw upon the guidance outlined in the DMRB Volume 11, Section 2, Part 5 Assessment and Management of Environmental Effects, and the more recently published Advice Note Seventeen: Cumulative Effects Assessment (The Planning Inspectorate, December 2015).

16 Conclusions

16.1.1 This EIA Scoping Report has identified the potential for significant effects that may result during construction and operation of the Proposed Scheme. This information has been used to make recommendations for whether further environmental assessment is necessary for individual topics. Where required assessment will be presented within the ES.

16.1.2 Table 16.1 provide a summary of the level of assessment required for each EIA topic scoping into the EIA.

Table 16.1: Summary of scoping for A47/A11 Thickthorn Junction

Topic	**Environmental Statement - Level of Assessment**
Air Quality	Detailed
Cultural Heritage	Detailed
Landscape	Detailed
Biodiversity	Detailed
Geology & Soils	Simple
Materials	Simple
Noise & Vibration	Detailed
People and Communities	Various across all sub-topics
Road Drainage and the Water Environment	Simple
Climate	Further Assessment
Combined and Cumulative Effects	Scoped in

16.1.3 Table 16.2 overleaf provides a summary of the potential effects of the Proposed Scheme and identifies whether further Environmental Assessment is required on a topic-by-topic basis.

Table 16.2: Summary of potential effects and further environment assessment requirements

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
Air Quality	Construction	Significant direct effects are unlikely with mitigation measures in place.	A qualitative assessment of receptors within 200m of construction activities will be undertaken.	Consultation will be undertaken with the Local Planning Authority to discuss the assessment approach and the study area once scheme specific traffic data is finalised.
	Operation	Dependant on traffic impacts which are yet to be determined.	The operational air quality impacts will be determined through a Detailed Level assessment.	
Cultural Heritage	Construction	Potential large adverse effect due to potential direct impact to the setting of the scheduled monument. Potential slight adverse effect due to potential physical impact on paleo-environmental and archaeological remains.	Assessment to a detailed level required.	Further consultation will be undertaken specifically with Historic England and Council Conservation and Historic Environment officers.
	Operation	Potential adverse effects due to impacts on the setting of designated heritage assets.	Assessment to a detailed level required.	
Landscape and Visual Effects	Construction	Landscape: Construction effects associated with the removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds and construction lighting. Option A - Potential (moderate) adverse impact on local landscape elements and character.	Assessment to a detailed level required.	Representative viewpoints to inform the assessment of visual effects will be agreed in consultation

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		Option B - Potential (moderate) adverse impact on local landscape elements and character. Visual: Construction effects associated with the removal of existing vegetation, earthworks and presence of construction plant, materials, machinery, construction compounds and construction lighting. Receptors with potential to be adversely affected include residential properties on the western edge of Cringleford and along Cantley Lane South and Norwich Road, users of the Thickthorn Interchange services and park and ride facilities and road users of the A47, A11, B1172 and Cantley Lane. Option A - Potential (large/moderate) adverse impact on visual receptors. Option B - Potential (large/moderate) adverse impact on visual receptors.		with the Local Planning Authority.
	Operation	Landscape: Year 1 operational effects associated with a reduction in extent of tree and hedgerow cover, loss of agricultural land and prominence of highway infrastructure. Option A - Potential (moderate) adverse impact on local landscape elements and character. Option B - Potential (moderate) adverse impact on local landscape elements and character. Landscape: Year 15 operational effects associated with the relative increase in highway infrastructure.	Assessment to a detailed level required.	

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		Option A - Potential (slight) adverse impact on local landscape elements and character. Option B - Potential neutral impact on local landscape elements and character. Visual: Year 1 operational effects associated with views of the road/highway infrastructure and vehicles. Receptors with potential to be adversely affected include residential properties on the western edge of Cringleford and along Cantley Lane South and Norwich Road, users of the Thickthorn Interchange services and park and ride facilities and road users of the A47, A11, B1172 and Cantley Lane. Option A - Potential (moderate) adverse impact on visual receptors. Option B - Potential (moderate) adverse impact on visual receptors. Visual: Year 15 operational effects associated with residual change in views following the establishment of Proposed Scheme mitigation planting. Option A - Potential (slight) adverse impact on visual receptors.		
Geology and Soils	Construction	Potentially significant adverse direct effects owing to direct encroachment of the Proposed Scheme on the former Cantley Lane landfill. This applies to widening of the A11 and the Cantley Lane Link (Option A (4)).	Assessment to a simple level required.	Consultation with the local authority and Environment Agency will be necessary to

