Norfolk County Council

LONG STRATTON BYPASS OUTLINE BUSINESS CASE

Environmental Impact Appraisal

PUBLIC

PROJECT NO. 70039894

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1 INTRODUCTION

1.1 INTRODUCTION

1.1.1. This report comprises the Environmental Impact Appraisal (the Appraisal) completed for the Long Stratton Bypass (LSB) Scheme (the Proposed Scheme) on behalf of Norfolk County Council (the Client).

1.2 PURPOSE

1.2.1. Norfolk County Council (NCC) has commissioned WSP to support the delivery of a Department for Transport (DfT) compliant Outline Business Case (OBC) for the Proposed Scheme. For the purpose of the Appraisal, the Proposed Scheme comprises two elements:

- The Eastern Bypass and associated development - a new road to the east of the existing Long Stratton settlement encouraging traffic using the A140 to avoid travelling through the town, with associated residential development;
- The Western Relief Road and associated development – a new road to the north-west of the existing Long Stratton settlement, connecting the A140 to Swan Lane, and unlocking land proposed for the associated residential development.

1.2.2. The LSB OBC is being developed to support an application for Proposed Scheme funding from the Major Road Network (MRN) Fund.

1.2.3. This Appraisal has been produced to support of the OBC. The purpose of the Appraisal is to:

- Provide an overview of the Proposed Scheme history related to the environment;
- Set out the methodology followed to provide this Appraisal;
- Identify and map the key environmental constraints applicable to the Proposed Scheme;
- Complete a Transport Analysis Guidance (TAG) appraisal in accordance with TAG Unit A3[1] to a level proportionate to OBC;
- Provide the key findings of the appraisal; and
- Set out the proposed next steps for the Proposed Scheme with regard to environment.

1.3 PROPOSED SCHEME

DESCRIPTION OF THE PROPOSED SCHEME

1.3.1. The A140 is a former Highways England trunk road that connects Norwich and Ipswich, the two main urban centres of the New Anglia Local Enterprise Partnership area. The key strategic importance of this route is recognised by the New Anglia Local Enterprise Partnership and features in both the Economic Strategy for Norfolk and Suffolk and in its newly published Integrated Transport Strategy.

[1] Department for Transport (May 2019). TAG Unit A3 – Environmental Impact Appraisal. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/825064/tag-unit-a3-environmental-impact-appraisal.pdf [Accessed September 2020]

1.3.2. The Proposed Scheme is illustrated in **Figure 1.1** (in **Appendix A**) with technical drawings provided in **Appendix B**. It comprises two elements:

- The Eastern Bypass (and associated development); and
- The Western Relief Road (and associated development).

Eastern Bypass

1.3.3. The Eastern Bypass and associated development comprises 109.7ha of land to the east of the A140. The road comprises a 4km long all-purpose bypass on the eastern side of Long Stratton, with:

- A 7.3m wide single carriageway;
- Two 1.0m hard edge strip;
- Variable width soft verges;
- A design speed of 100 km/h between Rhees Green roundabout and the existing A140 to the south and a design speed of 85 km/h between Rhees Green roundabout and the northern end of the bypass. The speed limits would be 60mph between Rhees Green roundabout and the existing A140 to the south, and 50mph between Rhees Green roundabout and the northern end of the bypass; and
- The proposed roundabout north of Long Stratton.

1.3.4. From south to north, the Eastern Bypass will include:

- A new four-arm roundabout on A140 Norwich Road (the Northern Gateway Roundabout) incorporating an access to development west of the A140;
- A priority junction with a new link to Church Lane, and the existing Church Lane will be diverted;
- A footbridge crossing for non-motorised users (NMUs) on the footpath between Long Stratton and St Michael's Church;
- A new three-arm roundabout near Edge's Lane, providing a link into new development
- A road overbridge to carry Hall Lane over the bypass;
- A new three-arm roundabout north of Parker's Lane with a single carriageway link to the A140 Ipswich Road at Parker's Lane; and
- A free-flowing connection to A140 Ipswich Road.

1.3.5. The A140 Ipswich Road will remain open for access and cyclists between the bypass and Parker's Lane, with no through traffic.

1.3.6. The 2017 Environmental Statement[2] (2017 ES) describes the associated development as:

'1275 no. dwellings, 8 hectares of employment land for uses within Class B1, B2 and B8, 2 hectare primary school site, community facilities site, associated infrastructure and public open space.'

[2] Norfolk Homes Ltd and Norfolk Land Ltd (2017). Long Stratton Environmental Statement – Main Report.

Western Relief Road

1.3.7. The Western Relief Road and associated development comprises 45.2 hectares to the west of the A140. The road comprises:

- Connections to the A140 using the western branch of the new four-arm roundabout on A140 Norwich Road (the Northern Gateway Roundabout);
- A 30mph road connecting the new roundabout to Swan Lane via a priority junction; and
- Connections on the 30mph road between the two points to development.

1.3.8. The 2017 ES[2] describes the associated development as:

'387 no. dwelling and 1.5 hectares of Class B1 employment land, associated infrastructure and public open space…with phase 1 housing consisting of 213 no. dwellings, associated infrastructure and public open space.'

Summary of terminology

1.3.9. The following terminology is used throughout this report when referring to different components of the Proposed Scheme (**Table 1-1**):

Table 1-1 - Proposed Scheme Description – Summary of terminology

Term	Meaning
Proposed Scheme	The Eastern Bypass and associated development and the Western Relief Road and associated development.
The Eastern Bypass	A new road around to the east of the existing Long Stratton settlement encouraging traffic using the A140 to avoid travelling through the town.
The Western Relief Road	A new road to the north-west of the existing Long Stratton settlement, connecting the A140 to Swan Lane.
Associated development	Land proposed for development surrounding and associated with the Eastern Bypass and the Western Relief Road.
Proposed Development Site (the Site)	The geographical footprint of all associated development.

NEED FOR THE PROPOSED SCHEME

1.3.10. The A140 carries approximately 18,000 vehicles per day through Long Stratton with approximately 2.7% heavy goods vehicles. The road through the town contains a number of junctions, one of which is signalised. Many of these junctions, as well as the road itself, do not meet current standards for layout and visibility. There is a 30mph speed restriction on the A140 through the centre of Long Stratton and 50mph zones either side of this on the approach to the town. This has a negative effect on journey times of people passing through the town. The present of the A140 through Long Stratton creates severance of the community within it.

1.3.11. The current speed restrictions, signal-controlled junction and pedestrian crossing act to slow down through traffic within the built-up area, creating a pinch point on the route. As part of the proposed

MRN it is important that the operation of the A140 is effective and supports the outcomes of the MRN objectives.

1.3.12. The existing A140 is a notorious bottleneck, yet a key route into the county. Congestion in the centre of Long Stratton holds up through traffic, causing delay, severance and poor environmental conditions within the town. When in place, average journey times through/around the town in the peak periods are expected to be reduced by approximately 4 to 8 minutes per trip.

1.3.13. One of the key justifications for the bypass is that it will remove the 'danger, noise, vibration and dirt caused by the continuous heavy traffic', which the 2013 Conservation Area Statement[3] highlights as one of the main impacts on the character of the Conservation Area and a barrier to greater use and enjoyment of the centre of Long Stratton.

1.3.14. **Table 1-2** outlines the objectives of the Proposed Scheme.

Table 1-2 – Proposed Scheme Objectives

Congestion	New road will take through traffic out of the village centre and reduce queues and delays to journeys.
Wider Connectivity – support to the MRN and SRN	Proposals seek to 'free up' the village centre and thus enhance efficiency and attractiveness of public transport and active modes;
Wider Connectivity – support to the MRN and SRN	By relieving congestion on the existing A140 the bypass will aid in improving journey times and reliability of bus services along this route. This should also make the route more accessible for sustainable modes;
Wider Connectivity – support to the MRN and SRN	Improved journey times and reliability will be offered to through traffic, better connection the towns and cities of the surrounding area.
Housing Growth	The bypass is included in a large housing and mixed-use planning application and is considered a critical component to enable their full delivery.
Economic Growth	A more efficient route around Long Stratton will better facilitate deliveries that would otherwise be subjected to congestion and speed limits through the village;
Economic Growth	By improving accessibility to and from the village centre, the bypass will provide more opportunity for businesses;
Economic Growth	Enabling the delivery of a significant new employment opportunities via new land allocated for businesses.
Safety and wellbeing of all users	Creating a new road, adhering to all modern design standards should provide an improved highway and reduce the rate and severity of road traffic incidents.

[3] South Norfolk Council (January 2013). Long Stratton Conservation Area Character Appraisal and Management Plan.

Safety and wellbeing of all users	Reducing heave traffic on the existing A140 should work to remove the impact of severance in Long Stratton and enable an enhanced local centre public realm;
Safety and wellbeing of all users	Reduction of HGV's and other through traffic in the village centre will assist in improving air quality in the village and reduce the noise impact from the existing road.

BACKGROUND OF THE PROPOSED SCHEME

1.3.15. A bypass for the A140 at Long Stratton, South Norfolk, has been campaigned for over many decades, being first raised back in the 1930s. Most recently, plans for a bypass were included in both the Greater Norwich Joint Core Strategy and Local Area Action Plan.

1.3.16. The Eastern Bypass is considered key to support the delivery of much needed housing and employment growth in the area. Long Stratton has been identified as a location for the development of at least 1,800 new homes and an additional 9.5ha of employment land. Two planning applications for this housing allocation and associated facilities were submitted in early 2018, one of which included a request for the full planning approval for the bypass. The two planning applications were described as follows:

- PP-06602334 or 2018/0112: Hybrid Application on 45.2 hectares of land to the west of the A140 seeking outline planning permission for 387 no. dwellings and 1.5 hectares of Class B1 employment land, associated infrastructure and public open space. Together with application for full planning permission for a western relief road (including a roundabout access at the north to the A140 and a priority junction access to Swan Lane at the south) and with phase 1 housing consisting of 213 no. dwellings, associated infrastructure and public open space.
- PP-06577801 or 2018/0111: Hybrid Application on 109.7 hectares of land to the east of the A140 seeking outline planning permission for 1275 no. dwellings, 8 hectares of employment land for uses within Classes B1, B2 and B8, 2 hectare primary school site, community facilities site, associated infrastructure and public open space. Together with application for full permission for a bypass (including a roundabout access at the north and a priority junction access at the south, 3 no. intermediate roundabouts providing local connectivity, and associated enabling works).

1.3.17. It is understood that although the planning applications have been submitted, they have not yet been granted consent. Changes to the design of the Eastern Bypass since the original submission of the planning application also need to be submitted for consideration, through an update to the planning application (anticipated to be submitted in the first half of 2021). It is understood that there are no changes to the Western Relief Road and associated development, or the quantum of development associated with the Eastern Bypass since the submission of the planning applications. It is understood that there are ongoing changes to the Eastern Bypass masterplan, however, these are not the subject of this report.

Review of 2017 ES

1.3.18. The 2017 ES[2] was prepared for the two concurrent applications (PP-06602334 or 2018/0112 and PP-06577801 or 2018/0111). The applications comprised an earlier design of the Proposed Scheme and include residential, commercial and community development.

1.3.19. The 2017 ES was prepared in accordance with the 2011 EIA Regulations[4], falling under the transitional arrangements set out in the 2017 EIA Regulations[5]. However, the 2017 ES considered as far as possible any additional requirements introduction by the 2017 EIA Regulations.

1.3.20. The 2017 ES scoped the following topics into the assessment:

- Air Quality;
- Archaeology;
- Biodiversity;
- Climate Change and Energy;
- Cultural Heritage;
- Ground Conditions and Contamination.
- Hydrology/Flood Risk/Water Resources;
- Landscape and Visual;
- Lighting;
- Noise and Vibration;
- Society and Economy;
- Soils and Agriculture; and,
- Traffic and Transport.

1.3.21. The key findings of the Environmental Impact Assessment were that[6]:

*'Overall, the impacts of the Proposed Development remaining after mitigation range from **major beneficial** to, at worse, **major/moderate adverse**. The majority of impacts are negligible or not significant, with the only moderate or major adverse impacts relating to Cultural Heritage (two assets) and a small number relating to Noise, which will be the subject of on-going assessment. Many of the adverse impacts are short-term and temporary in nature with most being reduced in their significance with time and as the effectiveness of the mitigation measures are put in place to manage and reduce these impacts.'*

REVIEW OF SOBC

1.3.22. A Strategic Outline Business Case (SOBC) was prepared in September 2018[7] to support a MRN funding bid to the DfT for the A140 Long Stratton Bypass. The bypass layout used in the SOBC appraisal was that developed by ASD Engineering on 13/06/18 on behalf of Norfolk Land Limited and Norfolk Homes.

[4] Town and Country Planning (Environmental Impact Assessment) (England) Regulations 2011, as amended by the Town and Assessment) (Amendment) Regulations 2015
[5] Town and Country Planning (Environmental Impact Assessment) Regulations 2017
[6] Norfolk Homes/Norfolk Land Ltd. (2017). Long Stratton Environmental Statement – Non-Technical Summary, paragraph 4.123
[7] WSP on behalf of Norfolk County Council (September 2018). Long Stratton Bypass, Strategic Outline Business Case [Ref. SOBC1.3]

1.3.23. A qualitative environmental appraisal was undertaken for the topics identified in TAG Unit A3 and concluded the following (Section 2.12):

- *'Noise: The scheme will considerably reduce the number of resident impacted by traffic related noise pollution.*
- *Air Quality: Overall improvement in air quality due to removal of traffic from the centre of Long Stratton, where high number of properties are within 200m of the existing A140, is expected.*
- *Townscape: Long Stratton is an attractive village that will greatly benefit from the removal of through traffic from its centre.*
- *Historic Environment: Removal of traffic from the village centre will generally improve the setting of some listed buildings, although the new route will affect the setting of listed buildings in Stratton St Michael. Five sites of known archaeological interest will be directly affected.*
- *Biodiversity: Majority of scheme passes through arable land of low ecological value. However, several ponds would be affected which may contain Great Crested Newts, however detailed mitigation measures have been developed to reduce the level of impact.*
- *Water Environment: Assuming construction impacts are mitigated, the overall impact of the proposed improvement would be marginally beneficial due to reduced risk of accidents causing severe pollution events.'*

1.4 CONSTRAINTS MAPPING

1.4.1. The baseline conditions and appraisal of potential impacts are set out in Chapters 2 to 13 of this Appraisal. Constraints maps for the Proposed Scheme are provided in **Appendix A**, these comprise:

- Figure 1.2: Social Constraints Plan;
- Figure 1.3: Environmental Constraints Plan; and
- Figure 1.4: Cultural Heritage Constraints Plan.

1.5 APPRAISAL METHODOLOGY

GENERAL METHODOLOGY

1.5.1. This Appraisal comprises an appraisal of the Proposed Scheme in accordance with TAG Unit A3. The TAG worksheets are provided in **Appendix C**. The topics appraised, and whether a qualitative or quantitative assessment has been undertaken, comprise:

- Quantitative:
  - Air Quality;
  - Greenhouse Gases (GHG); and
  - Noise.
- Qualitative:
  - Biodiversity;
  - Historic Environment;
  - Water Environment; and,
  - Landscape.

1.5.2. Townscape has been scoped out of the assessment, this is discussed further in Chapter 9. Additionally, the distributional impact assessment for noise and air quality is provided elsewhere in the OBC documentation.

1.5.3. The Appraisal considers the entire Proposed Scheme. While TAG typically applies to the appraisal of transport infrastructure, in this instance, the proposed transport infrastructure and the associated development are considered interrelated, and that the associated development can be considered consequential development (the associated development will be facilitated by the new road infrastructure). The Appraisal and TAG worksheets seek to differentiate the assessment of the road infrastructure from the associated development, where relevant. Specifically, monetised values from the TAG worksheets for Air Quality, Noise and Vibration, and Greenhouse Gases, are based on the transport infrastructure in isolation.

1.5.4. Furthermore, this Appraisal provides a high level qualitative appraisal of the Proposed Scheme for the following topics which would be likely to be considered in a statutory Environmental Impact Assessment (under the EIA Regulations 2017), or would otherwise need to be considered as part of an Environmental Impact Appraisal, but do not form part of the TAG guidance:

- Arboriculture;
- Climate Change Resilience;
- Population and Health;
- Materials and Waste; and
- Ground Conditions and Contaminated Land (including agricultural land).

1.5.5. Further information on the methodology for each topic is provided in the topic chapters, as set out in **Section 1.6**.

ASSUMPTIONS AND LIMITATIONS

1.5.6. The following assumptions and limitations apply to this Appraisal:

- This Appraisal does not form an Environmental Impact Assessment under the EIA Regulations 2017;
- The Appraisal is based on the Proposed Scheme as described in **Section 1.3** and shown in drawings 70039894-WSP-HGN-DR-CH-00100 – 00106 and CL-100, CL-101, CL-200 and CL-201 (located in **Appendix B**);
- The information presented in the 2017 ES has been relied upon for this assessment, additional surveys have not been undertaken to verify the information (with the exception of arboriculture);
- It is understood that there are no changes to the Western Relief Road and associated development since the submission of the planning applications; and
- The design of the Eastern Bypass has been updated since the submission of the 2017 ES and now extends outside this Proposed Development Site boundary in a number of locations (as shown on **Figure 1.1** in **Appendix A**). This appraisal has included consideration of this updated Eastern Bypass design (but not of the associated development of the Eastern Bypass).

1.6 STRUCTURE OF REPORT

1.6.1. The structure of this report comprises:

- Chapter 2: Air Quality;
- Chapter 3: Arboriculture;

- Chapter 4: Biodiversity;
- Chapter 5: Climate Change Resilience;
- Chapter 6: Greenhouse Gases;
- Chapter 7: Ground Conditions and Contaminated Land; and
- Chapter 8: Historic Environment;
- Chapter 9: Landscape;
- Chapter 10: Materials and Waste;
- Chapter 11: Noise;
- Chapter 12: Population and Health;
- Chapter 13: Water Environment'
- Chapter 14: Summary.

1.6.2. The report is supported by the following appendices:

- Appendix A: Figures;
- Appendix B: Scheme drawings;
- Appendix C: TAG Appraisal Sheets; and
- Appendix D: Borehole location plans.

2 AIR QUALITY

2.1 INTRODUCTION

2.1.1. This chapter presents the appraisal of Air Quality Impacts for the Proposed Scheme. This appraisal is based on the impacts of the Western Relief Road and Eastern Bypass only.

2.2 APPRAISAL METHODOLOGY

STUDY AREA

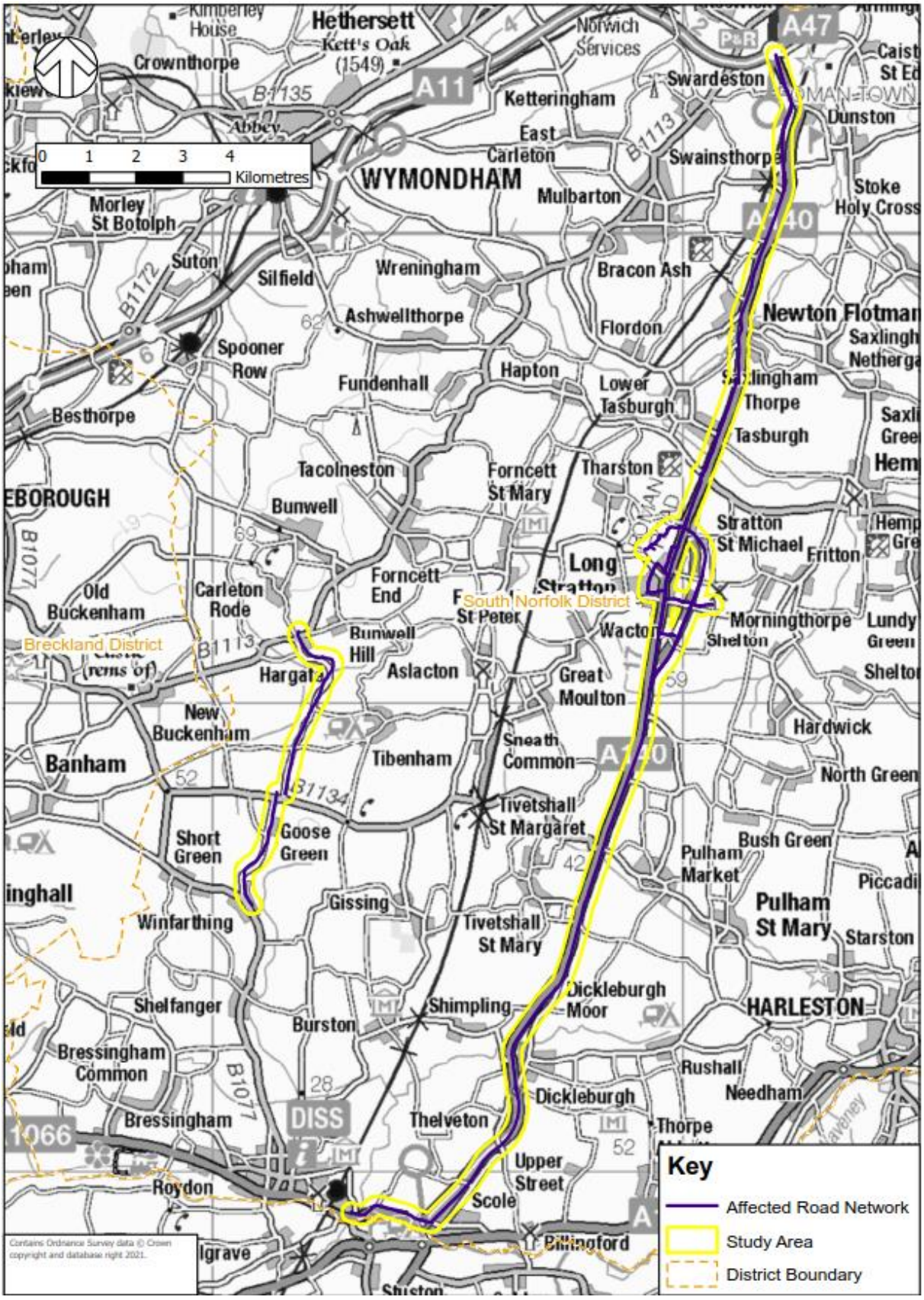
2.2.1. The study area has been determined by defining the affected road network (ARN) using DMRB LA 105 scoping criteria[8]:

- Change in annual average daily traffic (AADT) flow of 1,000 vehicles or more; or
- Change in AADT flow of heavy duty vehicles of 200 or more; or
- Change in road alignment of 5m or more.

2.2.2. The ARN extends from the eastern fringe of the small town of Diss along the A1066 to the A120 at Waterloo/Scole, and along the A120 through Long Stratton to the junction with the A47. The ARN also includes some minor roads within Long Stratton, the Eastern Bypass and Western Relief Road alignment, and a short section of the B1077 through the village of Winfarthing, Mill Road, Diss Road/Fen Road up to the village of Hargate. The study area extends 200m around the ARN. All impacts beyond 200m will be imperceptible and have been scoped out. The study area is shown in **Insert 2-1**.