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
				discuss the impact of the Proposed Scheme on the former Cantley Lane landfill site. This consultation would be undertaken for the Preferred Option, once confirmed.
	Operation	No significant adverse effects anticipated.	No further assessment required.	
Biodiversity	Construction	Potentially significant direct and indirect impacts to protected species, designated sites and sensitive habitats. Medium minor negative impact to protected species due to direct loss of woodland and scrub habitat. Development adjacent to Thickthorn Stream has the potential to impact protected species. Increased risk of pollution incident, such as contaminated land run off or spill/leaks of oils and fuels, and increased airborne pollutants into adjacent habitats which support these species; Changes in the drainage condition have the potential to have a negative impact upon protected species;	Assessment to a Detailed level required.	Detailed consultations have yet to be undertaken with various statutory and non-statutory bodies including Natural England, Environment Agency, local Councils, Norfolk Wildlife Trust and the RSPB. Further consultation with various non-

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		Night-time works may disturb nocturnal species (bats and badgers) due to lighting, noise and vibration.		statutory bodies may also be required.
	Operation	Potentially significant direct and indirect impacts to protected species, designated sites and sensitive habitats. Permanent loss and potential severance of habitats of biodiversity value. In the absence of appropriate design and treatment of run-off and other potential pollutants, operational effects could include significant medium intermediate negative impacts upon protected species.	Assessment to a Detailed level required.	
Materials	Construction	Potential direct effects associated with the import and use of materials, including: depletion of natural resources; noise and air emissions associated with their transportation; energy/fuel consumption through plant use and transportation; energy/fuel consumption through manufacture. Potential direct effects associated with the generation of waste arisings (inert, non-hazardous, green and hazardous) including: demand on handling/disposal capacity of regional waste management facilities; release of contaminants to air, land or water; noise and air emissions associated with their transportation; energy/fuel consumption through plant use and transportation.	An initial Simple Assessment is proposed, followed by a Detailed Assessment if the environment impacts cannot be clearly identified by the Simple Assessment.	Consultation and liaison with the Environment Agency will be ongoing, where relevant.

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
	Operation	Significant environmental effects from the use of materials and generation of waste are unlikely during the operation of the Proposed Scheme	No further assessment is required.	
Noise and Vibration	Construction	No significant effects with CEMP and appropriate mitigation measures in place.	Assessment to a detailed level required.	Consultation with Environmental Health Officers will be progressed following any consultations undertaken to date.
	Operation	Potential for significant adverse effects to noise sensitive receptors.	Assessment in the form of road traffic noise predictions is required for sensitive receptors.	
People and Communities	Construction	**NMUs** The removal of the footbridge would result in increased journey times and lengths during the temporary construction period. NMU facilities would be temporarily impacted through the presence of construction plant, machinery, materials, construction compounds and construction lighting and changes to barriers and traffic flows.	Assessment is required to a Simple Level in the first instance.	Specific consultation required as per sub-topic.
		Amenity Amenity is likely to be temporarily impacted. Construction activities may cause indirect effects for NMUs, due to noise, dust and the presence of construction plant, materials, compounds sites and machinery for a temporary period.	Assessment is required to a Simple Level in the first instance.	

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		MTs Driver Stress Driver stress for MTs would increase with changes in traffic flows and speeds, however these effects are not considered to be significant.	Assessment is required to a Simple Level in the first instance.	
		Community Severance The reconfiguration of the local road network, as well as an increase in construction traffic, could cause temporary severance for users of Thickthorn park and ride during the construction period. There may also be temporary severance for rail users as a result of the need to widen the existing bridge across the Breckland Railway Line, south of the interchange, as part of the Proposed Scheme.	Assessment is required to a Simple Level in the first instance.	
		Community Land and Community Facilities Thickthorn Park and Ride is likely to be impacted as a result of the construction works. Access to this facility for its users and the route of the buses could be temporarily affected	Assessment is required to a Simple Level in the first instance.	
		Development Land At this stage the extent of the land take is not yet know.	Assessment is required to a Simple Level in the first instance.	
		Demolition of Private Property and Associated Land Take Permanent land take and property demolitions are expected to result in significant adverse effects for landowners.	Assessment is required to a Simple Level in the first instance.	
		Local Economy If the Proposed Scheme results in new employment in the area, this could have a slight beneficial impact on employment rates.	Detailed assessment is required.	