[8] DMRB HA 207/07 Air Quality guidance and associated Interim Advice Note 170/12, which are referred to in TAG Unit A3 (May 2019) guidance, have been superseded by LA 105, which is available to download at: https://www.standardsforhighways.co.uk/dmrb/ [accessed November 2020]

Insert 2-1 – Study Area for Air Quality Impact



DATA REQUIREMENTS

2.2.3. The data sources used in this appraisal comprise:

- Broadland District Council and South Norfolk District Council 2019 Air Quality Annual Status Report (ASR)[9];
- Traffic data for without and with scheme in 2024 (opening year) and 2039 (design year) from the Suffolk County Transport Model (2016 base year);
- Road source emissions data from Defra's Emissions Factors Toolkit (version 10.1)[10];
- Meteorological data for 2016 from Norwich airport – used in predicting pollutant concentrations at receptors;
- Background and roadside pollutant concentration data from Defra's 2018-based Pollution Climate Mapping (PCM) model[11,12];
- Conversion of modelled oxides of nitrogen (NO_x) concentrations to nitrogen dioxide (NO_2) concentrations using Defra's NO_x to NO_2 calculator (version 8.1)[13]; and
- Ordnance Survey AddressBase data, provided by NCC under Contractor Licence, to identify sensitive receptor locations with relevant exposure to annual mean pollutant concentrations

APPRAISAL APPROACH

2.2.4. The appraisal has been undertaken following TAG Unit A3 guidance on Air Quality Impacts and has involved:

- Quantitative assessment based on modelling to determine vehicle emissions of NO_x and fine particulate matter ($PM_{2.5}$) with and without the scheme in the opening and design years, and dispersion modelling to determine road contributed annual mean concentrations of NO_x and $PM_{2.5}$ at relevant receptors in the scenarios. Concentrations have been predicted by dispersion modelling using ADMS-Roads model software[14].
- Monetary valuation of the Air Quality Impacts has been undertaken using the impact pathways approach, which accounts for changes in human exposure to annual mean NO_2 and $PM_{2.5}$ concentrations at relevant receptors and overall emissions of NO_x and $PM_{2.5}$ to determine the effects of impacts that do not directly affect households such as ecosystem damages.

[9] Broadland District Council and South Norfolk District Council (2019) 2019 Air Quality Annual Status Report (ASR). Available at: https://www.south-norfolk.gov.uk/residents/neighbourhood-issues/environmental-quality/air-quality [accessed November 2020]
[10] Defra (2020) Emissions Factors Toolkit (version 10.1). Available at: https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html [accessed November 2020]
[11] Defra (2020) Background Maps (2018 reference year). Available at https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html [accessed November 2020]
[12] Defra (2020) NO_2 and PM projections data (2018 reference year). Available at: https://uk-air.defra.gov.uk/library/no2ten/2020-no2-pm-projections-from-2018-data [accessed November 2020]
[13] Defra (2020) NOx to NO2 calculator (version 8.1). Available at https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html [accessed November 2020]
[14] Further information on ADMS-Roads can be found on the Cambridge Environmental Research Consultants webpage: http://www.cerc.co.uk/environmental-software/ADMS-Roads-model.html

2.3 KEY CONSTRAINTS

2.3.1. Air quality constraints have been considered in terms of:

- Local Air Quality Management (LAQM) status;
- Available ambient air quality monitoring data;
- PCM model predictions; and
- Existing receptors and those associated with adjacent development areas.

2.3.2. The study area is almost entirely within the South Norfolk District Council (SNDC) administrative area, with a very small, marginal part overlapping into the Mid-Suffolk District Council area between Diss and Waterloo.

2.3.3. SNDC reports that there are currently no Air Quality Management Areas within the SNDC area[9], indicating that air quality within district is good and that pollutant concentrations do not exceed the legal standards which have been set to protect public health[15,16,17,18].

2.3.4. Within the study area there are 7 SNDC monitoring sites, which are shown in **Insert 2-2**. These are all within Long Stratton along the A140 at roadside and use diffusion tubes to monitor annual mean NO_2 concentrations. The latest data published by SNDC is for 2018 and the concentrations at these sites range from 19.1 to 34.6 µg/m^3 (the standard is 40µg/m^3). The highest and lowest concentrations occur just to the north and south of the junction with Swan Lane.

2.3.5. There are no monitoring sites for $PM_{2.5}$. SNDC has not determined any problems with this pollutant[9].

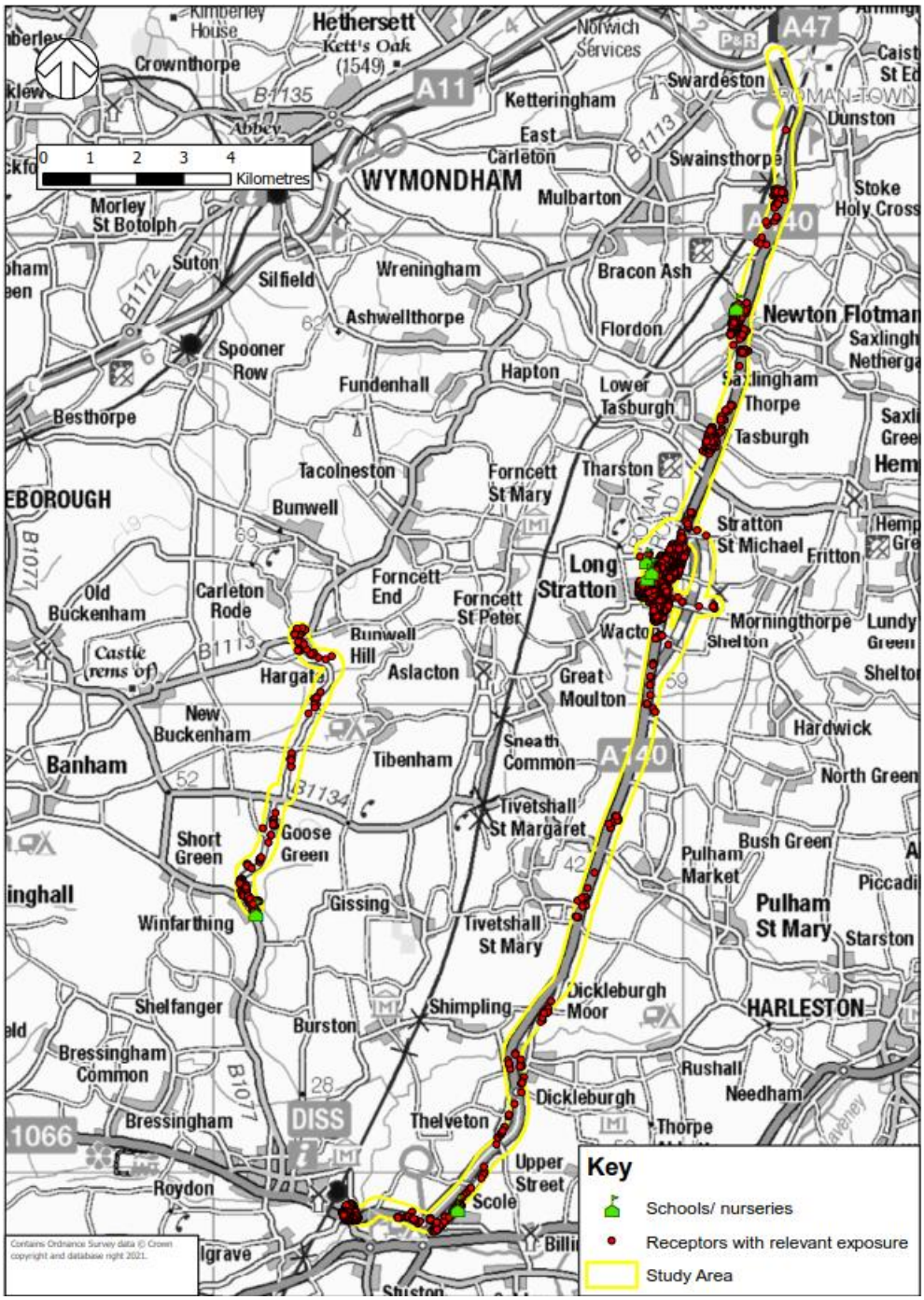
[15] Air Quality (England) Regulations (2000), Statutory Instrument 2000 No.928. Available at: http://www.legislation.gov.uk/uksi/2000/928/pdfs/uksi_20000928_en.pdf [accessed November 2020]
[16] Air Quality (England) (Amendment) Regulations (2002), Statutory Instrument 2002 No.3043. Available at: http://www.legislation.gov.uk/uksi/2002/3043/pdfs/uksi_20023043_en.pdf [accessed November 2020]
[17] Air Quality Standards Regulations 2010, Statutory Instrument 2010 No.1001. Available at: https://www.legislation.gov.uk/uksi/2010/1001/contents/made [accessed November 2020]
[18] Air Quality Standards (Amendment) Regulations 2016, Statutory Instrument 2016 No.1184. Available at: https://www.legislation.gov.uk/uksi/2016/1184/contents/made [accessed November 2020]

Insert 2-2 - Air Quality Monitoring Sites

2.3.6. There are no PCM model links, which are used by Defra in evaluating Limit Value[18] compliance, that overlap the ARN. The nearest PCM link, which falls just within the study area but just short of the ARN, is on the A1066 through Diss where the 2018 baseline roadside annual mean NO_2 is given as 17.1µg/m^3, which is well below the standard.

2.3.7. Existing receptors with relevant exposure are predominately residential and are located within Long Stratton. There are also 6 schools/nurseries within the study area which have relevant exposure. Existing receptors are shown in **Insert 2-3**.

Insert 2-3 - Existing Air Quality Receptors with Relevant Exposure



2.3.8. In summary, baseline air quality at existing receptors with relevant exposure within the study area is good, with pollutant concentrations likely to be well below standards. Baseline air quality in development areas that may be intersected by the study area is also likely to be good.

2.4 APPRAISAL

2.4.1. The Air Quality Impacts TAG sheet is provided in **Appendix C**.

KEY FINDINGS OF THE APPRAISAL PROCESS

2.4.2. Overall, with the Eastern Bypass and Western Relief Road there are improvements in local air quality in terms of NO_2 and $PM_{2.5}$ at locations with relevant human exposure. However, there are overall increases in emissions of NOx and $PM_{2.5}$ from the affected road network as a whole. No Air Quality Management Areas, or road links that are included in Defra reporting of Limit Value compliance are included in the ARN. No exceedances of air quality standards are predicted at existing receptors and are considered unlikely within adjacent new development areas.

PROPOSED NEXT STEPS

2.4.3. The following scope of works is proposed to be completed:

- Confirm whether an updated air quality assessment is required for an update of the EIA given significant effects are considered unlikely, in support of the planning process at the next stage.

3 ARBORICULTURE

3.1 INTRODUCTION

3.1.1. This chapter presents an appraisal of the key arboricultural constraints of the Proposed Scheme.

3.2 APPRAISAL METHODOLOGY

STUDY AREA

3.2.1. A study area comprising of the Proposed Scheme and a 15-metre buffer has been identified, as shown on **Figure 3.1** in **Appendix A**. The purpose of the 15-metre buffer is to ensure compliance with BS 5837[19] which recommends that all trees whose root protection areas (RPAs) extends into the developable area are identified and surveyed. The BS 5837 caps RPAs with a maximum radius of 15-metres meaning that the study area encompasses all trees which may be adversely impacted by construction of the Proposed Scheme.

DATA SOURCES

3.2.2. The following data sources were used in this appraisal:

- The identification of trees covered by a Tree Preservation Order or within a Conservation Area checked using the South Norfolk Council online mapping system[20].
- The presence of previously recorded ancient and veteran trees within the study area was checked using the Woodland Trust's Ancient Tree Inventory[21].
- The presence of ancient woodlands within the study area was checked using Natural England's Multi Agency Geographical Information for the Countryside (MAGIC) map[22].
- Information on the existing baseline arboricultural resource across the Proposed Development Site to the west of the A140 Norwich Road was obtained from the Arboricultural Impact Assessment (Ref. 17/306 AR01 Rev. A) produced by James Blake Associates Ltd and dated November 2017. Information comprised a series of plans identifying the location and quality of surveyed trees together with a partial list of survey data.

[19] British Standard 5837:2020. Trees in relation to design, demolition and construction. Recommendations.
[20] South Norfolk Council, 2020. *My South Norfolk* [online] Available at: https://my.south-norfolk.gov.uk/mysouthnorfolk.aspx [Accessed 26 October 2020].
[21] Ancient Tree Inventory, 2020. *Ancient Tree Inventory* [online] Available at: < https://ati.woodlandtrust.org.uk> [Accessed 26 October 2020].
[22] Magic (DEFRA), 2020. *Multi Agency Geographic Information for the Countryside* [online] Available at: < https://magic.defra.gov.uk/MagicMap.aspx> [26 October 2020].

3.2.3. Information on the existing baseline arboricultural resource across the Proposed Development Site to the east of the existing A140 was obtained through the completion of a walkover survey. The survey was undertaken on 15 October 2020 (by a Principal Arboricultural Consultant). The walkover survey was undertaken in accordance with the following criteria:

- Only moderate and high-quality trees, tree groups and wooded areas were recorded. The quality of recorded and un-recorded features was determined in accordance with the descriptors provided in **Table 3-1**.
- The trees have been inspected using the Visual Tree Assessment methodology as developed by Mattheck and Breoler[23].
- The tree survey was carried out from ground level only. No tissue samples were taken nor was any internal investigation of the subject trees undertaken.

APPRAISAL APPROACH

3.2.4. The arboricultural appraisal seeks to provide a high-level qualitative assessment of the Proposed Scheme. It aims to:

- Clarify which arboricultural features should be identified as potential constraints; and,
- Identify the likely impacts to arboricultural constraints.

3.2.5. The arboricultural appraisal has been undertaken with reference to the James Blake Associates Ltd Arboricultural Impact Assessment (Ref. 17/306 AR01 Rev. A) dated November 2017. This document supported the 2017 ES.

3.2.6. For the purposes of the Proposed Scheme, identifiable arboricultural constraints have been determined through reference to the following policy, legislation and guidance.

South Norfolk Local Plan, Development Management Policies Document (Adopted October 2015)[24].

3.2.7. The South Norfolk Local Plan, Development Management Policies document identifies development management policies which may be applicable to the identification of arboricultural constraints. Policy DM 4.8 ‘Protection of Trees and Hedgerows’ states that the Council ‘’will promote the retention and conservation of significant trees, woodlands and traditional orchards and will serve Tree Preservation Orders where necessary.’

3.2.8. Further guidance on the implementation of Policy DM 4.8 indicates that trees will be valued not only on their landscape merits but also on their ability to provide environmental, economic, social and climatic benefits. It is further stated that development should ensure a harmonious relationship between trees and structures and that tools such as TEMPO (Tree Evaluation Method for Preservation Orders) will be utilised when identifying trees suitable for statutory protection.

[23] Mattheck, C., Breloer, H., 2006. *The body language of trees*. Norwich: The Stationary Office
[24] South Norfolk Council (2015) *South Norfolk Local Plan, Development Management Policies Document* [Online] Available at https://www.south-norfolk.gov.uk/sites/default/files/Development_Management_Policies_Document_0.pdf (Last accessed 27 October 2020)

The Town and Country Planning Act 1990

3.2.9. Section 197 of the Town and Country Planning Act 1990 places a duty on the local planning authority to ensure that, where appropriate, planning conditions are imposed which require the preservation or planting of trees. Section 198 of the Act further provides local planning authorities with the powers to impose Tree Preservation Orders (TPO) where it is expedient in the interests of amenity.

3.2.10. Arboricultural constraints should therefore include reference to trees which are, or have the capacity to become, the subject of a TPO. The identification of trees worthy of statutory protection can reasonably be achieved through reference to 'Tree Preservation Orders and trees in conservation areas'[25]. This document defines trees which warrant statutory protection as those whose removal would have a 'significant negative impact on the local environment and its enjoyment by the public.'

The Natural Environment and Rural Communities (NERC) Act 2006

3.2.11. Section 40 of the NERC Act places a duty on local authorities and government departments to have regard for the conservation of biodiversity when exercising their normal functions. Biodiversity comprises all living things including animals, plants, fungi and micro-organisms and includes the communities and habitats that they form. Trees form integral elements of the natural environment either due to rarity, as part of an important habitat or because they directly support another species. Even widespread, common or non-native tree species are important due to their positive contribution towards a sustainable natural environment.

3.2.12. Compliance with the NERC Act therefore requires that the Proposed Scheme be undertaken with due regard for trees and their biodiversity value. Trees should be retained wherever practicable and opportunities taken to maintain and enhance their environmental contribution.

British Standard BS 5837: 2012 Trees in relation to design, demolition and construction – Recommendations

3.2.13. The British Standard BS 5837: 2012 Trees in relation to design, demolition and construction – Recommendations[26] (BS 5837) provides recommendations and guidance on the relationship between trees and the design, demolition and construction process. It sets out the principles and procedures to be applied to achieve a harmonious and sustainable relationship between trees and structures. The BS 5837 also provides guidance on how to assess the quality of an arboricultural feature, a summary of which is provided in **Table 3-1**.

[25] Ministry of Housing, Communities & Local Government (2014) *Tree Preservation Orders and trees in conservation areas* [Online] Available at https://www.gov.uk/guidance/tree-preservation-orders-and-trees-in-conservation-areas (Last accessed 27 October 2020)

[26] British Standards Institute. BS 5837: 2012 Trees in relation to design, demolition and construction – Recommendations. London: BSI.

Table 3-1 – Descriptors for BS 5837 quality assessment

Quality	Area of value	Estimated remaining life expectancy (years)	Description
High	Arboriculture Landscape Cultural	>40	Trees that are of particularly good examples of their species (e.g. notable specimens), especially if rare or unusual; or those that are essential components of groups, or of formal or semi-formal arboricultural features (e.g. the dominant and/or principle trees within an avenue). Trees, groups, or woodlands of particular visual importance as arboricultural and/or landscape features. Trees, groups or woodlands of significant conservation, historical, commemorative or other value (e.g. ancient trees, veteran trees and ancient woodland).
Moderate	Arboriculture Landscape Cultural	>20	Trees that might be high quality, but which are downgraded because of impaired condition (e.g. the presence of significant though remediable defects including unsympathetic past management and storm damage), such that they are unlikely to be suitable for retention beyond 40 years; or trees lacking the special quality necessary to merit a high-quality designation. Trees present in numbers, usually as groups or woodlands, such that they attract a higher collective rating than they might as individuals; or trees occurring as collectives but situated so as to make little visual contribution to the wider locality. Trees with material conservation or other cultural value.
Low	Arboriculture Landscape Cultural	>10	Unremarkable trees of very limited merit or such impaired condition that they do not qualify in higher categories. Trees present in groups or woodlands, but without this conferring on them significantly greater collective landscape value; and/or trees offering low or only temporary/transient landscape benefits. Trees with no material conservation or other cultural value.
Very-Low	None	<10	Trees that have serious irremediable structural defects; Trees that are dead or are showing signs of immediate and irreversible physiological decline, and; Trees infected with significant pathogens or very-low quality trees suppressing specimens of better quality.

METHODOLOGY

3.2.14. The method of arboricultural appraisal is as follows:

- Tree survey data provided as part of the 2017 Arboricultural Impact Assessment has been utilised to identify high and moderate quality arboricultural features located within the Proposed Development Site west of the A140 and on land in proximity to the Western Relief Road;

- Tree survey data collected during a walkover survey has been used to inform on the location of high and moderate quality arboricultural features within the Proposed Development Site east of the existing A140 and on land in proximity to the Eastern By-pass.
- Data (from the sources set out above) on the location of high and moderate features has been used to identify likely adverse arboricultural impacts associated with construction of the Western relief Road and Eastern Bypass. Impacts arising from associated development cannot be assessed in the absence of a plan which shows the likely position of items such as structures, roads and green infrastructure.
- Impacts have been defined on the basis that:
    - Arboricultural features within 15-metres of the proposed highway alignment are likely to become damaged during construction such that they will become unsustainable and will need to be removed;
    - Arboricultural features between 15 and 50 metres from the proposed highway alignment have the potential to become damaged during construction and are therefore identified as 'at risk of requiring removal'.
    - Arboricultural features in excess of 50 metres from the proposed highway alignment are unlikely to be adversely impacted during construction of the road.
    - Features not requiring removal for highway construction will still need to be considered when determining the layout of any associated development. It is assumed that the constraints associated with these features will be given adequate consideration and that they will be retained wherever reasonably practicable. In the absence of any obvious reason for removal it is assumed that these features can be retained.

3.2.15. Due to current stage of design associated with the Western Relief Road and Eastern Bypass it is not possible to identify whether there are any specific measures available which could be utilised to minimise tree damage or avoid tree removal. Also, as a general rule localised design modifications are rarely sufficient to permit the retention of trees within 15 metres of the highway alignment and are often only effective at retaining trees which are further away. It should therefore be assumed that trees within 15 metres of the proposed highway will only be retainable if the alignment is altered to increase the separation distance.

3.2.16. The results of the arboricultural appraisal are presented in **Figure 3.1** in **Appendix A**. These include the study area, arboricultural constraints and potential adverse impacts.

3.3 KEY CONSTRAINTS

3.3.1. For the purposes of this assessment, arboricultural constraints include those features whereby loss or damage would result in a significant detrimental effect to the baseline arboricultural resource. These are defined as trees, tree groups or wooded areas whose loss or damage would be contrary to the requirements of development management policy DM 4.8 and includes specimens with identifiable landscape, environmental, economic, social and climatic benefits. In accordance with this policy it also includes trees which would warrant statutory protection by virtue of a TPO. It is considered likely that the identification of such features will also satisfy the duties imposed on the local planning authority, or Norfolk County Council, by both The Town and Country Planning Act 1990 and the NERC Act 2006.

3.3.2. The BS 5837 provides a methodology for identifying the value of trees based upon their arboricultural, landscape and cultural values. This is a qualitative system of assessment but is one

which does require the surveyor to have regard for many of the benefits identified within Policy DM 4.8. For example, measurable criteria such as tree stem diameter can directly influence tree quality with those trees having a large diameter stem being potentially viewed as of a higher quality than those with small stem diameters. Given that stem diameter is directly linked to tree size and age this generally means that older, larger and healthy trees are of regarded as being of higher quality than those that are young, of limited stature or with only a short future life-expectancy

3.3.3. Research[27] suggests that the visual, environmental, climatic and other benefits of trees increase with both size and age. On this basis it would not be unreasonable to assume that arboricultural features recorded as high or moderate value under BS 5837 might warrant consideration under Policy DM 4.8 whilst those awarded low or very-low value do not possess the necessary identifiable benefits. This proposal would be consistent with that put forward within the 2017 Arboricultural Impact Assessment within which it was concluded that arboricultural impacts 'are deemed to be acceptable' on the basis that 'most trees to be removed are of low quality'. Thus, for the purposes of this assessment, arboricultural constraints shall be identified as any tree, tree group or woodland which is of high or moderate value when assessed in accordance with BS 5837 and the descriptors provided in **Table 3-1**.

3.3.4. Other constraints include a common law duty of care towards the owner of trees which are outside the Proposed Development Site but, which are close enough to the boundary, for branches and roots to grow into an area of the Proposed Scheme. Although there exists the right to prune encroaching branches and roots back to the boundary of the property within which a tree is growing this must still be undertaken with reasonable care. In practice what this means is that, whilst some pruning of branches and roots may be possible, their cutting back to a property boundary may not be possible if it destroys the tree or renders it unsafe. In these instances negotiation with a tree owner may be the only realistic option for fully removing above and below ground physical constraints associated with third-party trees.

3.4 APPRAISAL

RESULTS

Western Relief Road

3.4.1. Reference to the 2017 Arboricultural Impact Assessment identified the presence of one high-quality tree, 28 moderate-quality trees and three moderate-quality tree groups within the study area associated with the Western Relief Road.

3.4.2. The single high-quality tree[28] is an English oak (Quercus robur) and is located part-way along the eastern boundary of the sewage works. The remaining 31 moderate-quality trees and tree groups are distributed across the study area and comprise hedgerow trees or those growing within small

[27] Davies, H., Doick, K., Handley, P., O'Brien, L. and Wilson, J., 2017. *Delivery of ecosystem services by urban forests*. Edinburgh; Forestry Commission

[28] Referenced as T3361 within the survey schedule.

wooded areas. Moderate-quality features[29] are formed predominately from English oak with the occasional field maple (*Acer campestre*), ash (*Fraxinus excelsior*), sycamore (*Acer platenoides*) and willow (*Salix sp.*). Information on species is unavailable for four of the trees and all three tree groups.

3.4.3. Three moderate-quality trees are within 15 metres of the proposed highway alignment with an additional two moderate-quality trees within 50 metres. Potential adverse impacts associated with the current alignment of the Western Relief Road therefore include the loss of three moderate-quality trees and the possibility for two moderate-quality trees to either become damaged or require removal.

Eastern Bypass

3.4.4. The walkover survey identified the presence of three high-quality trees within the study area associated with the Eastern Bypass. Also recorded were 40 moderate-quality trees, two moderate-quality tree groups and one moderate-quality wooded area.

3.4.5. High-quality trees comprise three English oak two of which are located on field margins to the south of Hall Lane with the third positioned on the northern edge of a small wooded area some 200 metres north-east of St Mary's Church. Moderate-quality arboricultural features are present across the study area associated with the Eastern Bypass although the majority are located to the south of Hill Farm Road. Moderate-quality features include a range of tree species such as English oak, field maple, sycamore, horse chestnut (*Aesculus hippocastanum*), hornbeam (*Carpinus betulus*), ash and walnut (*Juglans regia*).

3.4.6. There are three moderate-quality trees within 15 metres of the proposed highway alignment. All three trees are positioned within the boundaries of existing residential properties and in proximity to areas where the Eastern Bypass crosses or joins with Parker's Lane. In instances where trees are in third-party ownership then there exists a Common Law precedent that development work avoids unacceptable damage. In these instances, design work should either seek to avoid the risk of damage to trees or an agreement should be reached with the tree owner which potentially facilitates tree removal or compensation.

3.4.7. A further two moderate-quality trees are located within 50 metres of the proposed highway alignment. Both are located adjacent to Parker's Lane and, whilst one tree appears to be within the garden of a residential property the other exists on the edge of a field.

3.4.8. Potential adverse impacts associated with construction of the Eastern Bypass therefore include the loss of three moderate-quality trees and the possibility for two moderate-quality trees to either become damaged or require removal.

[29] Trees are referenced as T2741, T3203, T3204, T3207, T3208, T3211, T3212, T3224, T3227, T3229, T3230, T3231, T3232, T3244, T3330, T3332, T3333, T3339, T3341, T3353 - T3357, T3361, T3363, T3368, T3376, T3383, T3384, T3392, G3210, G3226 and G3228 within the survey schedule.

KEY FINDINGS OF THE APPRAISAL

3.4.9. Implementation of the Proposed Scheme has the potential to require the removal of six moderate-quality trees (three from the Western Relief Road and three from the Eastern Bypass). A further four moderate-quality trees are sufficiently close to the highway alignment (two from the Western Relief Road and two from the Eastern Bypass) for them to be considered as at risk of damage or needing to be felled.

3.4.10. Three of the trees identified as within 15 metres of the Eastern Bypass and one tree within 50 metres are within the boundary of existing residential properties. In these instances, the Proposed Scheme should either be designed so as to avoid the risk of substantive tree damage or an agreement should be reached with the tree owners which permits damaging activities to proceed.

3.4.11. Construction of the Proposed Scheme will not require the removal of any high-quality tree nor is it likely to adversely impact the majority of the moderate-quality arboricultural features located within the study area.

PROPOSED NEXT STEPS

3.4.12. Guidance on the integration of trees into the design and construction process is provided within BS 5837 with recommendations on the steps to be followed presented in **Figure 3.1** in **Appendix A**. It is therefore proposed that the following scope of works be completed to ensure both compliance with BS 5837 and as means of ensuring that arboricultural constraints are suitably considered.

- Complete a BS 5837 compliant tree survey of all trees, tree groups, wooded areas and hedgerows which may be influenced by the Proposed Scheme.
- Utilise survey data to produce an updated Tree Constraints Plan (TCP). The TCP will enable likely arboricultural impacts to be identified and will assist in informing design. An update to the TCP provided within the ES is required on the basis that trees may have subsequently grown, have died or suffered attack by pests or disease. This may affect tree quality and constraints.
- Identify likely arboricultural impacts and seek opportunities to minimise the damage or removal of moderate quality trees. Persistent arboricultural impacts (such as the loss of any arboricultural feature regardless of quality) should be used to inform other design elements such as new planting and landscape proposals.
- Provide a technical specification for arboricultural mitigation during construction. This should take the form of an Arboricultural Method Statement and Tree Protection Plan and should set out the measures necessary to protect all arboricultural features during construction. These documents will support any impact assessment and future design work insofar as they will demonstrate how those trees who may be adversely impacted during construction can be sustainably retained.

4 BIODIVERSITY

4.1 INTRODUCTION

4.1.1. This chapter presents the appraisal of the Proposed Scheme on Biodiversity.

4.2 APPRAISAL METHODOLOGY

STUDY AREA

4.2.1. The study area is defined in accordance with guidance set out in the Design Manual for Roads and Bridges (DMRB) document LA 108 – Biodiversity[30] and LA 115 – Habitat Regulations Assessment[31]. LA 108 states that a zone of influence (the likely area of land which may be affected by either direct or indirect impact) varies for each biodiversity resource and should be set accordingly.

4.2.2. The following study areas have been used to collect baseline desk study data to inform this appraisal. They collectively form the biodiversity study area:

- Statutory designated sites:
  - Special Areas of Conservation (SAC) designated for bats – Up to 30km from the Proposed Scheme;
  - All other Natura 2000 sites (Special Protection Area (SPA), potential SPA (pSPA), SAC, candidate SAC (cSAC) and Ramsar sites) – Up to 2km or any distance where there are hydrological linkages between the Proposed Scheme and a Natura 2000 site; and
  - Site of Special Scientific Interest (SSSI), County Wildlife Site (CWS), National Nature Reserve (NNR), Local Nature Reserve (LNR) – Up to 1km from the Proposed Scheme.
- Habitats:
  - Habitats within and adjacent to the Proposed Scheme boundary;
  - Habitats listed on Natural England's Priority Habitat Inventory (PHI), Ancient Woodland Inventory (AWI) – Up to 1km from the Proposed Scheme; and
  - Waterbodies within 250 metres of the Proposed Scheme boundary.

DATA SOURCES

4.2.3. The data sources used in this appraisal comprise:

- Chapter 7 – Biodiversity of the 2017 ES written by Wild Frontier Ecology Ltd. This report outlines the following survey methods that were used to gather baseline data across 2015 and 2016:
  - "*Desk Study: a review of online information, regarding statutory designated nature conservation sites, and a data search with the Norfolk Biodiversity Information Service (NBIS)*

[30] DMRB (March 2020) LA 108 Biodiversity [on-line] https://www.standardsforhighways.co.uk/dmrb/search/af0517ba-14d2-4a52-aa6d-1b21ba05b465
[31] DMRB (March 2020) LA 115 Habitats Regulations assessment [on-line] https://www.standardsforhighways.co.uk/dmrb/search/e2fdab58-d293-4af7-b737-b55e08e045ae

to obtain biological records and information on non-statutory designated nature conservation sites;

- *An Extended Phase 1 Habitat Survey of the site completed between April and September 2015. This included an appraisal of the habitats' suitability for protected species and a search for signs of badger and water vole;*
- *Great crested newt (GCN) pond appraisals and surveys of all known and accessible ponds on the site and within 250 metres of it, completed between April and June 2015;*
- *Breeding bird surveys covering the whole site, completed between November 2015 and March 2016;*
- *Bat activity surveys comprising walked transect surveys and multiple deployments of static bat detectors (which record through the night) across the site, completed between May and September 2015; and*
- *Bat roost surveys involving tree roost appraisals and targeted surveys of trees with notable bat roost potential, completed between July and September 2015".*

APPRAISAL APPROACH

4.2.4. The biodiversity appraisal was conducted in accordance with guidance in Chapter 9 – Impacts on Biodiversity of the Department for Transports TAG UNIT A3 Environmental Impact Appraisal document[32].

4.2.5. The biodiversity appraisal did not require any quantitative modelling. The baseline year for this appraisal is 2017 (when the ES was produced). The appraisal included qualitative consideration of any future baseline that includes other likely planned development (including road developments) within the study area as detailed on the relevant planning documents provided by Norfolk County Council. A list of planning proposals[33] have been reviewed, currently none of these require to be considered apart from the Proposed Scheme itself (residential development and both road schemes – Eastern Bypass and Western Relief Road).

4.3 KEY CONSTRAINTS

4.3.1. The following biodiversity constraints apply to the Proposed Scheme, and are shown on **Figure 1.3** in **Appendix A** where possible:

- Habitats of Principal Importance (HPI): grassland, hedgerows and ponds;
- Bats;
- Badger *Meles meles*;
- Breeding and wintering birds;
- Great crested newt (GCN) *Triturus cristatus*;
- Reptiles;
- Water vole *Arvicola amphibius*; and

[32] Department for Transport (May 2019). TAG UNIT A3 Environmental Impact Appraisal [on-line] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/825064/tag-unit-a3-environmental-impact-appraisal.pdf

[33] https://www.longstrattoncouncil.info/planning-applications

- Terrestrial invertebrates.

Habitats of Principal Importance

4.3.2. Swan Lane Meadow contains HPI habitats such as; an area of semi-improved neutral grassland with swathes of marshy grassland. The meadow includes several species-rich hedgerows surrounding arable land, defining boundaries around farms and other fields.

4.3.3. There are several ponds and ditches present within and bordering the meadow.

Bats

4.3.4. Habitats present on the Site including woodlands, hedgerows, mature trees, waterbodies and scrub provide suitable habitat for foraging, commuting and roosting bats. Bat activity surveys recorded six species of bat on Site: common pipistrelle *Pipistrellus pipistrellus*, soprano pipistrelle *Pipistrellus pygmaeus*, noctule *Nyctalus noctula*, barbastelle *Barbastella barbastellus*, brown long-eared *Plecotus auratus* and one *Myotis* sp. Common pipistrelle were recorded roosting in trees on Site.

Badger

4.3.5. One active badger sett was identified on the site boundary south of Hall Farm.

Birds

4.3.6. Habitats present on Site are suitable for supporting breeding and wintering birds.

4.3.7. Breeding bird surveys recorded seven species with red-listed conservation status (indicating high conservation priority) and four species with amber-listed conservation status (indicating medium conservation priority).

4.3.8. Wintering bird surveys recorded 42 species using the site. Nine of these red-listed, eight are amber-listed and 25 green-listed. The low to moderate numbers of birds recorded on the site over winter do not indicate that the site is important to large numbers of foraging or roosting wintering birds.

Great Crested Newt

4.3.9. GCN presence was recorded in eight ponds, located either within, bordering or within 250m of the Proposed Development. Two of these ponds recorded "medium" GCN populations and the other six recorded "low" GCN populations. Breeding populations were recorded in seven (out of eight) ponds with presence.

Reptiles

4.3.10. The Site includes habitat suitable for supporting common and widespread reptile species. A desk-based assessment identified one off-site record for slow worm *Anguis fragilis* within 2km of the Proposed Scheme. No field survey for reptiles has been undertaken.

Water vole

4.3.11. Survey found signs of water vole (latrines) in two ditches in the far south of the Site, north of Crowgreen Farm.

Terrestrial invertebrates

4.3.12. The diverse range of habitats present on Site including woodland, scrub and grassland are likely to support a range of common and widespread species of terrestrial invertebrates.

4.4 APPRAISAL

4.4.1. The Biodiversity TAG worksheet is provided in **Appendix C**.

KEY FINDINGS OF THE APPRAISAL PROCESS

4.4.2. The Proposed Scheme will result in direct and indirect impacts to HPI through habitat loss and fragmentation during the construction phase and increased air pollution during the operational phase of the Proposed Scheme. The magnitude of impacts to HPI is considered to be minor negative based on the current design for the Proposed Scheme, resulting in a **slight adverse** assessment score.

4.4.3. Direct and indirect impacts to protected and notable species have also been identified in the appraisal. Based on the baseline survey work to date species likely to be impacted include bats, badger, water vole, birds and GCN. There is the potential for the Proposed Scheme to impact reptiles and terrestrial invertebrates based on the habitats present on the Site, however further baseline survey work is required to better assess these features. The magnitude of impacts to the species listed is considered to result in a **slight adverse** assessment score based on the current design of the Proposed Scheme and available baseline data.

4.4.4. The overall assessment score for the appraisal is '**slight adverse'** for biodiversity. However, with the implementation of further mitigation measures there is the potential for the assessment score to be improved.

PROPOSED NEXT STEPS

4.4.5. The following scope of works is proposed to be completed:

4.4.6. The baseline survey work completed to inform the ES was undertaken in 2015. According to current guidance from the Chartered Institute for Ecology and Environmental Management[34], a complete programme of updated baseline biodiversity surveys would be required to inform an updated ES as part of a forthcoming update or amendment to the planning application(s).

4.4.7. Proposals for species and habitat mitigation in relation to the Proposed Scheme will need to be prepared and then factored into the appraisal when available. Additionally, consideration should be given to Biodiversity Net Gain (BNG) should planning be sought through the Town and Country Planning Act 1990. The Environment Bill for England, once it receives royal assent, will make provision for planning permissions in England to be subject to a condition requiring the biodiversity gain objective to be met, which secures a BNG of 10% above the baseline.

[34] CIEEM Advice Note on the Lifespan of Ecological Reports & Surveys. Available at https://cieem.net/wp-content/uploads/2019/04/Advice-Note.pdf

5 CLIMATE RESILIENCE

5.1 INTRODUCTION

5.1.1. This chapter presents an appraisal of the key climate change constraints on the Proposed Scheme.

5.2 APPRAISAL METHODOLOGY

STUDY AREA

5.2.1. The study area for climate resilience is the Proposed Scheme, as defined by the Site boundary.

DATA SOURCES

5.2.2. The data sources used in this appraisal comprise the Met Office UK Climate Projections 2018 (UKCP18).

APPRAISAL APPROACH

5.2.3. The climate resilience appraisal is a qualitative assessment, based on the findings of the 2017 ES and using updated guidance from IEMA[35] and the DMRB[36]. The 2017 ES provided an assessment of the main impacts of climate change on the building aspects, however, the vulnerability of the infrastructure aspects is covered in limited detail. Furthermore, given the updated UKCP18 climate projections available, and the latest guidance from IEMA (2020) and the DMRB (2019) which postdate the 2017 ES assessment, a high level appraisal of the potential impacts of climate change on all Proposed Scheme receptors has been undertaken.

5.2.4. In line with the IEMA guidance, the sensitivity of receptors is the degree of response of a receiver (project asset, e.g., carriageway) to a change (climate change) and a function of its capacity to accommodate and recover from a change if it is affected (its ability to be resilient).

5.2.5. Sensitivity is determined in relation to:

- The susceptibility of the receptor (e.g. ability to be affected by a change) (the opposite of resilience); and
- The vulnerability of the receptor (e.g. potential exposure to a change).

5.2.6. The **susceptibility** of the receptor can be determined using the following scale:

- High susceptibility = receptor has no ability to withstand/not be substantially altered by the projected changes to the existing/prevailing climatic factors (e.g. lose much of its original function and form);
- Moderate susceptibility = receptor has some limited ability to withstand/not be altered by the projected changes to the existing/prevailing climatic conditions (e.g. retain elements of its original function and form); and

[35] IEMA (2020) EIA Guide to Climate Change Resilience and Adaptation
[36] Highways England (2019) LA 114 Climate

- Low susceptibility = receptor has the ability to withstand/not be altered much by the projected changes to the existing/prevailing climatic factors (e.g. retain much of its original function and form).

5.2.7. The **vulnerability** of a receptor can be defined using the following scale:

- High vulnerability = receptor is directly dependent on existing/prevailing climatic factors and reliant on these specific existing climate conditions continuing in future (e.g. river flows and groundwater level) or only able to tolerate a very limited variation in climate conditions;
- Moderate vulnerability = receptor is dependent on some climatic factors but able to tolerate a range of conditions (e.g. a species which has a wide geographic range across the entire UK but is not found in southern Spain); and
- Low vulnerability = climatic factors have little influence on the receptors (consider whether it is justifiable to assess such receptors further within the context of EIA, i.e., it is likely that such issues should have been excluded through the EIA scoping process).

5.2.8. Susceptibility and vulnerability can be combined to determine the overall sensitivity of receptors as presented in **Table 5-1**. Receptors with a sensitivity of medium or high should be subject to further assessment.

Table 5-1 – Determination of sensitivity of receptors

Susceptibility	Vulnerability - Low	Vulnerability - Moderate	Vulnerability - High
Low	Low sensitivity	Low sensitivity	Low sensitivity
Moderate	Low sensitivity	Medium sensitivity	Medium sensitivity
High	Low sensitivity	Medium sensitivity	High sensitivity

5.3 KEY CONSTRAINTS

5.3.1. Climate change will affect the Proposed Scheme during its construction and operation through changes in temperature, precipitation and wind, including extreme weather events. The 2017 ES identified projected changes in temperature variation and sea level rise from Met Office UK Climate Projections 2009. The projections have since been updated in 2018 (UKCP18[37]). A summary of the key projected climate features which have the potential to impact the Proposed Scheme is summarised below.

[37] Met Office (2019) UK Climate Projections User Interface. Available at: http://ukclimateprojections-ui.metoffice.gov.uk

5.3.2. Projections have been presented on a 25km^2 scale for Representative Concentration Pathway (RCP)) 8.5 (RCP8.5)[38],[39] (equivalent to the worst-case emissions' scenario), compared to a baseline of 1981-2010.

Temperature Variation

5.3.3. In general, UKCP18 predicts that climate change will lead to an increase in temperatures during both summer and winter. The 50th percentile (the central estimate) projections for mean average summer and winter temperature change are presented in **Table 5-2**.

Table 5-2 – Projected mean average summer and winter temperature change 2020-2080

	Summer	Winter
2020s (construction)	+0.9^{o}C	+0.6^{o}C
2050 (operation)	+2.9^{o}C	+1.7^{o}C
2080 (operation)	+4.4^{o}C	+3.1^{o}C

Precipitation Variation

5.3.4. In general, climate change is projected to lead to wetter winters and drier summers although natural variation, including extreme events such as storms and heatwaves, will continue to punctuate these trends. The 50th percentile (central estimate) projections for mean average summer and winter precipitation change are presented in **Table 5-3**.

Table 5-3 – Projected mean average summer and winter precipitation change 2020-2080

	Summer	Winter
2020s (construction)	-7%	+2%
2050 (operation)	-22%	+7%
2080 (operation)	-33%	+16%

[38]RCP8.5 is a high emissions scenario which combines assumptions about high population and relatively slow income growth with modest rates of technological change and energy intensity improvements, leading in the long term to high energy demand and GHG emissions in absence of climate change policies. The requirement to consider a high emissions scenario has derived from the National Policy Statement for National Networks paragraph 4.41 which identifies that a high emissions scenario should be applied to transport infrastructure which has safety-critical elements and an asset life of 60 years or over.

[39]Department for Transport (2014) National Policy Statement for National Networks (it is noted that although the NN NPS may not be the applicable policy statement this is considered to represent good practice)

Sea Level Rise

5.3.5. UKCP18 estimates sea level rise of between 10cm to 74cm between 2020 to 2095 on the Norfolk coast.

Extreme Weather Events

5.3.6. In addition to changes in average climate variables, climate change is projected to result in an increase in frequency and intensity of extreme weather events such as droughts, heatwaves, flash floods and storms.

5.4 APPRAISAL

RESULTS

5.4.1. The sensitivity of key Proposed Scheme receptors have been assessed in relation to their susceptibility and vulnerability to withstand changes in climate as detailed in **Table 5-4**. The key receptors appraised apply to both the Eastern Bypass and Western Relief Road (and associated development) assessment undertaken within the 2017 ES.

Table 5-4 – Appraisal of sensitivity of the key Proposed Scheme receptors

Receptor	**Potential impact**	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	**Sensitivity**	**Further assessment required?**
Construction Construction compound including materials and plant/equipment	Flooding/waterlogging of Site and excavations	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate The construction site would be vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.
Construction Construction compound including materials and plant/equipment	Overwhelming of site drainage by volume of surface water	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate The construction site would be vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.
Construction Construction compound including materials and plant/equipment	Excessive moisture in materials and stockpiles	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate The construction site would be vulnerable to extreme weather events however given the short	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.