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		Agricultural Land and Individual Farm Business The Proposed Scheme is likely to require both temporary and permanent land-take of some Grade 3 (good to moderate quality) agricultural land.	Assessment is required to a Simple Level in the first instance.	
	Operation	**NMUs** The Proposed Scheme would have a direct impact on users of Cringleford FP4a as the existing footbridge over A47 would be removed and a minor impact on Cringleford BR5. At this stage, two potential solutions are being considered for local access to Cantley Lane South and for pedestrian movements across the A47.	Assessment is required to a Simple Level in the first instance.	
		Amenity Depending on the proposed solution for Cantley Lane the Proposed Scheme could result in a minor adverse effect.	Assessment is required to a Simple Level in the first instance.	
		MTs Driver Stress Driver stress would be reduced as a result of the Proposed Scheme removing the dominant traffic movements from the junction leading to a reduction in peak hour congestion.	Assessment is required to a Simple Level in the first instance.	
		MTs View from the Road (Operation only) Prior to the establishment of Proposed Scheme mitigation planting, there would be 'open' views from the from sections of the A11 and A47. By year 15 of operation views will become more enclosed with establishment of highway boundary mitigation vegetation, but again balanced by potential for views through gaps in planting to maintain the baseline 'intermittent' nature of views.	Assessment is required to a Simple Level in the first instance.	

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		Community Severance The existing footbridge over the A47 to the south of the interchange would be removed. The footbridge currently allows for NMU access across Cantley Lane, and is used to access services in Cringleford such as the GP surgery. The link road between the A47 and A11 would also be permanently removed.	Assessment is required to a Simple Level in the first instance.	
		Community Land and Community Facilities It is not anticipated that there will be any permanent impacts on community land and community facilities.	Assessment is required to a Simple Level in the first instance.	
		Development Land Implementation of the Proposed Scheme may affect proposed future housing developments on adjacent land. In particular, recreational space set to be provided between the proposed housing development and the A47 is likely to no longer occur.	Assessment is required to a Simple Level in the first instance.	
		Demolition of Private Property and Associated Land Take No additional land take or demolition required post construction.	Assessment is required to a Simple Level in the first instance.	
		Local Economy Direct operational employment is not expected to be created as a result of the Proposed Scheme. However, there are likely to be increased indirect employment opportunities related to reduced congestion and improved journey times.	Detailed assessment is required.	

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		Agricultural Land and Individual Farm Business During the operational phase, the Proposed Scheme would require permanent land-take of some Grade 3 (good to moderate quality) agricultural land.	Assessment is required to a Simple Level in the first instance.	
Road Drainage and the Water Environment	Construction	The construction phase has the potential to impact upon the water environment (including groundwater) through mobilisation of sediments and contaminants due to earthworks, construction dewatering, vehicular movements, plant and vehicle washing and alterations to ground levels. The impacts of this would be mitigated by best practice construction measures to be included within the Construction Environment Management Plan (CEMP). Aquatic ecology and water quality may be affected by sediment and/or contaminants.	Assessment to a simple level required.	Consultation with the following organisations will be required with the Environment Agency, Norfolk County Council as LLFA, Norfolk Rivers IDB, South Norfolk District Council, and Anglian Water.
	Operation	All potential effects of Proposed Scheme operation on the water environment will be assessed and mitigated through the Proposed Scheme design. The effect of an increase in impermeable area could result in an increase in peak flow rates and volumes which could, in turn, increase flood risk, particularly within areas of Flood Zones 2 and 3. Loss of floodplain storage in Flood Zone 3, altering flood flow pathways and could increase fluvial flood risk upstream and downstream.	Assessment to a simple level required.	

Topic	Stage	Potential Effects	Requirement for Assessment	Requirement for Further Consultation
		Adverse effect on the status of the watercourse including the hydrological and geomorphological regime. Impacts on groundwater.		
Climate Change	Construction	Potential for increased CO_2 emissions. The construction site has the potential to be vulnerable to extremes of weather, although significant climate change is not expected during the construction period.	Further assessment required.	No further topic specific consultation is required.
	Operation	Potential for increased CO_2 emissions. Changes in climate have the potential to pose a risk to the Proposed Scheme assets and environmental receptors.	Further assessment required.	
Combined and Cumulative Effects	Construction	No assessment has been made at this stage.	The assessment for combined and cumulative effects will be undertaken and presented within an ES.	Consultation with the local planning authority.
	Operation	No assessment has been made at this stage.		

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Appendix A – DCO Site Boundary

Braymeadow Farm
Colney Lane
Thickthorn Farm
Norwich Road
B1172
Round House Way
Bluebell Road
Eaton Street
Newmarket Road
Cringleford
Keswick Road
Woolmuling Road
River Y
Cantley Lane South
Station Lane
A11
Station Farm
Cantley Farm
Cantley Lane
Intwood
Home Farm
Ivy Cottages
High Street
Norwich Lodge
Mulberry House
Intwood La

0 250 500 Metres

Key to symbols

DCO site boundary

References drawings

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	07/02/18	Drawing Produced	LC	BO	BJ

Mott MacDonald Sweco

Client: highways england

Drawing Status: For Information

Suitability: S0

Project Title: A47/A11 Thickthorn Junction

Drawing Title: Figure A.1 DCO Site Boundary

Scale	Designed	Drawn	Checked	Approved
1:13,000	Cutting, Lee	Cutting, Lee	O'Hickey, Ben	Jones, Bryn
Original Size	**Date**	**Date**	**Date**	**Date**
A3	19/12/17	19/12/17	19/12/17	19/12/17

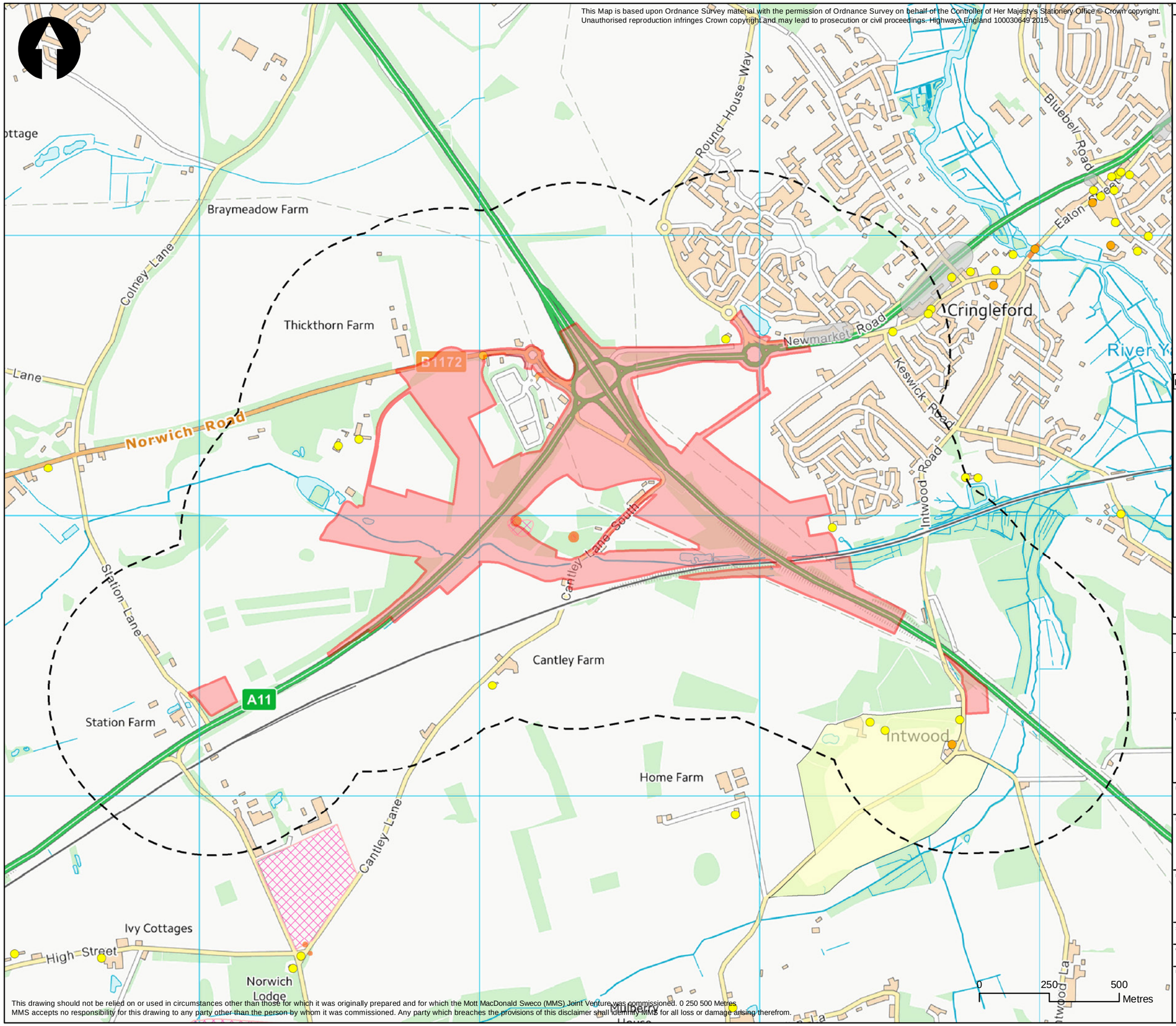
Drawing Number: HE PIN | Originator | Volume
HETTNJCT - MMSJV - EGN -
000 - RP - LX - 00001
Location | Type | Role | Number