Receptor	Potential impact	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	Sensitivity	Further assessment required?
			construction period, changes in climatic variables will be minimal.		
Construction Construction compound including materials and plant/equipment	Increased runoff from material piles	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate The construction site would be vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.
Construction Construction compound including materials and plant/equipment	Drying out of materials	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate The construction site would be vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.
Construction Construction compound including materials and plant/equipment	Deformation and melting of materials	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce	Moderate The construction site would be vulnerable to extreme weather	Low	No However, details of the measures to be included in the CEMP should be

Receptor	Potential impact	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	Sensitivity	Further assessment required?
		are protected and made safe from extreme weather events.	events however given the short construction period, changes in climatic variables will be minimal.		identified and confirmed.
Construction Construction compound including materials and plant/equipment	Overheating of plant and equipment	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate The construction site would be vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.
Construction Workforce	Health and safety risks from extreme temperatures	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate Construction workers would be vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.
Construction Workforce	Increase in dust	Low Assuming that measures are integrated into a Construction Environmental Management Plan	Moderate Construction workers would be	Low	No However, details of the measures to be

Receptor	Potential impact	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	Sensitivity	**Further assessment required?**
		(CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.		included in the CEMP should be identified and confirmed.
Construction Workforce	Health and safety risk of cranes and working at height in storm events	Low Assuming that measures are integrated into a Construction Environmental Management Plan (CEMP) to ensure the construction site, materials, plant and equipment and workforce are protected and made safe from extreme weather events.	Moderate Construction workers would be vulnerable to extreme weather events however given the short construction period, changes in climatic variables will be minimal.	Low	No However, details of the measures to be included in the CEMP should be identified and confirmed.
Operation Carriageway and roundabouts	Deformation and melting of paved surfaces	High There is no indication within the 2017 ES climate assessment that the choice of surface materials have been selected cognisant to projected increases in temperatures.	High	High	Yes
Operation Carriageway and roundabouts	Flooding of the carriageway	Low The 2017 ES Chapter 13 Hydrology and Flood Risk has identified that surface water infiltration and storage, catchment area, pipe systems and drainage catchment has been	High	Low	No

Receptor	Potential impact	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	**Sensitivity**	**Further assessment required?**
		designed for up to the 1 in 100-year (+40% climate change allowance).			
Operation Carriageway and roundabouts	Drainage infrastructure overwhelmed leading to surface water flooding	Low The 2017 ES Chapter 13 Hydrology and Flood Risk has identified that surface water infiltration and storage, catchment area, pipe systems and drainage catchment has been designed for up to the 1 in 100-year (+40% climate change allowance).	High	Low	No
Operation Structures – footbridges and overbridges	Increase in thermal expansion of bridge joints	High There is no indication within the 2017 ES climate assessment that structures have been designed cognisant to projected increases in temperatures.	High	High	Yes
Operation Structures – footbridges and overbridges	Drying out, cracking and subsidence of foundations	High There is no indication within the 2017 ES climate assessment that materials have been designed and selected cognisant to projected increases in temperatures and the risk of prolonged dry periods.	High	High	Yes
Operation Structures – footbridges and overbridges	Increase in wind loading on bridges	High There is no indication within the 2017 ES climate assessment that structures have been designed and selected cognisant to projected increases in wind and storm events.	High	High	Yes
Operation Soft verges	Loss of vegetation due to high temperatures or waterlogging	High	Moderate	Medium	Yes

Receptor	Potential impact	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	**Sensitivity**	**Further assessment required?**
		It is not clear from the 2017 ES if the climate change allowance in the flood risk assessment applies to vegetation and soils.			
Operation Soft verges	Destabilisation of soils	High It is not clear from the 2017 ES if the climate change allowance in the flood risk assessment applies to vegetation and soils.	Moderate	Medium	Yes
Operation Buildings	Risk of flooding to ground level areas	Low The 2017 ES Chapter 13 Hydrology and Flood Risk has identified that surface water infiltration and storage, catchment area, pipe systems and drainage catchment has been designed for up to the 1-in 100-year (+40% climate change allowance).	High	Low	No
Operation Buildings	Overheating in buildings	Low The 2017 ES identified a number of measures to mitigate the risk of overheating and the reliance on air conditioning systems through energy efficient design.	High	Low	No However, confirmation of where the Proposed Scheme design commits to the mitigation measures identified is advised.
Operation Buildings	Increased energy requirements for cooling	Low The 2017 ES identified a number of measures to mitigate the risk of overheating and the reliance on air conditioning systems through energy efficient design.	High	Low	No However, confirmation of where the Proposed Scheme design commits to the

Receptor	Potential impact	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	**Sensitivity**	**Further assessment required?**
					mitigation measures identified is advised.
Operation Buildings	Subsidence due to extreme precipitation events and drying out of ground from extreme temperature	High No indication within the 2017 ES climate assessment that materials have been designed and selected cognisant to projected increases in temperatures and the risk of prolonged dry periods.	High	High	Yes
Operation Buildings	Water shortages during drought conditions	Low The 2017 ES identified water efficiency measures within the design to meet the requirements of Building Regulation Part G.	Moderate	Low	No
Operation Public open space	Flooding of areas of open space	Low The 2017 ES Chapter 13 Hydrology and Flood Risk has identified that surface water infiltration and storage, catchment area, pipe systems and drainage catchment has been designed for up to the 1 in 100-year (+40% climate change allowance).	High	Low	No
Operation Public open space	Vegetation and planting failure due to waterlogging or scorching	High It is not clear from the 2017 ES if the climate change allowance in the flood risk assessment applies to vegetation and soils.	Moderate	Medium	Yes
Operation Public open space	Increased maintenance of vegetation required	High It is not clear from the 2017 ES if the climate change allowance in the flood risk assessment applies to vegetation and soils.	Moderate	Medium	Yes

Receptor	Potential impact	**Susceptibility** to withstand change, including any mitigation measures	**Vulnerability** to changing climate conditions	**Sensitivity**	**Further assessment required?**
Operation Workforce	Risks to health from overheating	Low The 2017 ES identifies that the Proposed Development will be designed in line with the CIBSE TM 59 'Design Methodology for the Assessment of Overheating Risk in Homes' and CIBSE TM52: 'The Limits of Thermal Comfort: Avoiding Overheating in European Buildings'.	High	Low	No However, confirmation of where the Proposed Scheme design commits to the mitigation measures identified is advised.

KEY FINDINGS OF THE APPRAISAL

5.4.2. The appraisal has determined that the following receptors have been assessed and appropriate mitigation identified. Therefore, with the integration of the proposed mitigation measures, they would not be sensitive to climate change nor would require further assessment. This includes:

- Potential impacts on the construction workforce and compound and including materials and plant/equipment;
- Potential impact associated with the flooding of the carriageway and drainage infrastructure;
- Risk of flooding to buildings;
- Risk to health of overheating in buildings and an increased energy requirement;
- Potential for water shortages in buildings; and
- Potential flooding of areas of open space.

5.4.3. The appraisal has highlighted that there are a number of Proposed Scheme receptors during the operation phase which have the potential to be sensitive to changes in climate and therefore require further assessment. These include the potential for:

- Deformation and melting of the carriageway and roundabouts;
- Increase in thermal expansion of bridge joints of structures;
- Drying out, cracking and subsidence of structures' foundations;
- Increase in wind loading on bridges;
- Loss of vegetation of soft verges due to high temperatures or waterlogging;
- Destabilisation of soils on soft verges;
- Subsidence of buildings due to extreme precipitation events and drying out of ground from extreme temperature;
- Vegetation and planting failure on areas of open space due to waterlogging or scorching; and
- Increased maintenance of vegetation required on areas of open space.

PROPOSED NEXT STEPS

5.4.4. The following scope of works is proposed to be completed:

- Further assessment undertaken on the receptors identified above which have the potential to be sensitive to changes in climate;
- Detail of the measures to be included in the CEMP should be identified and confirmed in order to ensure the resilience of the construction site and workforce to climate change; and
- Confirmation of where the Proposed Scheme design commits to the mitigation measures identified in the 2017 ES in relation to energy efficiency and reducing the risk of overheating.

6 GREENHOUSE GASES

6.1 INTRODUCTION

6.1.1. This chapter considers the potential changes in greenhouse gases (GHG) emissions caused by the Proposed Scheme with respect to the TAG appraisal method[40] for GHG.

6.1.2. The Proposed Scheme would change the physical layout of the road network, thus resulting in changes to vehicle flow, composition and speed. As such, it has the potential to cause changes in vehicular emissions of GHGs, which are assessed in this appraisal.

6.1.3. As defined by the Intergovernmental Panel on Climate Change,[41] GHG emissions are expressed as tonnes of carbon dioxide equivalent (tCO_2e) for the purposes of this appraisal.

6.2 APPRAISAL METHODOLOGY

STUDY AREA

6.2.1. The study area for the GHG assessment comprises the traffic model of the Affected Road Network.

6.2.2. The TAG assessment does not include consideration of the associated development of the Eastern Bypass and Western Relief construction GHG emissions.

DATA SOURCES

6.2.3. The data sources used in this appraisal comprised traffic data for the affected road network, obtained in accordance with DMRB Volume 11, Section 3, Part 14 Climate; LA 1149.

APPRAISAL APPROACH

6.2.4. TAG Unit A3 presents the methodology for assessing and valuing GHG emissions (as tCO_2e) associated with the operation of the Eastern Bypass and Western Relief Road for a defined appraisal period. The TAG guidance does not require the quantification of emissions from the associated development of the Proposed Scheme, therefore, GHG emissions from the associated development have not been not been quantified for this appraisal.

6.2.5. GHG emissions were quantified using TAG data from the Department of Transport. This considered the proportions of the vehicle types, fuel type, forecast fuel consumption parameters and emission factors. From this, emissions were quantified for each year over the lifetime of the Eastern Bypass and Western Relief Road (accounting for a 60-year appraisal period (2024 – 2083)).

6.2.6. The TAG output provided the net present value of the estimated change in tCO_2e emissions from road-based fuel consumption that is in the non-traded sector only.

[40] https://www.gov.uk/guidance/transport-analysis-guidance-tag
[41] https://www.ipcc.ch/reports/

6.2.7. The net present value was calculated based on the central cost estimates (£/tCO2) for traded CO2e emissions.

6.3 KEY CONSTRAINTS

LEGISLATIVE BACKGROUND

6.3.1. The UK is legally bound by the Climate Change Act 2008 (2050 target amendment) Order 2019[42] to achieve a target to reduce GHG emissions to 100% by 2050.

6.3.2. The Act introduced 'carbon budgets',[43] which set maximum GHG emission limits not to be exceeded during the respective period, to achieve a specified reduction in GHG emissions versus base year levels. So far, five carbon budgets have been transposed into law that run to 2032.

6.3.3. The budgets are set as follows:

- 2008 – 2012; 3,018,000,000 tonnes CO_2e ($MtCO_2e$); 23% reduction below base year levels;
- 2013 – 2017; 2,782,000,000 tCO_2e; 29% reduction below base year;
- 2018 – 2022; 2,544,000,000 tCO_2e; 35% reduction below base year by 2020;
- 2023 – 2027; 1,950,000,000 tCO_2e; 50% reduction below base year by 2025; and
- 2028 – 2032; 1,765,000,000 tCO_2e; 57% reduction below base year by 2030.

6.3.4. The opening year of the Proposed Scheme is 2026, which falls within the fourth carbon budget. The design year for the Proposed Scheme is 2041, for which a carbon budget is yet to be established.

6.3.5. The GHGs within the Climate Change Act 2008, which are applicable to road traffic are;

- Carbon dioxide (CO_2); and
- Nitrous oxide (N_2O).

BASELINE GREENHOUSE GASES

6.3.6. Total and road transport sector-specific emissions of CO_2e from South Norfolk are provided in **Table 6-1** along with the overall total for England for comparison and to provide regional context with respect to the Proposed Scheme.

Table 6-1 - Summary of transport emissions in England and South Norfolk

CO_2 Emission	Road Transport Emissions 2018 (tCO_2e)	Total Emissions 2018 (tCO_2e)	Road Transport Emissions as % of Total
South Norfolk	446,203	836,500	53.34%
England	126,801,117	344,824,273	36.77%

42 Her Majesty's Stationary Office (HMSO) (2008) Climate Change Act 2008

43 The Committee on Climate Change Carbon Budgets and Targets [online] https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/carbon-budgets-and-targets/ as accessed on 23/10/18

6.3.7. In total for England, GHG emissions from the transport sector account for 36.77% of total emissions, with road transport emissions within South Norfolk representing 53.34% of total regional emissions generated for the area (**Table 6-1**).

6.4 APPRAISAL

6.4.1. The Proposed Scheme will affect the GHG emissions during its construction and operation phase, but the TAG assessment focusses on the operational phase (traffic emissions).

6.4.2. **Table 6-2** presents the total operational road traffic emissions for the baseline and Proposed Scheme.

Table 6-2 - Baseline and Operational Emissions for Total (traded and non-traded) Traffic

Scenario	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO2e) 2024 (operational year)	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO2e) 2039 (future year)	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO2e) Average per year (2024 – 2083)	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO2e) Total (2024 – 2083)
Baseline Traffic Emissions ('Do Minimum') (tCO_2e)	32,392	26,054	26,899	1,613,932
Proposed Scheme ('Do Something') (tCO_2e)	29,075	24,467	25,081	1,504,885
Difference (tCO_2e)	-3,317	-1,587	-1,817	-109,046

KEY FINDINGS OF THE APPRAISAL PROCESS

6.4.3. The total baseline emissions are 1,613,932 tCO2e, which is higher than the total tCO2e emissions for the Proposed Scheme scenario; 1,504,885 tCO2e. This means that the Proposed Scheme leads to a net reduction in emissions of -109,046 tCO2e over the 60-year design life (**Table 6-2**).

6.4.4. The results of the greenhouse gas appraisal workbook are presented in **Appendix C** and are summarised as follows:

- Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be lower over the appraisal period relative to the Do Minimum case.
- The change in CO2e emissions (-109,046 tCO2e) equates to a NPV benefit of £4,684,090 for the assessed appraisal period.

PROPOSED NEXT STEPS

6.4.5. The following scope of works is proposed to be completed:

- Since the previous ES in 2017, there have been changes to the traffic flows in the affected road network of the Proposed Scheme, as well as changes to the GHG quantification methodology. As such, we recommend that an addendum is produced with updated traffic emission calculations for both the Do Minimum and Do Something scenarios.

7 GROUND CONDITIONS AND CONTAMINATED LAND

7.1 INTRODUCTION

7.1.1. This chapter presents an appraisal of the key ground conditions and contaminated land environmental constraints of the Proposed Scheme.

7.2 APPRAISAL METHODOLOGY

STUDY AREA

7.2.1. The study area includes the area within the Proposed Scheme boundary and areas up to 500m from the boundary that may influence the Proposed Scheme.

DATA SOURCES

7.2.2. The data sources used in this appraisal comprise:

- Long Stratton Bypass Desk Study Report, Norfolk Partnership Laboratory, dated August 2016. Ref. NOLA0004;
- Desk Study, Risk Assessment, Site Investigation and Quantitative Risk Assessment. Long Stratton Areas C, D, E and F, Norfolk Partnership Laboratory, dated April 2016. Ref: NOLA0005;
- Desk Study, Risk Assessment, Site Investigation and Quantitative Risk Assessment. Long Stratton Areas A and B, Norfolk Partnership Laboratory, dated April 2016. Ref: NOLA0006; and
- Long Stratton Environmental Statement, Chapter 17, Ground Conditions and Contamination, Cornerstone Planning Ltd, November 2017.

APPRAISAL APPROACH

7.2.3. WSP have undertaken a qualitative appraisal of the available data for the Proposed Scheme which also takes into account standards outlined in the Geology and Soils section (LA 109) of the Design Manual for Roads and Bridges (DMRB). The primary aim of the Appraisal is to identify any environmental constraints relating to ground conditions and contamination that may financially impact the Proposed Scheme.

7.3 KEY CONSTRAINTS

7.3.1. The following constraints relating to ground conditions and contaminated land have been appraised in the context of the Proposed Scheme:

- Geology;
- Hydrogeology;
- Hydrology;
- Soil Resources and Agriculture; and
- Contamination.

7.4 APPRAISAL

RESULTS

7.4.1. Geology

7.4.2. Based on British Geological Survey (BGS) mapping, the superficial geology underlying the majority of the Proposed Scheme is the Lowestoft Formation. Superficial Peat and Head deposits are noted to be located in the area of the Western Relief Road overlying the Lowestoft Formation. The bedrock geology underlying the Proposed Scheme is anticipated to be the Crag Group and Upper Chalk. The Proposed Scheme is not located within an area with any sites which are designated for geological reasons.

7.4.3. Ground investigations undertaken over the Proposed Scheme area identified the geology underlying the Proposed Scheme to comprise the following:

- Topsoil – encountered across the Site to a maximum depth of 0.50m below ground level (bgl);
- Made Ground – encountered in discreet locations to depths up to 1.40m bgl;
- Cover Silt – encountered to a maximum depth of 1.50m bgl;
- Lowestoft Formation – encountered across the majority of the Site as till to a maximum depth of 29.0m bgl;
- Glacial Sand and Gravel – encountered underlying the Lowestoft Formation with a maximum thickness of 7.60m;
- Crag Group – identified at thicknesses up to 10.00m; and
- Upper Chalk – Maximum proven thickness of 3.80m.

7.4.4. Hydrogeology

7.4.5. The superficial Peat deposits are classified by the Environment Agency as unproductive strata. The superficial Lowestoft Formation and Head deposits are classified as a Secondary Undifferentiated Aquifer. The Crag Group and Upper Chalk bedrock are classified as a Principal Aquifer. Previous investigations have identified groundwater within the Chalk to be present at between 10m and 15m below ground level.

7.4.6. Further details on hydrogeology are presented in **Chapter 13: Water Environment**.

7.4.7. Hydrology

7.4.8. The Proposed Scheme is located within the catchment of the River Tas. There are many tributaries within close proximity to the Proposed Scheme, the closest tributary is located approximately 25m west of the Eastern Bypass. In addition, multiple drainage channels and ponds are present within (and immediately adjacent to) the Proposed Scheme boundary.

7.4.9. The Proposed Scheme is located within a Nitrate Vulnerable Zone (NVZ) for surface water.

7.4.10. Soil Resources and Agriculture

7.4.11. The soil type of the majority of the Proposed Scheme is noted to be soil type 711r: Beccles 1, which are clayey and loamy soils which are characteristically encountered over chalky till.

7.4.12. Small areas associated with the north eastern part of the Eastern Bypass and the western part of the Western Relief Road have a soil type noted to be type 572n: Burlingham 1, which are loamy soils which are commonly encountered overlying chalky till or Head deposits.

7.4.13. A small area in the north west of the Western Relief Road has a soil type 411d: Hanslope, which are generally calcareous clayey soils.

7.4.14. A review of the 2017 Environmental Statement identified the total area of the Proposed Scheme area to be 154.9 hectares (ha) which includes Grade 2 (14.4 hectares), Grade 3a (69.2 hectares) and Grade 3b (64.6 hectares) land based on the Agricultural Land Classification grades. Grades 2 and 3a are defined as the best and most versatile land.

7.4.15. Contamination

7.4.16. A review of historical maps and available information identified a number of potential sources of contamination associated with the Proposed Scheme and surrounding area. These include:

- Made Ground deposits;
- Agricultural land and farming practices;
- Potentially infilled ponds;
- Petrol Filling Station located in Long Stratton to the east of the Proposed Scheme; and
- Sewage treatment works located outside of the Proposed Scheme area adjacent to the west.

7.4.17. Ground investigations have been undertaken in 2003 and 2018 over the Proposed Scheme area to investigate potential sources of contamination and their potential impact to identified receptors. The investigation comprised windowless sampling boreholes, machine excavated trial pits and hand augers. Following the ground investigation, a Generic Quantitative Risk Assessment[44] was undertaken. The pertinent points of the assessment are summarised below:

- The soil analytical results were compared to Category 4 Screening Levels (C4SLs), Soil Guideline Values (SGVs) and Suitable for Use Levels (S4ULs) assuming a 'residential with home grown produce' land use. All soils submitted for analysis were found to be below the assessment criteria. The risk to human health was noted to be Low.
- Groundwater samples were not collected or tested as part of the investigation, however the assessment noted that due to the depth of groundwater, the risk was considered to be Very Low;
- Significant concentrations of ground gases were not identified during the sampling. The assessment concluded that the gas regime was negligible and required no gas protection measures.

[44] Provided in three reports:

Norfolk Partnership Laboratory. Desk Study Risk Assessment, Site Investigation & Quantitative Risk Assessment, Long Stratton, Norfolk, Development Land East, Areas C, D E and F. Ref: NOLA0005. Dated April 2016

Norfolk Partnership Laboratory. Desk Study Risk Assessment, Site Investigation & Quantitative Risk Assessment, Long Stratton, Development Land West, Areas A & B, Norfolk. Ref: NOLA0006. Dated April 2016.

Norfolk Partnership Laboratory. Site Investigation Factual Report, Long Stratton Bypass, Norwich, Norfolk. Ref: NOLA0008. Dated October 2018.

KEY FINDINGS OF THE APPRAISAL

7.4.18. Based on the results summarised above, the following key findings have been identified:

Geology

- No significant constraints relating to geology have been identified.
- The 2017 Environmental Statement identified the impact on geology to be neutral.

Hydrogeology

- Based on the hydrogeological conditions identified at the Site, it is not anticipated that significant quantities of groundwater will be encountered during the construction of the Proposed Scheme. However, should piles be required to be founded within the Chalk bedrock, a Piling Risk Assessment may be required to assess the risks from piling activities to the chemical quality of groundwater within the Principal Aquifer.
- A controlled waters risk assessment, including groundwater sampling and analysis has not been undertaken.

Hydrology

- No significant constraints relating to hydrology in the context of contamination have been identified, however consideration should be given to protecting surface water courses from contamination during construction of the Proposed Scheme.
- Constraints to hydrology in the context of drainage are presented in **Chapter 13: Water Environment**.

Soil Resources and Agriculture

- Given that the agricultural land in the vicinity of the Proposed Scheme is classified as Grades 2, 3a and 3b there will be a loss of this land during the construction and operation of the road. Based on the 2017 Environmental Statement, the Proposed Scheme will result in the loss of approximately 148 hectares of agricultural land which will have a permanent, adverse moderate/major effect.
- The 2017 Environmental Statement suggested that the handling and storage of soils are subject to a Construction Environmental Management Plan (CEMP) and/or Defra's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009). By following this best practice the long term effect on soil resources is minor adverse to negligible.

Contamination

- Based on the previous ground investigations and assessment, a limited risk to human health has been identified. It is noted that no assessment of controlled waters has been undertaken.
- The 2017 Environmental Statement the residual risks from contamination to be none/negligible.

PROPOSED NEXT STEPS

7.4.19. The following scope of works is proposed to be completed:

- Completion of an agricultural land desk-based assessment, and survey if required, to determine the agricultural land classification of the study area or footprint of the Proposed Scheme;
- Refinement of the design and construction planning where possible to reduce the likelihood of contaminating surface water courses during construction;
- Refinement of the design and construction planning where possible to reduce land take of the most sensitive agricultural land (Grade 2 and 3a);

- Consideration should be given to a piling risk assessment should piling into the Upper Chalk be proposed; and
- Further ground investigation is likely to be required to assess the risks to controlled waters.

8 HISTORIC ENVIRONMENT

8.1 INTRODUCTION

8.1.1. This section of the report provides a high-level appraisal of the likely Cultural Heritage impacts specific to the Proposed Scheme. Cultural Heritage (also commonly referred to as the historic environment) comprises above ground and buried heritage assets, including buildings, structures, monuments, and landscapes of heritage interest, including, where appropriate, the setting of sensitive (designated) heritage assets, along with archaeological remains and palaeoenvironmental deposits.

8.1.2. Statutory provision for the safeguarding of heritage assets has been made at a national and local level. For this reason, their presence or potential presence can constitute a constraint and may affect the initial appraisal of a scheme and in the subsequent design, planning and programming.