Project Ref. No.: HETTNJCT

Revision: P02

Appendix B – Environmental Constraints Figures

- Site Level - 500m buffer
- Wider Context – 5km buffer (reduced site area detail)



Key to symbols

- DCO site boundary
- Indicative 500m buffer
- Listed Building - Grade
  - II
  - II*
- Registered Parks & Gardens
- Scheduled Monument
- Historic Landfill Sites
- Noise Important Areas (NIA)

References drawings

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	07/02/18	Drawing Produced	LC	BO	BJ

Mott MacDonald Sweco

Client: highways england

Drawing Status: For Information

Suitability: S0

Project Title: A47/A11 Thickthorn Junction

Drawing Title: Figure B.1 Environmental Constraints Site Level

Scale	Designed	Drawn	Checked	Approved
1:13,000	Cutting, Lee	Cutting, Lee	O'Hickey, Ben	Jones, Bryn
Original Size	**Date**	**Date**	**Date**	**Date**
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Project Ref. No.: HETTNJCT

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River Wensum

Catton Grove Chalk Pit

Sweetbriar Road Meadows, Norwich

St James' Pit

Eaton Chalk Pit

Caistor St. Edmund Chalk Pit

Shotesham Common

0 250 500 Metres

Key to symbols

- DCO site boundary
- Indicative 5km buffer
- Listed Building - Grade
  - I
  - II
  - II*
- countryparks
- Registered Parks & Gardens
- Scheduled Monument
- Ancient & Semi-Natural Woodland
- Ancient Replanted Woodland
- Local Nature Reserve (LNR)
- Site of Special Scientific Interest (SSSI)
- Special Area Conservation (SAC)
- Historic Landfill Sites
- Noise Important Areas (NIA)

References drawings

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	07/02/18	Drawing Produced	LC	BO	BJ

Mott MacDonald Sweco

Client: highways england

Drawing Status: For Information

Suitability: S0

Project Title: A47/A11 Thickthorn Junction

Drawing Title: Figure B.2 Environmental Constraints Wider Context

Scale	Designed	Drawn	Checked	Approved
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Location | Type | Role | Number

Project Ref. No.: HETTNJCT

Revision: P02

Appendix C – Lighting Impact Assessment Methodology

Introduction and study area

A Lighting Impact Assessment Study will be included as part of the EIA process to determine the likely effects of this design on the surrounding environment. The assessment will ensure that the preliminary lighting design will conform to maximum allowable obtrusive lighting levels and will provide recommended luminaire types, mounting heights and angles for use within various areas of the Proposed Scheme.

The lighting assessment will inform the landscape and ecology Environmental Impact Assessments and will be included as a technical appendix to the Landscape and Visual Impact Assessment. The assessment is considered important to assess possible impacts on potential bat roosts or foraging routes and nearby residential properties.