8.2 APPRAISAL METHODOLOGY

STUDY AREA

8.2.1. The study area comprised a 500m buffer around the Proposed Development Site boundary for the identification of non-designated heritage assets and 1km buffer for designated (protected) heritage assets, due to the longer views and hence the potential impacts upon the setting of these assets. The buffers are shown on **Figure 1.4** in **Appendix A**, alongside the heritage assets.

DATA SOURCES

8.2.2. The key data sources data sources in this appraisal comprise:

- National Heritage List for England (NHLE). Statutory designations, including scheduled monuments; statutorily listed buildings; registered parks and gardens; and registered battlefields;
- Norfolk Historic Environment Record (HER) Primary repository of archaeological information; including past investigations, local knowledge, find spots, and documentary and cartographic sources;
- South Norfolk Council: Long Stratton Conservation Area Character Appraisal (2013);
- Beacon Planning: Land at Long Stratton Heritage Statement (2017);
- British Geological Survey (BGS). Solid and drift geology and topography, which can provide an indication of potential for early human settlement;
- National Library of Scotland. Online historic Ordnance Survey mapping from the 1st edition (1860s/70s) onwards;
- Google Satellite imagery and Streetview (viewed October 2020). The imagery was scrutinised to assist with the appraisal of possible impacts to the setting of designated heritage assets.

APPRAISAL APPROACH

8.2.3. This high-level appraisal follows the guidance set out in:

- Department for Transport (DfT), 2019, TAG Unit A3 Environmental Impact Appraisal Chapter 8;
- Ministry of Housing, Communities and Local Government, 2019, National Planning Policy Framework (NPPF);
- Historic England, 2016, The setting of heritage assets. Historic Environment Good Practice Advice in Planning Note 3;

- Chartered Institute for Archaeologists (CIfA), 2014, Standards and Guidance for Historic Environment Desk-based Assessment.

8.2.4. The appraisal has identified the key likely impacts on cultural heritage and includes an accompanying TAG sheet produced in line with DfT TAG Unit A3 Environmental Impact Appraisal guidelines.

8.2.5. Several limitations to the high-level appraisal should be recognised. The report has not included a review of a full range of resources (e.g. documentary, cartographic, air photographic, and geotechnical, architectural and engineering sources) that would normally be consulted in a full desk-based assessment for required for a planning application. No site walkover has been carried out across the Site area itself. For this reason, it is possible that there are assets within the Site which have not been identified by this assessment (e.g. previously unrecorded buried archaeological remains). In the absence of intrusive archaeological field investigation, it is possible that there are buried assets within the Site that have not been identified by this appraisal.

8.2.6. Outline of appraisal approach:

- The assessment is qualitative;
- The guidance followed is Department for Transport (DfT) TAG Unit A3 Environmental Impact Appraisal; National Planning Policy Framework (NPPF) (MHCLG 2019, MHCLG 2018b); Historic England, 2016 *The setting of heritage assets. Historic Environment Good Practice Advice in Planning Note 3*;
- Impacts can either be direct or indirect, adverse or beneficial. The scale can be either large, moderate, slight or neutral as defined in the TAG guidance.

8.3 KEY CONSTRAINTS

BASELINE CONDITIONS

Designated heritage assets

8.3.1. There are no statutorily designated heritage assets such as scheduled monuments, registered parks or gardens or registered battlefields along the line of the Eastern Bypass and Western Relief Road Three listed buildings are currently shown on the digitised plan as located within the Proposed Development Site Boundary. These are: the Grade II listed Pair of Cottages occupied by Mr and Mrs Groves immediately south of Lower Cottages (NHLE ref: 1153668), the Grade II listed Cherry Tree Farmhouse (NHLE ref: 1153568) and the Grade II listed Walnut Tree Cottage and Low Cottage (NHLE ref: 1050313). There are also listed buildings located immediately adjacent to the Site boundary, for example the Grade II listed The Rectory (NHLE ref: 1050314).

8.3.2. Part of the eastern boundary of the Long Stratton Conservation Area is located immediately adjacent to the Proposed Development Site Boundary (and 20m west of the Eastern Bypass). Part of the eastern boundary of the conservation area is also currently shown on the digitised plan as being within the Proposed Development Site Boundary. The conservation area contains buildings that contribute significantly to its historic character (medium heritage significance in accordance with DMRB criteria).

8.3.3. Neither the local planning authority or Norfolk County Council has identified any Archaeological Priority Areas within the boundaries of the authority.

8.3.4. There are 86 listed buildings located within the 1km study area. Three of these are Grade I listed

buildings (high heritage significance in accordance with DMRB criteria), three are listed Grade II* (high significance) and 80 are listed Grade II (medium significance).

8.3.5. There are three Grade I listed buildings located within the study area. These are:

- The Church of St Mary (NHLE ref: 1304232) in the Long Stratton Conservation Area, is located 50m west of the Proposed Development Site Boundary (50m west of the Eastern Bypass associated development and 60m north of the Eastern Bypass);
- The Church of St Michael (NHLE ref: 1304267) in Stratton St Michael, is located 35m north-east of the Proposed Development Site Boundary (35m north-east of the Eastern Bypass associated development and 170m north-east of the Eastern Bypass);
- The Grade I listed Church of St Mary (NHLE ref: 1373411) in Tharston, is located 535m north-west of the Proposed Development Site Boundary (535m north-west of the Western Relief Road associated development and 795m north-west of the Western Relief Road).

8.3.6. There are three Grade II* listed buildings located within the study area. These are:

- The Old Rectory (NHLE ref: 1373264) in Stratton St Michael is located 40m north-east of the Proposed Development Site Boundary (40m to the north-east of Land East of A140 and 150m north-east of the Eastern Bypass);
- Premises owned by Mr Tunmore and G.J. Cracknell and Son (NHLE ref: 1050276) in the Long Stratton Conservation Area, is located 85m west of the Proposed Development Site Boundary (85m west of the Eastern Bypass associated development and 765m west of the Eastern Bypass);
- Tharston Hall (NHLE ref: 13734080) is located 370m north-west of the Proposed Development Site Boundary (370m north-west of the Eastern Bypass associated development and 570m north-west of the Western Relief Road);

8.3.7. The Long Stratton Conservation Area contains 32 of the 80 Grade II listed buildings located within the 1km study area. The closest is Belvedere Stores and 2 Adjoining Cottages (NHLE ref: 1050308). This asset is located 15m west of the Proposed Development Site Boundary.

8.3.8. There are 48 other Grade II listed buildings located within the 1km study area. These are located in Long Stratton (beyond the boundary of the Long Stratton Conservation Area), Stratton St Michael, and Tharston. Assets currently located within or adjacent to the Proposed Development Site Boundary are noted at paragraphs 8.3.1 and 8.3.2. There are also assets located within close proximity to the Proposed Scheme, such as Pair of Houses owned by Mr B R Weeden (NHLE ref: 1153535) in Stratton St Michael, located 30m north of the Proposed Development Site Boundary (30m north of the Eastern Bypass associated development and 55m north-east of the Eastern Bypass). The furthest from the Proposed Scheme is the group at Bretts Manor. This consists of the Grade II listed Quintons (NHLE ref: 1050824) and Bretts Manor (NHLE ref: 1180030) located 925m and 945m west respectively from the Proposed Development Site Boundary (925m and 945m west of the Eastern Bypass associated development and 960m and 985m west of the Eastern Bypass).

8.3.9. The Grade II listed buildings also include a number of individual houses and cottages located across the study area, as well as a large number of listed buildings which are part of farm complexes. These include Wood Green Farm, Mayfield Farm and Hollies Farm to the east of the Proposed Development Site Boundary.

8.3.10. The Long Stratton Conservation Area was designated in 1975 and reviewed in 2010. Apart from the designated heritage assets located within the conservation area, there are also a number of

buildings which are not listed but are considered to be of 'townscape significance.' There are 18 in total, with one asset, Wall to Churchyard on Ipswich Road (east side), relevant to the Grade I listed parish church. In addition, St Mary's churchyard is one of five prominent open spaces in the conservation area. It is one of two open spaces that is considered to make a positive contribution to the character and appearance of the conservation area (the other three are classified as having the potential to do so). At its closest point, the eastern boundary of the Long Stratton Conservation Area is shown either within the Proposed Development Site boundary or located immediately adjacent to (outside) the Proposed Scheme (and 20m west from the Eastern Bypass).

8.3.11. The presence of curtilage structures associated with some of the designated heritage assets within the study area is considered a possibility, but it would be considered as part of a more detailed future assessment. Curtilage is the original property boundary of the listed building and, whilst an associated structure within the curtilage may not be specifically mentioned in the statutory description, is may be covered by the listing protection.

Non-designated heritage assets

8.3.12. There have been six archaeological investigations within the Proposed Scheme boundary. A further 19 archaeological investigations have taken place within the 500m study area. These have provided a reasonable insight into the nature and extent of past human activity over the area of Proposed Scheme.

8.3.13. A fieldwalking survey and trial trench evaluation were carried out on a previous proposed alignment of the Eastern Bypass in 2003 and 2004. The fieldwalking survey (the systematic collection and plotting of artefacts from the surface of a ploughed field to identify areas of activity) recorded multi-period finds (HER refs: 20788, 60789, 60790) comprising prehistoric worked and burnt flints, medieval and post-medieval pottery sherds and post-medieval coins, brick, tile, glass fragments and a buckle. In the southernmost area of the Proposed Scheme boundary, the evaluation revealed a 2nd to 4th century AD Romano-British roadside settlement with deposits of 'dark earth', middens (rubbish dumps), smithing slags, two tracks with metalled flint surfaces, pits, gullies, and ditches (HER ref: 44502). In the northern area of the Proposed Scheme boundary, south of Church Lane (HER ref: 60792) the evaluation recorded a post-medieval ditch and a small number of early and later medieval pottery sherds and a post-medieval coin. In the northern part of the Proposed Scheme, north of Church Lane, later medieval features were recorded, centred around a hollow way (sunken road) dated to the 11th-14th centuries (HER ref: 44503). A series of shallow pits, shallow ditches flanking a depression and a pit cutting the centre of the depression were also recorded. The depression was thought to be another hollow way running east from the main track.

8.3.14. The majority of the area of the Proposed Scheme was subject to a geophysical survey in 2017. The results of this fieldwork are not recorded on the Norfolk HER. Subsurface archaeological features can be identified as geophysical anomalies, and a more detailed desk-based assessment would review the results of the survey. The limitations of this non-intrusive survey method should be recognised in that success is very much dependent on geology conditions. Some types of archaeology, for example finds concentrations, are typically missed by this survey method.

8.3.15. A fieldwalking survey and trial trench evaluation were carried out on a current alignment of the Eastern Bypass in 2020. The results of this fieldwork are not yet available but would be reviewed in a more detailed desk-based assessment.

8.3.16. Within the Proposed Scheme boundary the following non-designated heritage assets are recorded on the Norfolk HER. An initial indication of the likely significance of the assets has been included as part of this appraisal in **Table 8-1**.

Table 8-1 - Significance of identified assets

Description	HER ref(s).	Significance
The Pye Roman Road, the route of which aligns with the modern A140.	7947	Medium or high, depending on survival and any associated roadside activity.
Possible Roman cremations or kilns and other prehistoric and Roman remains	7937	Cremations and kilns would be of medium or high significance depending on the extent of the remains; the significance of other 'prehistoric and Roman remains' would depend on their nature and extent.
The site of a Roman settlement and a possible Roman road	44502	Medium or high, depending on nature and extent of remains.
Earthworks of medieval manor, possibly the site of Sayes manor	14583	Medium or high, depending on nature and extent of remains.
A medieval moat at Hall Farm	10070	Medium or high, depending on nature and extent of remains.
The possible site of medieval church	15801	Medium or high, depending on nature and extent of remains.
A medieval hollow way and medieval pits	44503	Medium.
Earthworks of a medieval hollow way and at least three medieval tofts	14118	Medium.
Areas of multi-period finds that have been recorded during field walking and metal detecting	12513, 16111, 18273, 25916, 35894, 40566, 60788, 60789, 60790	Low. Where there are concentrations, they can provide an indication of an area of higher potential warranting intrusive investigation.
Areas of finds of early medieval, later medieval to post-medieval pottery	10164, 14108, 14109, 14111, 14119, 18274	Low. Where there are concentrations, they can provide an indication of an area of higher potential warranting intrusive investigation.
A scatter of prehistoric burnt flints	61199	Low, but may indicate an area of higher potential for significant remains, warranting intrusive investigation.
Fragments of Roman pottery, slag and part of a lava quern	14105	Low, but may indicate an area of higher potential for significant remains, warranting intrusive investigation.
A post-medieval ditch, a small number of Late Saxon and medieval pottery sherds and a post-medieval coin	60792	The ditch is of low significance. The significance of the pottery finds is uncertain. Saxon pottery is friable, and its presence

Description	HER ref(s).	Significance
		may indicate previously unrecorded occupation.
The site of a Royal Observer Corps post, set up in 1959 and closed in 1968	35390	Low.
A possible medieval moat and multi-period finds: the earthworks of a possible medieval moat, now destroyed by ploughing. Roman coin, Roman pottery and tile, and medieval and post medieval pottery, coins and metal finds found by fieldwalking and metal detecting	36819	The finds are of Low significance. Further investigation would be required to determine whether the moat ditch has been entirely removed, along with any evidence of settlement within the enclosure. The significance of any remains that might survive would depend on their nature and extent.

Potential for possible, previously unrecorded archaeological remains

8.3.17. Based on an appraisal of the data on the HER, there is a high potential for previously unrecorded non-designated heritage assets from the prehistoric period onwards to be present within the Proposed Scheme boundary. Any previously unrecorded assets could be of low, medium or high significance, depending on their nature, date, extent and survival. Whilst the Proposed Scheme skirts the periphery of the historic settlement of Long Stratton, there is potential for outlying secondary settlement.

8.3.18. The Proposed Scheme is located on relatively flat ground, in fields to the south, east and north-west of the urban area of Long Stratton.

8.3.19. Due to the land being agricultural there is a high potential for buried archaeological remains from the prehistoric period onwards to survive within the area of the Proposed Scheme. Mechanised ploughing will have caused some disturbance to any archaeological remains represent to a depth of around 0.3–0.4m, although cut features such as pits and ditches are likely to survive intact.

8.4 APPRAISAL

8.4.1. The accompanying Cultural Heritage TAG sheet is provided in **Appendix C**.

KEY FINDINGS OF THE APPRAISAL PROCESS

Above ground heritage assets

Physical impacts (and setting)

8.4.2. Part of the eastern boundary of the Long Stratton Conservation Area is shown within the Proposed Development Site Boundary. Part of the eastern boundary is also located adjacent to (outside) the Proposed Scheme. The Proposed Development Site Boundary also currently includes three listed buildings, while other assets are located adjacent to or in close proximity to the Proposed Scheme. There is the potential for physical impacts to these assets. Physical impacts should be avoided. There is also the potential to impact on the significance of these designated heritage assets through changes to their setting.

8.4.3. The presence of curtilage structures associated with some of the designated heritage assets within the study area is considered a possibility, but it would be considered as part of a more detailed

future assessment. Curtilage is the original property boundary of the listed building and, whilst an associated structure within the curtilage may not be specifically mentioned in the statutory description, is may be covered by the listing protection.

Setting impacts

8.4.4. The Proposed Scheme has the potential to impact on the significance of designated heritage assets located beyond the Site boundary through changes to their setting. Setting is the way in which an asset is understood and experienced and is not an asset in itself. Changes to setting could include the loss of surrounding rural and agricultural land, new intrusive built development, impacts from traffic flow and noise, as well as impacts from road infrastructure such as road lighting.

8.4.5. The three Grade I listed buildings located within the study area are parish churches. These are the Church of St Mary in Long Stratton, the Church of St Michael in Stratton St Michael and the Church of St Mary in Tharston. These assets are located outside of the Proposed Development Site Boundary and the potential for setting impacts is discussed in the following paragraphs.

8.4.6. The Church of St Mary is defined by its relationship to its churchyard, one of the conservation area's prominent open spaces, and to the non-designated churchyard wall (described as a historic boundary wall) considered to be of 'townscape significance.' The asset is also defined by its location off Ipswich Road and by its visual and historic relationships to the Long Stratton Conservation Area and to the individual designated and non-designated heritage assets located within the conservation area boundary, particularly the Grade II listed St Mary's Rectory (NHLE ref: 1153550) and the Grade II listed Long Stratton Church School (NHLE ref: 1373267). The Proposed Scheme is located in close proximity to the Church of St Mary, just to the east of the asset. The Proposed Scheme would potentially impact on its immediate rural setting. There would be also be potential impacts from the Eastern Bypass and Western Relief Road caused by traffic flow, traffic noise and from road lighting, although intervening built form and tree belts will mitigate some of these impacts. The Proposed Scheme also has the potential to significantly reduce traffic flow and traffic noise from Ipswich Road which would be beneficial to the asset's setting.

8.4.7. The Church of St Michael in Stratton St Michael is defined by its relationship to its churchyard, to the Grade II* listed The Old Rectory and to the other heritage assets in Stratton St Michael. It is also defined by its rural location on Church Lane and views out from the asset towards the Proposed Scheme are characterised by rural and agricultural land. The Proposed Scheme has the potential to impact on the asset's setting through the loss of this rural landscape and from the impacts caused by new built development, traffic flow, traffic noise and road lighting. The close proximity of the asset from the Proposed Scheme means that these impacts will affect its immediate setting.

8.4.8. The Church of St Mary in Tharston is defined by its relationship to its churchyard and to the Grade II listed Mausoleum in Churchyard South of Church of St Mary (NHLE ref: 1050022). It is also defined by its location on Hall Lane and its relationship to heritage assets in, or in the vicinity of, Tharston. The immediate setting and long views out from the asset are characterised by rural and agricultural land. Potential impacts from the Proposed Scheme, caused by new built development, traffic noise and lighting are possible. Distance, intervening built form and vegetation may mitigate impacts.

8.4.9. There are three Grade II* listed buildings located within the study area. These assets are located outside of the Proposed Development Site Boundary and the potential for setting impacts is discussed in the following paragraphs.

8.4.10. The Old Rectory in Stratton St Michael is defined by its relationship to the Church of St Michael, its location on Church Lane and its relationship to other heritage assets in Stratton St Michael. Views out from the asset towards the Proposed Scheme are characterised by rural and agricultural land. The Proposed Scheme has the potential to impact on the asset's setting through the loss of this rural setting and from the impacts caused by new built development, traffic flow, traffic noise and road lighting. The close proximity of the asset from the Proposed Scheme means that these impacts will affect its immediate setting.

8.4.11. Premises owned by Mr Tunmore and G.J. Cracknell and Son in Long Stratton is defined by its location on the A140 and its relationship to the Long Stratton Conservation Area. Its setting is also defined by visual and historic relationships to other heritage assets located within the conservation area boundary. Visual impacts from the Proposed Scheme are likely, although the asset's key relationships would not be impacted and views out towards the Site do not greatly contribute to the asset's significance.

8.4.12. The setting of Tharston Hall is defined by its relationship to heritage assets located in and within the vicinity of Tharston. It has a particular relationship to the parish church and to the Grade II listed Boden House (NHLE ref: 1302085) also situated on Brand's Lane. It is self-contained within its own grounds, although long views out towards the Site do contribute to the asset's significance. The Proposed Scheme is likely to impact on the setting of the asset through new built development, traffic flow, traffic noise and road lighting.

8.4.13. The relationship of the 32 Grade II listed buildings located within the Long Stratton Conservation Area are primarily to the conservation area itself and to heritage assets located within the conservation area boundary. Visual impacts from the Proposed Scheme are likely, although the asset's key relationships would not be impacted and views towards the Proposed Development Site do not greatly contribute to the assets' significance. However, there is likely to be a greater impact on the setting of heritage assets located to the south of the conservation area, especially in proximity of the Church of St Mary, notably the Grade II listed Belvedere Stores and 2 Adjoining Cottages. The Proposed Scheme has the potential to significantly reduce traffic flow and traffic noise from the A140 which would be beneficial to the assets' setting.

8.4.14. The setting of the other 48 Grade II listed buildings located within the study area would also potentially be impacted by the Proposed Scheme. Setting impacts would be caused by new built development and impacts from the Eastern Bypass and Western Relief Road in the form of traffic flow, traffic noise and road lighting. The group of assets to the north of Long Stratton and in Stratton St Michael are likely to see the greatest impacts to their settings. The designated heritage assets to the west of Land East of A140 and the Eastern Bypass, and those south of the conservation area on Ipswich Road – characterised by isolated dwellings and farm complexes – are also likely to see a greater level of impact.

8.4.15. Apart from potential physical impacts to small sections of the Long Stratton Conservation Area, the Proposed Scheme would also impact on the asset's setting. The Proposed Scheme has the potential to reduce traffic flow and traffic noise from the existing A140 which would be beneficial to the conservation area's setting. The conservation appraisal describes the asset and its setting:

> *'Long Stratton straddles the A140 Norwich to Ipswich road about one kilometre south of its crossing of the Tas valley at Tasburgh, whence a low plateau stretches south to the Suffolk border at the river Waveney. From the north there is a pronounced descent to the centre of*

the village. This combines with two gentle S-bends in the road - one centred on its junction with Swan Lane, the other on that with Flowerpot Lane - to close views out of the village and to bring particular buildings into unexpected focus. For this reason Long Stratton is a place at which to stop rather than simply to speed through. This makes it more, not less, imperative that the village is freed from the heavy traffic which pounds through it constantly. The current draft Joint Core Strategy for South Norfolk proposes the delivery of a bypass as part of a larger scheme for further residential development and improvements in the town.[45]

8.4.16. The character and appearance of the conservation area is focused on the historic core of the town and the relationship of the asset to the existing A140 road. The Long Stratton Conservation Area is defined by its relationship to the individual heritage assets located within it, while the conservation area appraisal makes it apparent that traffic flow and traffic noise are also prominent, which would detract from its character, appearance and setting.

8.4.17. The setting of the conservation area is also defined by its relationship to other heritage assets located within the study area, for example to the cottages and farm complexes located to the east of Long Stratton. The Proposed Scheme has the potential to impact on the conservation area's setting through new built development and the impacts from the Eastern Bypass in the form of traffic flow, traffic noise and road lighting.

8.4.18. The Proposed Scheme includes the Eastern Bypass and the Western Relief Road. This is designed to reduce traffic levels on the A140 Norwich Road and Ipswich Road. This has the potential to significantly reduce traffic flow and traffic noise from the existing A140. This would be beneficial to the Long Stratton Conservation Area and to individual heritage assets located along the existing A140.

Buried heritage assets

8.4.19. Within the Site boundary the non-designated heritage assets described in the baseline conditions and previously unrecorded non-designated assets could potentially be impacted.

8.4.20. Works carried out as part of the initial site set up, including preliminary topsoil stripping across the Site and any temporary access roads and temporary work compounds and topsoil storage areas, the installation of site fencing and welfare facilities could cause an impact. The excavations for the Proposed Scheme would entirely remove any archaeological remains within the excavation footprint.

Summary

8.4.21. No designated heritage assets are located within the operational footprint of the Eastern Bypass or Western Relief Road. A number of heritage assets have been identified in the study area of the Proposed Scheme. The Long Stratton Conservation Area and 3 Grade II listed buildings are located within the boundary of the associated development of the Eastern Bypass.

8.4.22. The Proposed Scheme has the potential to cause the following impacts:

- Adverse physical impacts to heritage assets in relation to the associated development.

[45] Long Stratton Conservation Area Character Appraisal (South Norfolk Council), 5

- Adverse impacts to the setting of heritage assets from all components of the Proposed Scheme.
- Beneficial impacts to the conservation area and the setting of assets located on the A140 through a reduction in traffic flow and noise.
- Adverse impacts to known and unknown below ground non-designated heritage assets.

8.4.23. It is advised that direct physical impacts to designated heritage assets should be avoided through design refinements and construction environmental management; however due to uncertainty regarding the temporary works required for the Eastern Bypass or Western Relief Road or works required for the Proposed Scheme and the design of the associated development this cannot be confirmed at this stage.

8.4.24. The potential impacts to the setting of built heritage assets range from Slight Beneficial in some cases, to Large Adverse in other cases. The Large Adverse impacts relate to the Grade I listed Church of St Michael (Ref. 1304267) and the Grade II* listed The Old Rectory (Ref. 1373264). The conclusion of Large Adverse for these assets is considered to be a worst-case scenario at this stage. The possibility of mitigating these impacts will need to be explored further at the next stage. As stated, Slight Beneficial impacts have also been identified to a number of assets through the reduction of traffic in the Long Stratton Conservation Area. Impacts to the setting of other designated heritage assets ranged from Moderate Adverse to Slight Beneficial.

8.4.25. The potential impacts on archaeology range from Slight Adverse in some cases, to Large Adverse in other cases. The severity of impact would depend on the significance of the asset. The heritage significance of such assets depends on their nature, date, extent and survival but might be local or regional (potentially national if extensive and well preserved). The impact will also depend on factors such as final design, construction techniques and impact management strategies.

8.4.26. The overall assessment score for historic environment is **Large Adverse**.

8.4.27. Impact mitigation has not been considered at this stage of the assessment, however, there is the potential to reduce adverse impacts with the implementation of mitigation measures for above ground and below ground heritage assets.

PROPOSED NEXT STEPS

8.4.28. Where any potential adverse effects resulting from the Proposed Scheme are identified, strategies to reduce the impact of the Proposed Scheme should be examined. Where the effects are on the setting of heritage assets, and where the setting is judged to contribute the significance of the asset, the impacts may be mitigated by design, the introduction of screening or an appropriate road lighting scheme.

8.4.29. For below ground remains, the impacts can be reduced where feasible and warranted, through either mitigation by design, allowing remains to be preserved *in-situ*, or through preservation by record (i.e. archaeological excavation).

8.4.30. Following further assessment and consultation, recommendations for preliminary site-based archaeological investigations will be made, where required, bearing in mind the non-intrusive and intrusive work carried out on previous iterations of the proposed scheme to date. This might include additional targeted archaeological trial evaluation trenches. Sufficient time should be allowed in the planning programme to allow the results of such work to feed into the planning submission documents. The results of the assessment and site-based evaluations, along with informal and formal consultations, should enable the formulation of appropriate mitigation through design

considerations, targeted archaeological excavation in advance of construction and recording, and/or archaeological monitoring during preliminary groundworks. The successful implementation of an agreed programme of archaeological mitigation would aim to reduce or offset any adverse effects to neutral.

9 LANDSCAPE AND VISUAL IMPACT

9.1 INTRODUCTION

9.1.1. This chapter provides an appraisal of the Proposed Scheme in relation to potential Landscape and Visual Impact. It is assumed the Landscape and Biodiversity Strategy including Green Infrastructure elements and features outlined in the Design and Access Statement (2017) will be largely retained in the Proposed Scheme.

9.2 APPRAISAL METHODOLOGY

STUDY AREA

9.2.1. The study area comprised a 2km buffer around the Proposed Development Site boundary and takes a holistic view considering the likely landscape and visual effects resulting from the Proposed Scheme on Long Stratton as well as the wider setting.

DATA SOURCES

9.2.2. The data sources used in this appraisal comprise:

- MAGIC Maps;
- Ordnance Survey Mapping;
- Long Stratton - Environmental Statement - Main Report (2017)[46];
- Long Stratton - Design and Access Statement (2017)[47];
- South Norfolk Landscape Assessment (2001); and
- National Character Area profiles: 83: South Norfolk and High Suffolk Claylands[48].

APPRAISAL APPROACH

9.2.3. An initial qualitative appraisal of potential landscape and visual impact has been undertaken for the Proposed Scheme. This follows guidance contained in Chapter 5 – The Environmental Capital Approach and Chapter 6 – Impacts on Landscape in TAG Unit A3[49]. Information on settlement patterns, tranquillity, cultural associations and land cover elements have been provided in a summary worksheet along with other key environmental resources affecting landscape character and visual amenity. An appraisal of how the Proposed Scheme would fit within the landscape is included along with an overall review of potential impacts on landscape and visual receptors using the standard seven-point scale defined in TAG Unit A3. The landscape appraisal considers the effect of the Proposed Scheme on the wider landscape, including Long Stratton town in keeping with

[46] Norfolk Homes, (2017). Long Stratton - Environmental Statement - Main Report

[47] Norfolk Homes, (2017). Long Stratton - Design and Access Statement - land west

[48] Natural England, (2014). National Character Area profiles: 83: South Norfolk and High Suffolk Claylands

[49] Department for Transport, (2019). TAG UNIT A3 Environmental Impact Appraisal

South Norfolk Landscape Character Assessment 2001. As such, a townscape appraisal has been scoped out.

9.2.4. The appraisal has been carried out from current design information, desk-based research and an awareness of the existing landscape context from a review of the data sources outlined above. A brief review of the National Character Area and the South Norfolk Landscape Assessment has been undertaken but there has been no detailed study completed for local character.

9.3 KEY CONSTRAINTS

9.3.1. The farmland surrounding Long Stratton is crossed by public rights of way. Many of these routes connect Long Stratton with the small farmsteads, hamlets and historic commons which are characteristic of the area and a relevant consideration to the Proposed Scheme.

9.3.2. There are no internationally important designations close to the Site and the nearest Sites of Special Scientific Interest (SSSI) are Fritton Common (c. 1.7km east of the Proposed Development Site), Pulham Market Big Wood (c. 1km south of the Proposed Development Site) and Forncett Meadows (c. 2.4km west of the Proposed Development Site), as shown on **Figure 1.3** in **Appendix A**. Wood Green and Tyrell's Wood are both County Wildlife Site. There are mosaics of valuable wetland habitat along the floodplains of the tributary stream valleys which flow northwards to the River Tas network. One of these streams lies to the west of the Proposed Scheme. Isolated blocks of deciduous woodland lie within the arable farmland and on common land to the east of Long Stratton. The largest of these is Tyrell's Wood but there are smaller blocks of woodland such as Devil's Wood and The Grove, which are prominent within the arable farmland.

9.3.3. There is a concentration of listed buildings along the A140 in the historic centre of Long Stratton, but many of the farmsteads and rural villages in the countryside around Long Stratton have listed buildings, including particularly Long Stratton Mills on Mill Lane (Grade II), St Michael's Church, Stratton St Michael (Grade I), Woodgreen farmhouse (Grade II) and Picton Farmhouse (Grade II). There are Conservation Areas for the settlements of Long Stratton, Wacton and Fritton. There are no Registered Historic Parks and Gardens and/or Scheduled Monuments in the vicinity of the Site. A more complete description of cultural heritage is provided in Chapter 8.

9.3.4. There are likely to be views to parts of the Site from the footpaths and rural roads to the north-west and east of Long Stratton and there are also views from the town, particularly from Parker's Lane, Hall Lane and parts of Swan Lane and the A140.

9.3.5. Receptors who are likely to experience the changes in views and visual amenity are:

- Residents in properties on the north-west and eastern edges of Long Stratton, including particularly those in St Michael's Close, Hall Lane and Parker's Lane;
- Residents in properties along Church Lane in Stratton St Michael and in some of the individual properties along rural lanes to the east of Long Stratton;
- Pedestrians and cyclists using the local footpaths and rural lanes that connect Long Stratton with the countryside surrounding the town;
- Motorists travelling along local roads – A140, Swan Lane, Forncett Road, Brand's Lane, Church Lane, Mill Lane, Hall Lane, Parker's Lane and Wood Lane.

9.4 APPRAISAL

9.4.1. The landscape and visual TAG sheet is provided in **Appendix C**.

KEY FINDINGS OF THE APPRAISAL PROCESS

9.4.2. The Proposed Scheme is anticipated to introduce a new road corridor, highway infrastructure and associated development into a predominantly rural landscape. It would cut through the landscape, disrupting existing field patterns and changing local land cover. This would likely result in a noticeable change in the landscape character, however the proposed enhancement to Green Infrastructure would assist integration of the Proposed Scheme into the local landscape. There would be minimal disruption to existing woodland or trees and extensive new planting would compensate for the loss or degradation of existing vegetation and it is anticipated create a landscape of greater diversity with the potential gain in ecological value.

9.4.3. The long expansive views characteristic of Long Stratton's landscape would be retained as set out in the Design and Access Statement[50] through iterative masterplanning. While the introduction of the Proposed Scheme would reduce tranquillity at a local level, the location of the Proposed Scheme close to the existing town of Long Stratton and mitigation measures to enhance visual containment would limit a reduction in tranquillity being experienced at a wider level.

9.4.4. The Proposed Scheme would cut through the local farmland landscape, disrupting the existing field pattern and historic paths and tracks, and cause localised hedgerow and hedgerow tree removal within the immediate vicinity of the Site. The likely adverse cultural and landscape impacts would be mitigated through proposed new planting integrating the Proposed Scheme within its wider context. The masterplan[51] is landscape led with the intention to conserve and restore degraded/lost Green Infrastructure connections and reinforce development edges.

9.4.5. The Proposed Scheme would impact local landcover, introducing new roads and housing developments into the landscape, and result in a net loss of arable land use at the local level. In conclusion, the TAG Landscape Impacts Worksheet assessment score is **Slight Adverse**, including mitigation measures.

PROPOSED NEXT STEPS

9.4.6. The following scope of works should be considered for an update or amendment to the planning application.

9.4.7. The baseline survey work completed to inform the ES was undertaken in 2017. A review of baseline information including landscape surveys would be required to inform an updated ES as part of a forthcoming update or amendment to the planning application(s).

9.4.8. The likely impacts arising from the Proposed Scheme should be determined, and any significant adverse effects identified.

[50] Norfolk Homes, (2017). Long Stratton - Design and Access Statement - land west

[51] Norfolk Homes, (2017). Long Stratton - Design and Access Statement - land west

9.4.9. Where any potential adverse effects resulting from the Proposed Scheme are identified, strategies to avoid, reduce or remediate (offset) potential adverse effects on the landscape, views and visual amenity should be examined as part of the design and scope of the EIA (or update to the EIA).

9.4.10. Where effects cannot be avoided through alignment/design choices, a mitigation strategy should be developed to reduce the potential effects. Remediation of vegetation lost through construction of the Proposed Scheme is considered following avoidance and reduction of potential effects during design. The broad principles of mitigation are set out below:

- Tree and shrub species as mitigation planting to reflect the immediate local character along the new route grouped to reflect local form and vegetation pattern;
- Earthworks should be designed carefully to blend the new road alignment into the landscape;
- Avoid long lengths of screen planting, mounding or carriageway in cuttings where these interventions would be at odds with the surrounding landscape or serve to emphasise the linearity of the bypass;
- Consider enhancement planting outside the Proposed Development site boundary where mitigation could be more effective and in keeping with the existing landscape character;
- Create habitats of value. For example, develop grassland habitats along the corridor on low nutrient soils to encourage species diversity and provide visual interest to road users;
- Drainage ponds to provide wetland habitat and their layout should reflect local character. The design of the ponds and immediate setting should be naturalistic; and
- Create, frame, or enhance views and interest for road users and local receptors.

10 MATERIALS AND WASTE

10.1 INTRODUCTION

10.1.1. This chapter presents an appraisal of the key materials and waste environmental constraints of the Proposed Scheme. An assessment of impacts and effects from material consumption and waste generation was absent from the previous 2017 ES.

10.2 APPRAISAL METHODOLOGY

STUDY AREA

10.2.1. The study areas (as defined in LA110) that are applicable to the Proposed Scheme are:

- The **primary study area** is defined by the extent of works within the Proposed Scheme, that is the Eastern Bypass, Western Relief Road and associated areas of development.
- The **secondary study area** is represented by the geographical extent to which waste infrastructure is suitable and available for the management of arisings and waste generated by the Proposed Scheme. Accordingly, using professional judgement to take into account the balance between the Proximity Principle and value for money (regarding materials and waste logistics), and considering the extent of available data to compile a baseline assessment, the secondary study area is determined to comprise the East of England region (Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk and Suffolk).

DATA SOURCES

10.2.2. The data sources used in this appraisal comprise:

- Standards for Highways (2019) Design Manual for Roads and Bridges Sustainability & Environment Appraisal LA110 Material Assets and Waste. Appendix E/1 Regional and national recycled aggregate targets for England;
- Department for Business, Energy & Industrial Strategy (2020) Monthly Bulletin of Building Materials and Components;
- East of England Aggregates Working Party Annual Monitoring Report (2017);
- Mineral Products Association, Profile of the UK Mineral Products Industry, 2018 Edition;
- United Kingdom Steel Production, 1969-2020 Data (online);
- Norfolk Minerals and Waste Core Strategy Development Policy Document (September 2011) Interactive Policy Map;
- Natural England MAGIC mapping website;
- DEFRA, Basis of the UK BAP target for the reduction in use of peat in horticulture – SP0573 (2009);
- Defra (2019) UK Statistics on Waste;
- Environment Agency, Waste Data Interrogator (2018) Waste Management Information 2018: East of England;
- Environment Agency, Waste Data Interrogator (2018) Waste Management Information 2018: England; and
- Environment Agency, Remaining landfill capacity, England (2018).

10.2.3. This high-level assessment has been carried out in accordance with DMRB standard LA110 Material assets and waste[52].

10.2.4. The assessment (and any recommendations for the management) of material assets and waste is based upon the regulatory requirement to apply the Waste Hierarchy, to work in accordance with the Proximity Principle, and to drive increasingly circular action across industry.

10.2.5. The baseline scenario, through desktop research, describes the current and likely future state (in the absence of the Proposed Scheme) of the:

- types and quantity of material used in operations on the existing land use, within the primary study area;
- types and quantities of waste produced in operations on the existing land use within the primary study area;
- availability of key construction materials required for the Proposed Scheme within the secondary study area; and
- waste infrastructure and remaining landfill capacity within the secondary study area.

Materials

10.2.6. An assessment of the effects of consuming resources has been undertaken by considering the origins and sources of materials, including their general availability (production, stock, sales) and assumptions made regarding the proportion of recovered (reused or recycled) content they contain in the absence of any suitable data. No sustainability features of materials have yet been identified for use on the Proposed Scheme.

10.2.7. The reuse of excavated and other arisings - recovered from site or elsewhere, that meet waste exemption criteria or comply with the CL:AIRE Definition of Waste Code of Practice (DoWCoP)[53] - has also (based on professional judgement and experience of similar road schemes) been considered as part of the assessment of materials. Reuse of arisings and other recovered materials has the ability to reduce adverse impacts associated with the consumption of primary resources.

Waste

10.2.8. An assessment of the remaining landfill capacity in East of England region has been used to determine the potential impacts and effects of waste generated by the Proposed Scheme.

10.2.9. The assessment considers the type and volume of waste to be generated by the Proposed Scheme and determines the potential impact on remaining landfill capacity in the region. Wherever waste is recovered (diverted from landfill) the influence of this action has been considered in the assessment of significance of effect.

10.2.10. According to LA110, an environmental assessment of material assets and waste should be a quantitative exercise. However, at this stage no quantitative data (type and volume data for

[52] DMRB LA110 Material assets and waste (2019)
[53] CL:AIRE Definition of Waste Code of Practice [https://www.claire.co.uk/projects-and-initiatives/dow-cop]

materials and waste) has been made available to carry out the assessment. Therefore, a qualitative approach has been undertaken based on conservative estimates and proportionate worst-case scenarios applied, where relevant, to the assessment criteria.

Significance Criteria

10.2.11. The assessment shall adopt the significance criteria set out in LA110, which do not require separate assessment of sensitivity and magnitude of change. Significance criteria set down in LA110 are provided in **Table 10-1**.

Table 10-1 – Material Assets and Waste Significance Criteria

Significance category	Description Materials	Description Waste
Very Large	▪ No criteria: use criteria for large categories.	▪ >1% reduction or alteration in national capacity of landfill, as a result of accommodating waste from a project; or ▪ Construction of new (permanent) waste infrastructure is required to accommodate waste from a project.
Large	▪ Project achieves <70% overall material recovery / recycling (by weight) of non-hazardous Construction and Demolition Waste (CDW) to substitute use of primary materials; and ▪ Aggregates required to be imported to site comprise <1% re-used / recycled content; and ▪ Project sterilises ≥1 mineral safeguarding site and/or peat resource.	▪ >1% reduction in the regional capacity of landfill as a result of accommodating waste from a project; and ▪ 50% of project waste for disposal outside of the region.
Moderate	▪ Project achieves less than 70% overall material recovery / recycling (by weight) of non-hazardous CDW to substitute use of primary materials; and ▪ Aggregates required to be imported to site comprise re-used/recycled content below the relevant regional percentage target*.	▪ >1% reduction or alteration in the regional capacity of landfill as a result of accommodating waste from a project; and ▪ 1-50% of project waste for disposal outside of the region.
Slight	▪ Project achieves 70-99% overall material recovery / recycling (by weight) of non-hazardous CDW to substitute use of primary materials; and ▪ Aggregates required to be imported to site comprise re-used/recycled content in line with the relevant regional percentage target*.	▪ ≤1% reduction or alteration in the regional capacity of landfill; and ▪ Waste infrastructure has sufficient capacity to accommodate waste from a project, without compromising integrity of the receiving infrastructure (design life or capacity) within the region.
Neutral	▪ Project achieves >99% overall material recovery / recycling (by weight) of non-hazardous Construction Demolition Waste (CDW) to substitute use of primary materials; and	▪ No reduction or alteration in the capacity of waste infrastructure within the region.

Significance category	Description Materials	Description Waste
	▪ Aggregates required to be imported to site comprise >99% re-used / recycled content.	

Notes: *Recycled aggregate target. The recycled aggregate target for East of England is 31%

ASSUMPTIONS AND LIMITATIONS

10.2.12. The assessment is subject to the following assumptions and limitations:

- National data for material resource availability, landfill capacity and waste recovery is only updated periodically. The most up-to-date sources of available information have been used at the time of writing which is up to and including 2019 (unless stated otherwise).
- The assessment is based upon the validity of the collated information and concerns any material assets or waste expected to be consumed or generated (respectively) during the 'in scope' lifecycle phases of the Proposed Scheme.
- Landfill operators can claim commercial confidentiality for their data at time of submission; data for sites with a commercial confidentiality agreement in place are therefore unavailable for the analyses presented in this chapter.
- A lifecycle assessment (including embodied carbon and water) of materials has not been included as the effort and resources required are deemed disproportionate to the benefit they would offer the assessment of significance of effect.
- Impacts and effects resulting from the transportation of material resources and waste to and from the site have not been included as these would be considered in other specialist topics, e.g. air quality, noise and climate, as appropriate.
- Specific information on the potential for incorporating recycled or secondary content of materials has not been provided at this stage but would be considered further during the detailed design and construction phase. As such, a worst-case scenario has been applied and assumes that aggregates to be imported to site will comprise a recycled content that is below the regional percentage target of 31%.

10.3 KEY CONSTRAINTS

10.3.1. Based on the scale and characteristics of the Proposed Scheme, the following elements could potentially give rise to likely significant effects and should therefore be considered for assessment in accordance with Highways England's Design Manual for Road and Bridges (DMRB) LA 110 Material Assets and Waste[54], herein referred to as 'LA110':

[54] Standards for Highways (2019) Design Manual for Roads and Bridges Sustainability & Environment Appraisal LA110 Material Assets and Waste [online] Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3.html [Accessed 07/10/2020]

- The consumption of material resources (from primary, recycled or secondary, and renewable sources, and including products offering sustainability benefits) including the generation and use of arisings recovered from site; and
- The production and disposal of waste to landfill.

10.3.2. The following key receptors have been identified as:

- **Material assets** – consumption impacts on immediate and long-term availability, resulting in depletion of natural resources; and
- **Landfill void capacity** – reductions in regional and national infrastructure, resulting in unsustainable use or loss of resources and temporary or permanent degradation of the natural environment (landfill is considered an increasingly sensitive receptor in the UK).

10.4 APPRAISAL

BASELINE

10.4.1. This section describes baseline material consumption and waste disposal for the current land use and provides regional / national information and data in the context of which the assessment (currently qualitative) will be undertaken.

10.4.2. The most up to date sources of information have been used to collate data for material resource availability, landfill capacity and waste recovery. Indication of the most recent year from which data has been acquired is provided throughout. The baseline data collected and presented in this section were obtained by desk study, from publicly available data sources.

Materials currently required

10.4.3. The operation and maintenance of the current land use within the Proposed Scheme boundary comprises agricultural fields intersected by hedgerows, drainage channels and ponds and single lane carriageways.

10.4.4. Although no data exists for the current land use, it is anticipated that material consumption is limited to nominal quantities of construction materials. Therefore, the current use of resources within the boundary of the Proposed Scheme is deemed minimal.

Availability of Construction Materials

10.4.5. **Table 10-2**[55] [56] [57] [58] provides a summary of the availability of the main construction materials in East of England (Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk and Suffolk) and the UK, as required to deliver typical highways schemes.

[55] Department for Business, Energy & Industrial Strategy (2020) Monthly Bulletin of Building Materials and Components [link]
[56] East of England Aggregates Working Party Annual Monitoring Report (2017) [link]
[57] Mineral Products Association, Profile of the UK Mineral Products Industry, 2018 Edition [link]
[58] United Kingdom Steel Production I 1969-2020 Data I 2021-2022 Forecast I Historical (Online) [https://tradingeconomics.com/united-kingdom/steel-production] (Accessed 14 October 2020)

Table 10-2 - Construction Materials Availability on the East of England and the UK

Material Type	East of England	UK
Sand and gravel *	10.6 million tonnes (Mt)	58.5 Mt
Permitted crushed rock *	0.4 Mt (2017)	114.5 Mt (2017)
Concrete blocks #	3.1 million square meters (Mm^2) (Midlands)	9.1 Mm^2
Primary aggregate *	12.6 Mt (2017)	203 Mt (2017)
Recycled and secondary aggregate *	(no data)	74 Mt (2017)
Ready-mix concrete *	1.4 million cubic meters (Mm^3) (2017)	25.9 Mm^3 (2017)
Steel +	(no data)	7.2 Mt
Asphalt *	2.4 Mt (2017)	27.3 Mt (2017)

stocks + production * sales

Data availability: 2019 unless otherwise stated

10.4.6. Across the UK, the availability of construction materials typically required for highways construction schemes, indicates that stocks / production / sales remain buoyant.