Guidance and best practice

In considering the potential effects of the proposed development, the following aspects of obtrusive light, taken from the Institute of Lighting Professionals Guidance Note for the Reduction of Obtrusive Light GN01:2011 must be considered and assessed:

- Sky Glow
- Light Intrusion
- Luminaire / Luminous Intensity
- Building or Façade Luminance

The assessment will be in accordance with the following legislation and guidance. Further guidance documents will be consulted as appropriate – the following list is not exhaustive:

- Environmental Protection Act 1990
- Clean Neighbourhoods and Environment Act 2005
- DEFRA: Statutory Nuisance from Insects and Artificial Light
- The Landscape Institute and Institute of Environmental Assessment, 3rd Edition, 2013
- Institution of Lighting Professionals (ILP) *Guidance Notes for the Reduction of Obtrusive Light* (GN01):2011)
- Institution of Lighting Professionals (ILP): ILP Professional Lighting Guide 04, *Guidance on Undertaking Environmental Lighting Impact Assessments* (2013)
- Commission Internationale de l'Eclairage (CIE) 150: Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations
- CIE 126: Guidelines for Minimising Sky Glow
- The Chartered Institution of Building Services Engineers (CIBSE) LG06 The Exterior Environment 2016
- BS EN 12464 Part 2 Outdoor Lighting
- BS EN 13201 European Norm for Road Lighting
- BS 5489-1:2013 Code of Practice for the Design of Road Lighting and Public Amenity Areas
- Bat Conservation Trust and the ILP: Bats and Lighting in the UK: 2009
- Bat Conservation Trust: Statement on the Impact and Design of Artificial Light on Bats. 2011

- Bat Conservation Trust: Landscape and Urban Design for Bats and Biodiversity. 2012
- Bat Conservation Trust: Artificial Lighting and Wildlife Interim Guidance: Recommendations to Help Minimise the Impact of Artificial Lighting, 2014

Proposed methodology and scope

The assessment will follow best practice guidance detailed in 'Institution of Lighting Professionals (ILP): ILP Professional Lighting Guide 04, *Guidance on Undertaking Environmental Lighting Impact Assessments*'. Potential receptors will be identified and discussed with the Local Planning Authority (LPA) as well as landscape and ecology teams to agree the proposed receptor locations and identify any further survey requirements or assessment methodology.

A baseline survey will be carried out, this will provide lux measurements and photographs taken at a survey viewpoint for each receptor and will provide a baseline against which any obtrusive light from the proposed development can be compared.

Information gathered on baseline surveys will facilitate agreement with the LPA in determining which environmental lighting zone the site falls under and therefore the maximum permissible levels of obtrusive light. Environmental zones are set out in Table C.1.

Table C.1: Environmental zones

Zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark	UNESCO Starlight reserves, IDA Dark Sky Parks
E1	Natural	Intrinsically dark	National Parks, Areas of Outstanding Natural Beauty etc.
E2	Rural	Low district brightness	Village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Small town centres or suburban locations
E4	Urban	High district brightness	Town / city centres with high levels of night-time activity

Source: Guidance Notes for the Reduction of Obtrusive Light GN01:2011 (ILP/2011)

Potential effects, including monitoring and mitigation measures

The Proposed Scheme is likely to result in obtrusive light impacts associated with construction such as temporary lighting for safety and security, lighting of haul routes, laydown areas, offices and temporary parking areas etc. There are also likely to be obtrusive lighting impacts during the operational phase as a result of any proposed lighting or changes to existing lighting.

Where mitigation is required, it will be zone and use specific i.e. it will be specific to areas of the site and further assessed by the proposed use of the zone. Mitigation measures will also take into account the findings of the landscape / ecological assessment and any such mitigation which is proposed in the associated reporting.

Appendix D – Road Drainage and Water Environment Figures

- Figure 13.1 – Surface Water Features
- Figure 13.2 – Groundwater Bodies
- Figure 13.3 – Surface Water Flood Risk
- Figure 13.4 – Groundwater Flooding

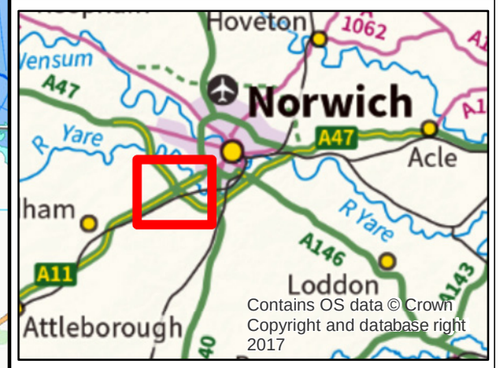
Key to symbols

- DCO site boundary
- Indicative 1km buffer
- OS Surface Water
- Flood Zone 3
- Flood Zone 2
- WFD - Surface Water Operational Catchments Cycle 2

WFD - River, Canal and Surface Water Transfer Waterbodies Cycle 2

- River

References drawings



Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	07/02/18	Drawing Produced	LC	BO	BJ

Mott MacDonald Sweco

Client: highways england

Drawing Status: For Information

Suitability: S0

Project Title: A47/A11 Thickthorn Junction

Drawing Title: Figure 13.1
Surface water features and flood zones

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Original Size	**Date**	**Date**	**Date**	**Date**
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Project Ref. No.: HETTNJCT

Revision: P02

0 250 500 Metres

Key to symbols

- DCO site boundary
- Indicative 1km buffer

Source protection zones

- Zone II - Outer Protection Zone
- Zone III - Total Catchment

BGS Aquifer Maps - Superficial Deposits Designation

- Secondary A
- Secondary (undifferentiated)

Note:
BGS Aquifer Maps -
Bedrock Designation - Principal

References drawings

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	07/02/18	Drawing Produced	LC	BO	BJ

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Client: highways england

Drawing Status: For Information

Suitability: S0

Project Title: A47/A11 Thickthorn Junction

Drawing Title: Figure 13.2 Groundwater Bodies

Scale	Designed	Drawn	Checked	Approved
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Original Size	**Date**	**Date**	**Date**	**Date**
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Drawing Number: HE PIN | Originator | Volume
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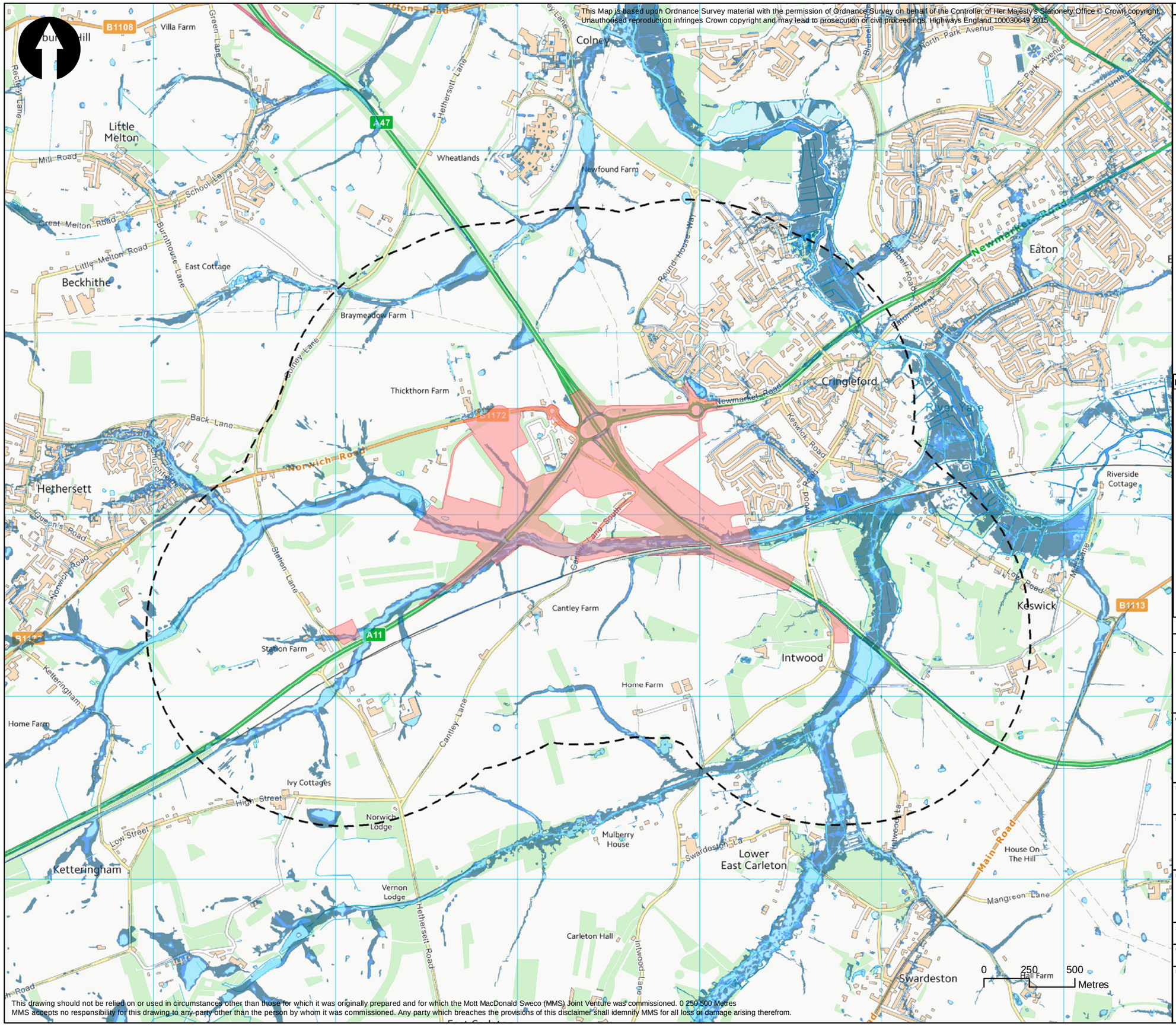
Location | Type | Role | Number