10.4.7. Currently, data for the East of England regarding materials typically required for highways construction, are incomplete; for example, information on recycled aggregate sales and steel production are not available for the region (**Table 10-2**). Accordingly, a full picture of resource availability in the secondary study area cannot be obtained. The East of England does however have a higher than average recycled content target for aggregate (31%) by comparison with the average for England (25%)[59].

10.4.8. Where data are available, the average availability of construction materials in East of England is commensurate with other UK regions. For example, stocks of concrete blocks, and sales of primary aggregate, ready-mix concrete and asphalt are comparable. However, sales of sand and gravel are higher than the average, whilst permitted crushed rock is lower.

10.4.9. The Norfolk Minerals and Waste Core Strategy DPD Interactive Policy Map[60] identifies a sand and gravel mineral safeguarding area (MSA) within the boundary of the Proposed Scheme. This MSA is identified beneath Swan Lane (located to the west of Long Stratton High Street) which extends northwards along the drainage channel/stream at the western edge of the Proposed Scheme for the

[59] DMRB LA110 Material assets and waste (2019)
[60] Norfolk Minerals and Waste Core Strategy Development Policy Document (September 2011) Interactive Policy Map [link] (Accessed 07 October 2020)

development associated with the Western Relief Road. There are no MSA's identified relating to the Eastern Bypass and associated development.

10.4.10. There are no known peat resources[61] or active peat extractions[62] within the primary study area.

Site arisings

10.4.11. The current land use within the primary study area is expected to generate minimal volumes of site arisings, limited to potential earthworks on agricultural land, and surplus materials generated during minor repair works on highways – some of which is expected to be diverted from landfill. Although no data exist, it is anticipated (using professional judgement) that the current generation of site arisings is currently minimal.

10.4.12. Defra data (**Table 10-3**) show that within England, the recovery rate for non-hazardous construction and demolition wastes have remained above 90% since 2010. This exceeds the EU target of 70%, which the UK must meet by 2020[63].

Table 10-3 - Non-Hazardous Construction and Demolition Waste Recovery in England

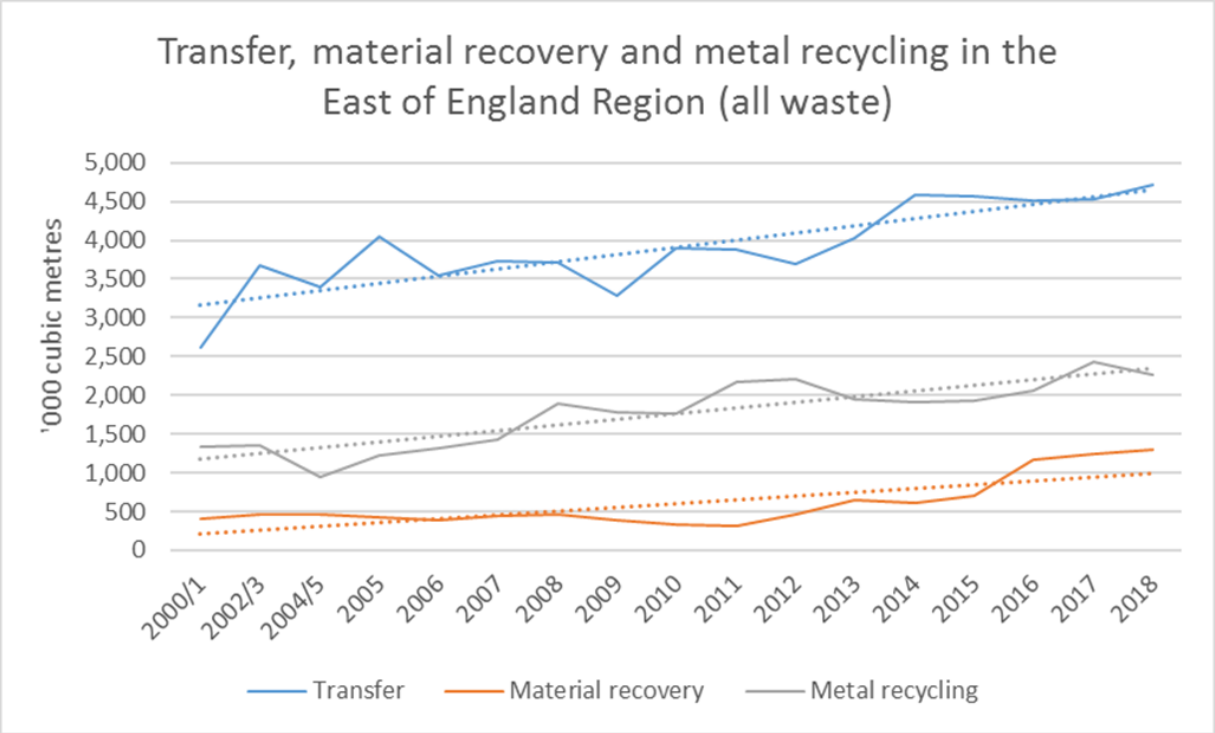
Year	Generation (Mt)	Recovery (Mt)	Recovery rate (%)
2010	53.6	49.4	92.2%
2011	54.9	50.8	92.5%
2012	50.5	46.4	92.0%
2013	51.7	47.6	92.0%
2014	55.9	51.7	92.4%
2015	57.7	53.3	92.3%
2016	59.6	55.0	92.1%

Note: Defra's 2019 update of the data in this table did not extend the data range beyond 2016

10.4.13. No regional data for construction, demolition and excavation production or recovery rates are currently available for the East of England. However, data in **Graph 10-1** has been collated to show that rates of waste recovery in the region have risen steadily over the past 18 years[64]. Metal recycling shows a slight decline since 2017, though the overall trend continues to rise. Data are provided for all waste types in the East of England and hence will include, but are not specific to, construction, demolition and excavation wastes.

[61] Natural England MAGIC mapping website [link] (Accessed 07 October 2020)
[62] DEFRA, Basis of the UK BAP target for the reduction in use of peat in horticulture – SP0573 (2009) [http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15991] (Accessed 07 October 2020)
[63] Defra (2019) UK Statistics on Waste [link]
[64] Environment Agency, Waste Data Interrogator (2018) Waste Management Information 2018: East of England [link]

Graph 10-1 - Transfer, Materials Recovery and Metal Recycling in the East of England (2000/1 - 2018)



10.4.14. Trends for materials transfer and recovery, and metal recycling, in the East of England indicate that there is likely to be regional infrastructure and capacity for the transfer and recovery for construction, demolition and excavation wastes from the Proposed Scheme. Construction and demolition recovery trends across England (**Graph 10-1**) and data in **Table 10-4** confirm this assertion[65].

Table 10-4 - Permitted Waste Recovery Management Sites in the East of England (2018)

Waste Recovery Facility Type	Number of Sites
Incineration	14
Transfer	356
Treatment	388
Metal recovery	281
Use of waste	3
Total	**1,042**

[65] Environment Agency, Waste Data Interrogator (2018) Waste Management Information 2018: England [link]

10.4.15. The availability of materials recovery infrastructure in the East of England, and across England, suggests that there is strong potential to divert site arisings generated by the Proposed Scheme from landfill.

Waste Currently Generated and Disposed

10.4.16. Waste generated for disposal to landfill from activities undertaken on the current land use is expected to comprise non-recoverable wastes from farming practices, routine maintenance and infrequent repair of the roads and ancillary infrastructure. Although no waste data exists, it is anticipated (using professional judgement) that even in the worst-case scenario, the current waste generation and disposal is minimal in the context of available regional capacity.

Remaining Landfill Capacity

10.4.17. Environment Agency data[66] confirm that at the end of 2018, 53 landfill sites in the East of England were recorded as having 49.7 million cubic meters (Mm^3) of remaining capacity. These data are presented in **Table 10-5**, which also shows the change in capacity from 2017 to 2018.

Table 10-5 - Remaining landfill capacity in East of England

Landfill type	Capacity in 2017(m^3)	Remaining capacity m^3 (2018)	2017 to 2018 capacity comparison (Million m^3)
Hazardous (merchant and restricted)	0	0	0
Inert	18,459,260	18,928,162	+0.5
Non-hazardous (including stable hazardous waste cells)*	33,201,573	30,803,161	-2.4
Total	**51,660,833**	**49,731,392**	**-1.9**

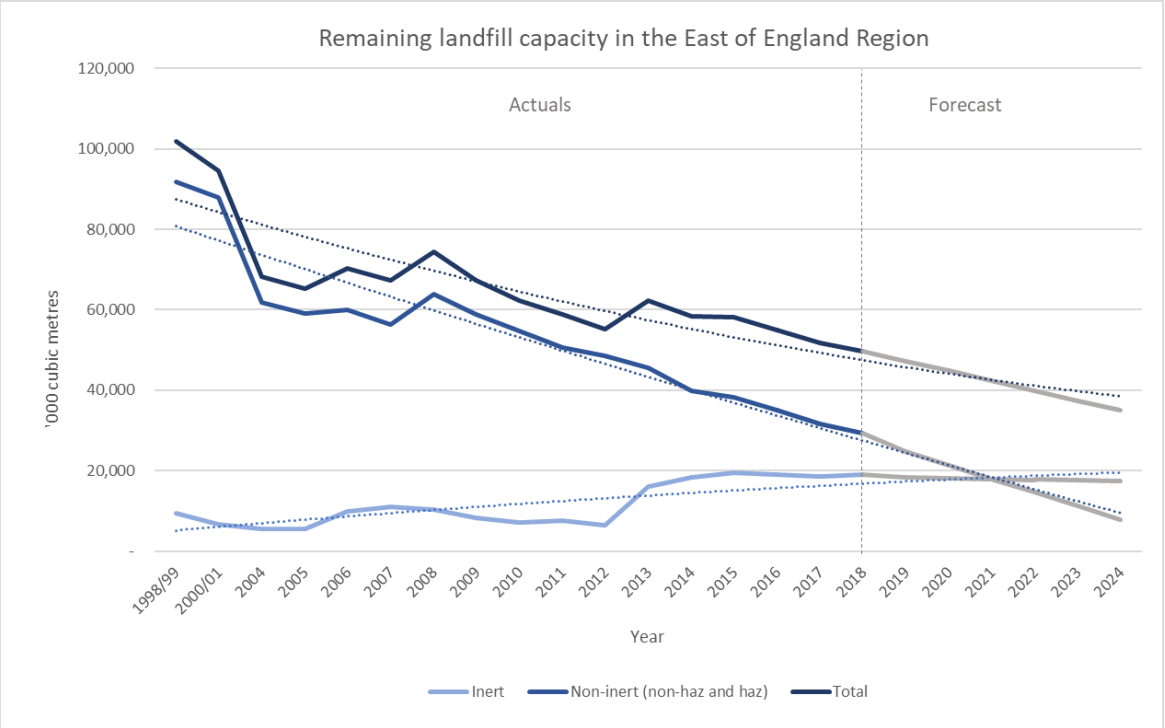
*Note: non-hazardous sites can accept some stable non-reactive hazardous waste (SNRHW) into specific dedicated cells. However, this is usually only permitted as a small part of the overall capacity of the site.

10.4.18. There are no hazardous waste landfill sites within the East of England region. In accordance with the proximity principle, the nearest hazardous waste landfill is in Northamptonshire, which falls within the East Midlands region.

10.4.19. Baseline regional landfill capacity is detailed in **Graph 10-2**. Simple statistical forecasting (using the Microsoft Excel forecasting function) has been used to demonstrate long term void capacity to the estimated year of planned Proposed Scheme completion (2024) in the absence of future provision.

[66] Environment Agency, Remaining landfill capacity, England (2018) [link]

Graph 10-2 - Landfill Capacity in the East of England



10.4.20. Baseline data indicates that in the absence of future provision, inert, non-inert and total landfill capacity is likely to become an increasingly sensitive receptor throughout the duration of the construction phase and in operation. **Graph 10-2** shows that in the absence of future provision, waste capacity in the East of England is forecast to reduce from 2018 to 2024 by as much as:

- Inert waste - 9% to 17.3 Mm^3;
- Non-inert waste - 74% to 0.78 Mm^3; and
- Total waste - 30% to 34.9 Mm^3.

KEY FINDINGS OF THE APPRAISAL

Material assets

10.4.21. The Proposed Scheme requires the consumption of primary and secondary materials for the construction of new road sections, roundabouts and overbridges (all on greenfield land) as well as tie-in of structures to the existing roads. Furthermore, primary and secondary materials will be required for the construction of:

- 1,275 dwellings and development of 8 hectares of employment land (for uses within Class B1, B2 and B8), a 2-hectare primary school site, a community facilities site, associated infrastructure and public open spaces associated with the Eastern Bypass; and
- 387 dwellings and 1.5ha of Class B1 employment land, associated infrastructure and public open space associated with the Western Relief Road.

10.4.22. Primary materials required for the Proposed Scheme are a finite resource and whilst some will be available through local and regional supply, national or wider sourcing is also likely to be required. Based on a worst-case scenario, it is anticipated that up to 100% of the primary materials will be sourced nationally.

10.4.23. An estimate of the percentage of re-used, recycled and secondary materials cannot currently be calculated based on the information available to date, therefore a worst-case scenario has been used to assess impacts. This assumes that imported aggregates will comprise reused/recycled content *below* the regional percentage target of 31%.

10.4.24. Whilst it is anticipated that reasonable efforts will be made to maximise the specification and use of secondary and recycled content, impacts from consuming primary resources would still arise from the Proposed Scheme. These would be considered adverse, direct and permanent, and would result in the depletion of natural resources and local or regional stocks and result in the degradation of the natural environment.

Waste

10.4.25. Site preparation and remediation (incorporating groundworks), and excavation and site clearance, will produce construction arisings (e.g. topsoil, earthworks, vegetation). The exact proportion of construction arisings that can be recovered would be assessed as part of later design stages. Preliminary assessment based on professional judgement indicates that there is potentially high value to be gained from recovering resources.

10.4.26. Where diverting site arisings from landfill is not possible, the impacts associated with disposing of waste would be adverse, permanent and direct.

10.4.27. After mitigation, any wastes which cannot be diverted from landfill are expected to have an adverse impact on landfill capacity in the region. Mitigation measures would be anticipated to include reuse of arisings during the construction phase of the Proposed Scheme, along with recycling of any surplus site arisings.

10.4.28. A high-level overview of the key impacts from resources consumed and waste generated is provided in **Table 10-6**. Assessment findings are presented based on professional judgement in the absence of quantified data.

Table 10-6 – Assessment of key impacts

Key Receptor	Summary of Key Impacts	Assessment
Material assets/ resources	An estimate of the volume of bulk materials (steel, concrete, asphalt) required is not available at the time of writing. The percentage of recycled content across these materials has not yet been determined, therefore a worst-case scenario has been used to assess impacts. This assumes that imported aggregates comprise reused/recycled content *below* the regional percentage target of 31%. A worst-case scenario applied to material recovery suggests that less than 70% overall material recovery / recycling (by weight) of non-hazardous Construction and Demolition Waste (CDW) (to substitute use of primary materials) would be achieved. The Proposed Scheme does not sterilise one or more MSA and/or peat resource. The sand and gravel MSA identified is present beneath an existing road and the proposed associated development for the Western Relief Road is not anticipated to further and adversely impact the deposit.	**Moderate (adverse)**

Key Receptor	Summary of Key Impacts	Assessment
Landfill void capacity	The completion date for the Proposed Scheme construction is expected to be Q3/Q4 2024. The available total landfill capacity (based on existing trends) is anticipated to be 34.9 Mm^3. A worst-case scenario applied to generation of waste has the potential for more than 1% reduction or alteration in the regional capacity of landfill as a result of accommodating waste from the Proposed Scheme. In addition, it is anticipated there may be a requirement to dispose of hazardous waste outside of the region, although the estimated volume is not known. However, it not anticipated to exceed 50% of the total waste from the Proposed Scheme.	**Moderate (adverse)**

PROPOSED NEXT STEPS

10.4.29. LA110 provides five questions to ascertain if the Proposed Scheme would require further environmental assessment, as provided in **Table 10-7**. Where the response to one or more of the questions is "yes", or there is insufficient data to provide a robust justification, the Proposed Scheme should be taken forward for further appraisal.

10.4.30. In the current absence of project specific data, the findings of **Table 10-7** confirm that further assessment is required.

Table 10-7 – Determination for Further Assessment

Question	Response
Is the project likely to recover/reuse little on site material thereby requiring materials to be imported to site?	Insufficient data. No early design estimates have been provided at this stage. Excavated arisings on site (earthworks) may not be suitable for reuse on the Proposed Scheme as structural fill, however early design assumptions should allow for reuse of surplus cut in environmental screening and landscape bunds.
Is the project likely to use little/no recycled/secondary materials thereby requiring the majority of materials used on the project to comprise primary materials?	Insufficient data. There is currently insufficient information available to identify opportunities for sourcing recycled materials for the Proposed Scheme. Until a quantitative assessment of this position can be undertaken, there remains a data gap and an inability to answer the question definitively.
The project is likely to sterilise (substantially constrain/prevent existing and potential future use of) minerals or peat resources?	No. The Proposed Scheme is not anticipated to sterilise any mineral resources. The sand and gravel MSA is partially located beneath the existing Swan Lane. There are no peat resources or extractions within the Temporary and Permanent Land Take of the Proposed Scheme.

Question	Response
Would the project generate large quantities of waste relative to regional landfill capacity?	Insufficient data. There is insufficient information available to identify waste volumes likely to be generated by the Proposed Scheme. Quantitative assessment of waste forecasts (by type and volume) is therefore required and - as there remains a data gap in this context – there is currently an inability to answer the question definitively.
Will the project have an effect on the ability of waste infrastructure within the region to continue to accommodate waste from other sources?	Insufficient data. There is insufficient information available to identify waste volumes likely to be generated by the Proposed Scheme. Quantitative assessment of waste forecasts (by type and volume) is therefore required and - as there remains a data gap in this context – it is not possible to answer the question definitively.

10.4.31. The following scope of works is proposed, based on the assumption that data required for environmental assessment would be available:

- Baseline data collection, through desktop research, to verify the baseline scenario and the current and likely future state (in the absence of the Proposed Scheme) of:
  - The types and quantity of material use associated with operation of the existing land use within the primary study area, where available;
  - The types and quantities of waste produced associated with operation of the existing land use within the primary study area, where available;
  - Information on availability of key construction materials required for the Proposed Scheme within the secondary study area; and
  - Information on waste infrastructure and remaining landfill capacity within the secondary study area.
- In accordance with LA110, undertake a quantitative assessment to clearly establish the following:

  For materials

  - Types and quantities of materials required to construct the Proposed Scheme;
  - Information on materials that contain secondary / recycled content;
  - Information on any known sustainability credentials of materials to be consumed;
  - The type and volume of materials that will be recovered from off-site sources for use on the proposed scheme;
  - The cut and fill balance; and
  - Details of on-site storage and stockpiling arrangements, and any supporting logistical details.

  For waste

  - The amount of waste (by weight) that will be recovered and diverted from landfill either on site or off site (i.e. for use on other projects);

- Types and quantities of waste arising from the project (demolition, excavation arisings and remediation) requiring disposal to landfill;
- Details of on-site storage and segregation arrangement for waste and any supporting logistical arrangements; and
- Potential for generation of hazardous waste (type and quantity).

- An assessment of the effects of consuming materials required during the construction phase will be undertaken by considering the origins and sources of materials, including their general availability (production, stock, sales) and the proportion of recovered (reused or recycled) materials they contain (including other sustainability features).
- The reuse of excavated and other arisings (that meet waste exemption criteria or comply with the CL:AIRE DoW CoP) will be evaluated as part of the assessment of materials, to determine whether the adverse impacts associated with the consumption of primary resources can be reduced.
- An assessment of the remaining landfill capacity in the East of England will be used to determine the impacts and effects of waste generated during the construction phase of the Proposed Scheme.
- The assessment shall consider the type and volume of waste to be generated by the Proposed Scheme and determine the potential impact on remaining landfill capacity in the region; this will be completed for inert and non-inert (non-hazardous and hazardous) waste types, where data are available. Wherever waste is recovered (diverted from landfill) the influence of this action will be taken into account in the assessment of significance of effect.
- The quantitative elements of the assessment will use data on material and waste type and quantity, as provided by the design team or client for the Proposed Scheme.

11 NOISE

11.1 INTRODUCTION

11.1.1. This chapter presents a noise appraisal of the Eastern Bypass and Western Relief Road to help inform the Outline Business Case (OBC). The appraisal methodology and baseline conditions are described, followed by a summary of the findings of the noise appraisal, including the outcome of the TAG Unit A3 noise analysis.

11.1.2. **Table 11-1** includes a definition of basic acoustic terms used in this chapter.

Table 11-1 – Glossary of Basic Acoustic Terms

Term	Definition
A-weighting, dB(A)	The human ear has a non-linear frequency response, being less sensitive at low and high frequencies and most sensitive in the mid-range frequencies. The A-weighting scale is applied to measured sound pressure levels so that these levels correspond more closely to the subjective response.
Decibel (dB)	The unit of measurement used for sound pressure levels. The decibel scale is logarithmic rather than linear. The threshold of hearing is 0 decibels while the threshold of pain is about 130 decibels.
Facade	Sound level that is determined 1 metre (m) in front of a window or door in a facade.
Free-field	The sound level that is measured or calculated, in the open, without any reflections from nearby surfaces except the ground.
L_{A10}	The A-weighted sound level, in dB, that is exceeded 10% of the measurement period. This is the standard index used within the UK to describe traffic noise.
$L_{A10,18h}$	The noise level, in dB, that is exceeded 10% of the time between 06:00 and 24:00.
L_{Aeq}	The equivalent continuous sound level (L_{Aeq}) is the level of a notional steady sound, which at a given position and over a defined period of time, would have the same A-weighted acoustic energy as the fluctuating noise.
L_{night}	A facade noise index derived from the $L_{A10,18h}$ using the TRL conversion method TRL PR/SE/451/02 (see paragraph 11.2.5)
$L_{night,outside}$	For the purpose of night-time noise assessment, the $L_{night,outside}$ is the equivalent continuous sound level $L_{Aeq,8h}$ for the period 23:00 to 07:00 assessed outside a dwelling and is free-field.

11.2 APPRAISAL METHODOLOGY

APPRAISAL APPROACH

11.2.1. The appraisal has been completed in accordance with the TAG Unit A3 guidance for Noise Impacts. The methodology references DMRB guidance where appropriate, however, this is not a full and complete assessment under DMRB, as a proportionate appraisal has been undertaken, with the scope and methodology being tailored to support the OBC.

TAG Unit A3 Environmental Impact Appraisal, Department for Transport[67]

11.2.2. There is growing evidence on the links between environmental noise and health outcomes. The Department for Environment, Food and Rural Affairs (Defra) has produced web-based guidance[68] on assessing the impacts of transport-related noise from different sources (covering road, rail and aviation sources) using an 'impact pathway' approach and covering a range of impacts on:

- annoyance;
- sleep disturbance; and
- health impact, including heart disease (acute myocardial infarction, or AMI), stress and dementia.