Project Ref. No.: HETTNJCT

Revision: P02

0 250 500 Metres



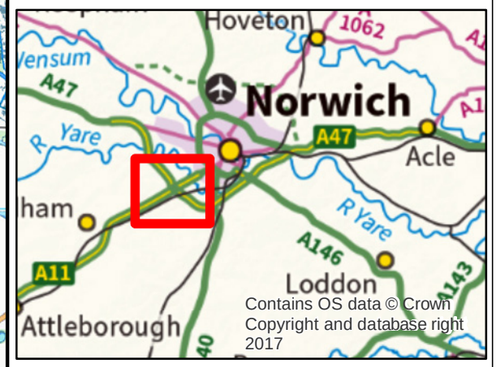
Key to symbols

- DCO site boundary
- Indicative 1km buffer

Surface water flood risk

- 1 in 30yr extent
- 1 in 100yr extent
- 1 in 1000yr extent

References drawings



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P02	07/02/18	Drawing Produced	LC	BO	BJ

Mott MacDonald Sweco

Client: highways england

Drawing Status	Suitability
For Information	S0

Project Title: A47/A11 Thickthorn Junction

Drawing Title: Figure 13.3 Risk of flooding from surface water

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Original Size	**Date**	**Date**	**Date**	**Date**
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HETTNJCT - MMSJV - EGN -
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Location | Type | Role | Number

Project Ref. No.: HETTNJCT

Revision: P02

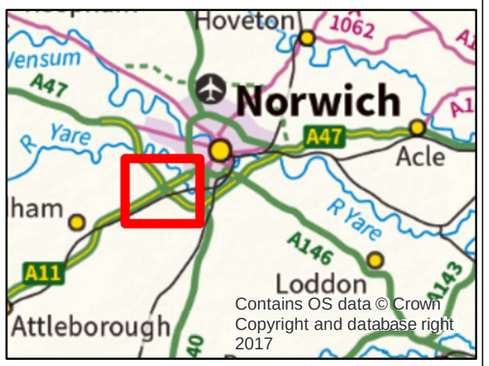
Key to symbols

- DCO site boundary
- Indicative 1km buffer

Susceptibility to groundwater flooding

- < 25%
- >= 25% <50%
- >= 50% <75%
- >= 75%

References drawings



Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	07/02/18	Drawing Produced	LC	BO	BJ

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Client: highways england

Drawing Status: For Information

Suitability: S0

Project Title: A47/A11 Thickthorn Junction

Drawing Title: Figure 13.4 Groundwater flooding

Scale	Designed	Drawn	Checked	Approved
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Original Size	**Date**	**Date**	**Date**	**Date**
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Drawing Number: HE PIN | Originator | Volume
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Location | Type | Role | Number

Project Ref. No.: HETTNJCT

Revision: P02

0 250 500 Metres