11.2.3. The methodology includes five steps as follows:

- scoping;
- quantification of noise impacts;
- estimation of the affected population;
- monetary valuation of changes in noise impact; and
- consideration of the distributional impacts of changes in noise.

Scoping (Step 1)

11.2.4. TAG Unit A3 requires that scoping should be consistent with the scoping of the environmental assessment, with the aim being to decide how noise impacts should be appraised and to define a study area for the Eastern Bypass and Western Relief Road. The noise appraisal should be proportional to the Eastern Bypass and Western Relief Road and their likely impact, with analysis being no more detailed than is required to support robust decision making.

11.2.5. TAG Unit A3 notes (in paragraph 2.2.3) that consideration needs to be given to how to address night-time noise and that for road-based schemes, "*conversion between different noise measures is considered sufficiently robust for the effects of night-time noise on sleep disturbance to be transformed from daytime measures*". This approach has been adopted for the Eastern Bypass and Western Relief Road, through the use of the formulas contained in TRL Project Report PR/SE/451/02[69].

11.2.6. Paragraph 2.2.6 of TAG Unit A3 notes that the guidance "*does not specify any analysis for situations where noise impacts on potentially noise sensitive non-residential receptors such as schools or hospitals*". Where impacts are likely to be significant, the TAG Unit A3 guidance is that they should be reported separately.

[67] TAG Unit A3 Environmental Impact Appraisal (Chapter 2 Noise Impacts), Department for Transport. 2019.
[68] https://www.gov.uk/guidance/noise-pollution-economic-analysis.
[69] TRL Limited. Project Report PR/SE/451/02. Converting the UK Traffic Noise Index $L_{A10,18h}$ to EU Noise Indices for Noise Mapping. P G Abbott & P M Nelson (TRL Limited). 2002.

11.2.7. For road schemes, TAG Unit A3 makes reference to the DMRB Volume 11, Section 3, Part 7 Noise and Vibration[70]. This guidance was superseded in 2019 by DMRB LA 111 Noise and vibration[71], which itself was most recently updated in May 2020. Key aspects of DMRB LA 111 are described later in this section (from paragraph 11.2.22).

Quantification of Noise Impacts (Step 2)

11.2.8. The Eastern Bypass and Western Relief Road are likely to affect noise levels in the area, as experienced at nearby sensitive receptors, in the following ways. They will:

- change the physical alignment of existing traffic links at their junction with the Bypass and Relief Road and introduce new traffic along their length; and
- have the potential to alter vehicle flow characteristics, such as traffic volumes, composition, and speeds on the existing road network.

11.2.9. TAG Unit A3 requires the likely noise impacts to be quantified and to this end reference is made to the Calculation of Road Traffic Noise (CRTN)[72]. A 3-dimensional digital noise model has been prepared using CadnaA® software to quantify the likely road traffic noise levels during the operational phase of the Eastern Bypass and Western Relief Road, with calculations following the methodology in CRTN (see paragraph 11.2.28 onwards).

11.2.10. TAG Unit A3 includes some guidance on how to deal with property demolitions or house building, stating that "*where there are grounds to confidently predict changes in the affected number of households between the without scheme and with scheme cases, this should be reflected in the appraisal*". The intention is that the Eastern Bypass and Western Relief Road would act as a catalyst for local development and to this end land parcels have been determined along the Eastern Bypass and Western Relief Road (see **Figure 11.1** in **Appendix A**). However, plans are not fully developed and details on the type and layout of future buildings are insufficient to allow meaningful noise predictions. For this reason future dwellings have not been included in the monetary valuation of noise impacts, although the potential noise levels affecting each associated development parcel are considered in Section 11.4 commencing at paragraph 11.4.27.

11.2.11. The CRTN has been used to predict road traffic noise levels in terms of $L_{A10,18h}$. The following corrections have been used to calculate relevant daytime and night-time noise levels for use in the TAG Unit A3 assessment:

- $L_{Aeq,16h} = L_{A10.18h} – 2$ dB (from paragraph 2.2.13 of TAG Unit A3); and
- $L_{night} = 0.90 \times L_{A10,18h} – 3.77$ dB (from TRL Report PR/SE/451/02, Method 3 for non-motorway roads).

[70] Design Manual for Roads and Bridges (DMRB). Volume 11 Environmental Assessment. Section 3 Environmental Assessment Techniques. Part 7 HD 213/11 – Revision 1 – Noise and Vibration. The Highways Agency, Transport Scotland, Welsh Government and the Department for Regional Development Northern Ireland. 2011.
[71] Design Manual for Roads and Bridges. Sustainability & Environmental Appraisal. LA 111 Noise and Vibration Revision 2. Highways England. 2020.
[72] The Calculation of Road Traffic Noise. The Department of Transport and Welsh Office. 1988

11.2.12. The output from quantification process is a matrix of households experiencing different noise levels in the scenarios with and without the Eastern Bypass and Western Relief Road. The noise levels are defined in 3 dB wide bands running from 45 dB to 81 dB for both $L_{Aeq,16h}$ and L_{night}.

11.2.13. The calculations have been carried out for the Eastern Bypass and Western Relief Road opening year and a forecast (or future) year 15 years after opening:

- do-minimum, opening year 2024, (without Bypass and Relief Road)[73];
- do-something, opening year 2024, (with Bypass and Relief Road)[74];
- do-minimum, forecast year 2039, (without Bypass and Relief Road); and
- do-something, forecast year 2039, (with Bypass and Relief Road).

11.2.14. The noise model has been used to predict receptor specific noise levels at a height of 4 metres. The façade subject to the greatest magnitude of change has been used in the analysis in line with the guidance in DMRB LA 111.

11.2.15. It should be noted that paragraph 2.2.17 of TAG Unit A3 notes the following regarding night-time impacts "*As well as through the monetisation process described in step three below, night noise impacts should be assessed by determining the number of households where the WHO Interim Night Noise Target of 55 dB L_{night} noise level is exceeded for the last forecast year in the with and without scheme cases*". For this analysis, it is considered appropriate to use a different sift mechanism, based on the highest noise level, to derive a representative noise level for each dwelling. This is because the use of the façade with the greatest magnitude of noise change may not identify the highest noise level affecting the property.

Estimation of the Affected Population (Step 3)

11.2.16. The matrix of the numbers of residential receptors experiencing without Bypass and Relief Road and with Bypass and Relief Road noise levels in 3 dB bands for $L_{Aeq,16h}$ and L_{night} have been entered into the TAG Noise Workbook to estimate the likely affected population and to monetise the impact.

11.2.17. The TAG Noise Workbook contains dose-response functions for each impact pathway (see paragraph 11.2.2) for road traffic noise. These functions describe, at different noise levels, the percentage of the population affected (for sleep disturbance and annoyance/amenity) or the increased risk of adverse health outcomes (for acute myocardial infarction (AMI), stroke and dementia).

11.2.18. These relationships, in combination with the matrix of information generated during Step 2 (regarding the number of households experiencing different with Bypass and Relief Road and without Bypass and Relief Road noise levels), can be used to estimate the number of people affected under each impact pathway.

11.2.19. The TAG Noise Workbook goes on to develop per household, marginal monetary values for each impact pathway (based on an average of 2.3 people per household). These values are contained

[73] In this chapter the terms 'do-minimum' and 'without Bypass and Relief Road' have been used interchangeably
[74] In this chapter the terms 'do-something' and 'with Bypass and Relief Road' have been used interchangeably

within the workbook and so the estimation of the population affected for each impact pathway is effectively subsumed within the monetary valuation described in the next sub-section (Step 4 – see below).

Monetary Valuation of Noise Impacts (Step 4)

11.2.20. The TAG Noise Workbook generates the following outputs, which are intended to complement each other:

- the net present value of the change in noise, both as an overall value and broken down into the five impact pathways; and
- quantitative results in the form of the number of households experiencing increased or decreased noise in the forecast year during the day and night.

11.2.21. The monetary valuation is based on the estimation of the number of Disability-Adjusted Life Years (DALYs) lost (or gained) under each impact pathway, taking into account a value of £60,000 per DALY.

Design Manual for Roads and Bridges (DMRB), LA 111 Noise and Vibration

11.2.22. Design Manual for Roads and Bridges (DMRB) LA 111 Noise and Vibration was first published in November 2019 (and most recently updated in May 2020) and supersedes its predecessor DMRB HD 213/11 Noise and Vibration.

11.2.23. The document sets out the requirements for noise and vibration assessments from road projects, applying a proportionate and consistent approach using best practice and ensuring compliance with relevant legislation. A fundamental aim of the assessment is that likely significant effects on sensitive receptors within the relevant study areas should be determined and reported.

11.2.24. Perception of changes in noise is different depending on whether the change is sudden (e.g. in the short-term when a road scheme is opened) or more gradual (i.e. in the long-term, over time). Therefore, different scales are identified in DMRB LA 111 for short-term (Table 3.54a) and long-term (Table 3.54b). These tables are combined in **Table 11-2**.

Table 11-2 – Magnitude of Change – Short-term and Long-term

Magnitude	Noise change, dB LA10,18h or Lnight Short-term	Noise change, dB LA10,18h or Lnight Long-term
Major	Greater than or equal to 5.0	Greater than or equal to 10.0
Moderate	3.0 – 4.9	5.0 – 9.9
Minor	1.0 – 2.9	3.0 – 4.9
Negligible	Less than 1.0	Less than 3.0

11.2.25. A DMRB LA 111 assessment shall determine whether a change of 1 dB or more in the short-term and/or 3 dB or more in the long-term is anticipated (i.e. an impact of minor magnitude).

11.2.26. The assessment should consider beneficial as well as adverse impacts and include both short-term and long-term changes, which are defined as follows:

- short-term: do-minimum, opening year 2024 vs. do-something opening year 2024;
- long-term: do-minimum, opening year 2024 vs. do-something forecast year 2039; and
- long-term: do-minimum, opening year 2024 vs. do-minimum, forecast year 2039.

11.2.27. To help determine likely significance, it is also useful to establish the LOAEL (the lowest observed adverse effect level) and SOAEL (significant observed adverse effect level) for all sensitive receptors[75]. The LOAELs and SOAELs for operational road traffic noise are defined in Table 3.49.1 in DMRB LA 111 and reproduced in **Table 11-3**.

Table 11-3 – LOAEL and SOAEL for Operational Road Traffic Noise

Time period	LOAEL	SOAEL
Day (06:00 – 24:00)	55 dB $L_{A10,18h}$ (façade)	68 dB $L_{A10,18h}$ façade
Night (23:00 – 07:00)	40 dB $L_{night,outside}$ (free-field)	55 dB $L_{night,outside}$ (free-field)

Calculation of Road Traffic Noise (CRTN), 1988

11.2.28. The CRTN memorandum describes the procedures for calculating noise from road traffic. The factors which may influence road traffic noise levels at source can be divided into two groups:

- road related factors - gradient and surface type; and
- traffic related factors - flow, speed and the proportion of heavy-duty vehicles.

11.2.29. The Basic Noise Level (BNL) is described in the CRTN. It does not relate to any specific receptor, but rather is a measure of source noise, at a reference distance of 10 m from the nearside carriageway edge of a specific length of highway. It is determined by obtaining the estimated noise level from the 18-hour traffic flow and then applying corrections for vehicle speed, percentage of heavy vehicles, gradient and road surface as described in CRTN.

11.2.30. The propagation of noise is also covered in CRTN and includes corrections for distance and, if appropriate, either ground cover or screening. Other receptor specific corrections include the (angle of) view of the road and reflections either from the façade of the receptor and or from reflecting structures on the far side of the road.

STUDY AREA

11.2.31. DMRB LA 111 includes (in paragraph 3.44, Note 1) the following advice on the extent of a suitable study area for the operational road traffic assessment, although it is acknowledged that the study area can be varied for individual projects.

[75] The LOAEL and SOAEL are health-based terms. The LOAEL is level above which adverse effects on health and quality of life can be detected, The SOAEL is the level above which significant adverse effects on health and quality of life occur. See the Noise Policy Statement for England (NPSE – published in March 2010 by Defra) for further details.

'An operational study area defined as the following can be sufficient for most projects, but it can be reduced or extended to ensure it is proportionate to the risk of likely significant effects:

1) the area within 600 m of new road links or road links physically changed or bypassed by the project;

2) the area within 50 m of other road links with potential to experience a short term BNL change of more than 1.0 dB(A) as a result of the project.'

11.2.32. For this TAG Unit A3 assessment and in line with DMRB LA 111 guidance, the main study area has been determined based on a 600 m buffer around the Eastern Bypass and Western Relief Road and the existing road links relieved by the Bypass and Relief Road. Detailed road traffic noise predictions have been undertaken at all receptors within this area. The do-something road links and the 600 m buffer are shown in **Figure 11.1** in **Appendix A**.

11.2.33. However, there is potential for the Eastern Bypass and Western Relief Road to have an impact beyond the main study area. Consequently, a preliminary BNL assessment has been undertaken along the wider road network (i.e. outside the main study area and within the Traffic Reliability Area[76]) using the traffic data used in the development of the OBC.

DATA SOURCES

11.2.34. The data sources used in this appraisal comprise:

- OS MasterMap from Ordnance Survey;
- OS AddressBase Plus from Ordnance Survey;
- 1 m 2019 DTM (digital terrain model) Lidar from the Defra survey data download website;
- 3d engineering drawings of the Eastern Bypass (ACAD-LSB Surface Export (P02) 15-10-2020, dated 15/10/2020) and 2d engineering drawings of the Western Relief Road (369-SP Land East Masterplan, dated 01/06/2020) that were available at the time of preparation of the OBC; and
- traffic data (flow, composition and speed) used in the development of the OBC for individual links within the Traffic Reliability Area.

11.2.35. These data have been utilised as set out in **Table 11-4**.

[76] Referred to as the Model Study Area within the Local Model Validation Report submitted as part of the OBC.

Table 11-4 – Data Utilised in the TAG Unit A3 Appraisal

Model Layer	Existing Model	Future Model
Roads	All roads aligned to OS MasterMap base mapping. Relevant traffic data for the do-minimum scenarios (opening and forecast years) have been assigned to each link.	For existing roads unaffected by the Eastern Bypass and Western Relief Road, as for Existing Model. The Bypass and Relief Road have been aligned with engineering drawings. Relevant traffic data for the do-something scenarios (opening and forecast years) have been assigned to each link.
Bridge	N/A	3d engineering drawings were used to align the bridge carrying Hall Lane over the Eastern Bypass in the do-something scenarios.
Topography	1 m 2019 DTM lidar used to generate height contours at 0.5 m spacing	As for existing topography, except for the Eastern Bypass where 3d engineering drawings were used to generate height contours at 0.1 m spacing along the length of this route. 3d engineering drawings were not available for the Western Relief Road, so this route has been modelled 'at grade' on top of the topography generated using the 1 m 2019 DTM lidar.
Buildings	Polygonised footprints extracted from OS MasterMap	Polygonised footprints extracted from OS MasterMap
Calculation points	OS AddressBase Plus data used to identify the use of the building	OS AddressBase Plus data used to identify the use of the building

11.3 KEY CONSTRAINTS

IDENTIFIED SENSITIVE RECEPTORS

11.3.1. Existing residential receptors within the study area have been identified using OS AddressBase® data in combination with information on the location of buildings taken from provided OS MasterMap data. A total number of 2,067 dwellings are located within the main study area (see paragraph 11.2.32) and have, therefore, been included within the assessment.

11.3.2. In addition, TAG Unit A3 requires that consideration be given to other noise-sensitive non-residential receptors such as schools or hospitals (see paragraph 11.2.6). These include the following receptors, which have been identified within the main study area (as described in paragraph 11.2.32).

Table 11-5 – Other Noise Sensitive Non-residential Receptors

Use	Address
Community	Village Hall, Ipswich Road, Long Stratton, NR15 2TA
Education	Jack in the Box Nursery, Manor Road, Long Stratton, NR15 2XR
Education	Manor Field Infant & Nursery, Manor Road, Long Stratton, NR15 2XR

Use	Address
Education	St Mary's C of E Junior School, Swan Lane, Long Stratton, NR15 2UY
Education	Long Stratton High School, Manor Road, Long Stratton, NR15 2XR
Place of Worship	St Mary's Church, Ipswich Road, Long Stratton
Place of Worship	St Michael's Church, Church Lane, Stratton St Michael
Place of Worship	Long Stratton Methodist Church, Manor Road, Long Stratton, NR15 2XS
Place of Worship	Congregational Church, Ipswich Road, Long Stratton, NR15 2TF
Medical / Care	Long Stratton Health Centre, Flowerpot Lane, Long Stratton, NR15 2TS
Medical / Care	Long Stratton Medical Partnership, Swan Lane, Tharston, NR15 2UY
Medical / Care	Harker House, Flowerpot Lane, Long Stratton, NR15 2TS
Medical / Care	The Mayfields Care Home, Swan Lane, Long Stratton, NR15 2UY
Medical / Care	Trafalgar Lodge, 70 Swan Lane, Long Stratton, NR15 2UY
Medical / Care	Nelson Lodge, 72 Swan Lane, Long Stratton, NR15 2UY

ASSOCIATED DEVELOPMENT

11.3.3. As noted previously, the intention is that the Eastern Bypass and Western Relief Road will act as a catalyst for associated development on adjacent land parcels.

11.3.4. These parcels are identified in **Figure 11.1** in **Appendix A** and described further in the table below for associated development adjacent to the Eastern Bypass. Currently, only the size and location of the development parcels adjacent to the Western Relief Road are known, as shown on **Figure 11.1** in **Appendix A**.

Table 11-6 – Associated Development – Eastern Bypass

Proposed Use	Number	Area (Ha)	Dwelling Units *
Residential	13 parcels	36.5 (total)	1168 – 1277
Community	-	0.7	-
Education	-	2.0	-
Employment	Three parcels	8.4 (total)	-
Potential further land	Four parcels	14.6 (total)	469 – 512

Note:
* Unit numbers taken from drawing 369-SP Land East Masterplan, dated 01/06/2020 and based on a density of 32-35 units per hectare

DEFRA IMPORTANT NOISE AREAS

11.3.5. The Government, through consultation with Defra and local authorities, has prioritised areas where people are most exposed to noise and are at greatest risk of experiencing significant adverse impact to health and quality of life as a result of their exposure to noise. These identified areas are termed 'Noise Important Areas' (NIAs).

11.3.6. The NIAs falling within the noise study area are tabulated below (from north to south) and are illustrated in **Figure 11.1** in **Appendix A**. These are all owned by Norfolk County Council (the highway authority).

Table 11-7 – Noise Important Areas

NIA	Length	Location	Location
5014	65 m	A140 – west side	Immediately south of Brand's Lane
5013	1190 m	A140 – both sides	Running the length of Long Stratton
5012	270 m	A140 – both sides	Immediately south of Parkers Lane
11318	415 m	A140 – west side	Immediately north of where the Eastern Bypass would re-join the current line of the A140 at its southern end

BASELINE NOISE LEVELS

11.3.7. Although not required for the TAG Unit A3 analysis, noise level contours without the Eastern Bypass and Western Relief Road have been produced for the base year of 2017. These are presented in **Figure 11.2** in **Appendix A** and confirm that road traffic using the A140 through Long Stratton dominates the noise climate in the study area.

11.3.8. At this stage a baseline noise survey has not been undertaken by WSP. However, in 2017, a noise survey was undertaken in the area by others, as reported within the noise chapter of an Environmental Statement (ES) relating to a previous iteration of the Proposed Scheme and published in November 2017.

11.3.9. The survey was conducted between June and September 2017 (excluding the school holiday period) at eleven locations surrounding the Proposed Scheme. The measurements were limited to the daytime period and were conducted over short periods, with the $L_{A10,18h}$ being estimated from the $L_{A10,3h}$ measured between 10:00 and 17:00 hours, by subtracting 1 dB, in line with the guidance contained in the CRTN.

11.3.10. The $L_{A10,18h}$ was estimated at eight of the eleven locations as reported in Table 12.13 of the 2017 ES. With a single exception, the estimated $L_{A10,18h}$ levels range between 43 dB and 56 dB depending on proximity of the local noise sources, but particularly the A140. The exception was at a location reported to be five metres from the edge of the A140, where the estimated $L_{A10,18h}$ level was 76 dB.

11.4 APPRAISAL

TAG UNIT A3 APPRAISAL SUMMARY

11.4.1. The output spreadsheet from the TAG Unit A3 Noise Workbook is provided in **Appendix C**.

11.4.2. The results of the noise appraisal are summarised below. These have been generated by analysing data for each residential receptor based on the façade with the greatest magnitude of noise change:

- In the forecast year, 703 households would experience an increase in daytime noise, whilst 646 households would experience a decrease in daytime noise.
- In the forecast year, 50 households would experience an increase in night-time noise, whilst 354 households would experience a decrease in night-time noise.
- The overall appraisal indicates that the operation of the Eastern Bypass and Western Relief Road is likely to generate a beneficial noise impact and that the 'net present value of change in noise' is calculated to be £6,075,704.
- The impact pathways described earlier in this chapter have been assessed, and the Eastern Bypass and Western Relief Road are likely to generate a beneficial effect for all pathways. The following net present values have been calculated:
  - Sleep disturbance: £2,676,378
  - Amenity: £2,187,834
  - AMI: £698,114
  - Stroke: £204,724
  - Dementia: £308,655.

OUTLINE NOISE IMPACT ASSESSMENT

11.4.3. The primary objective of this commission has been to undertake a TAG Unit A3 noise appraisal to help inform the OBC. However, it has also been possible to gain an initial appreciation of the magnitude and geographical extent of likely noise impacts through further consideration of noise levels and noise changes as described below.

Noise Level Contours

11.4.4. The noise model has been used to generate the following noise level contour plots in terms of $L_{A10,18h}$ (figures located in **Appendix A)**:

- **Figure 11.3**: do-minimum, opening year 2024, without Bypass and Relief Road;
- **Figure 11.4**: do-something, opening year 2024, with Bypass and Relief Road;
- **Figure 11.5**: do-minimum, forecast year 2039, without Bypass and Relief Road; and
- **Figure 11.6**: do-something, forecast year 2039, with Bypass and Relief Road.

Noise Change Contours

11.4.5. The noise level contours have been further processed to generate the following noise change contour plots in terms of $L_{A10,18h}$:

- **Figure 11.7**: short-term: do-minimum, opening year 2024 vs. do-something, opening year 2024;
- **Figure 11.8:** long-term: do-minimum, opening year 2024 vs. do-something, forecast year 2039; and
- **Figure 11.9**: long-term: do-minimum, opening year 2024 vs. do-minimum, forecast year 2039.

DMRB LA 111 Noise Change Tables for Dwellings

11.4.6. Predictions have been carried out for a total of 2067 residential receptors within the main study area. Noise level changes for the short-term and long-term are presented in **Table 11-8** and **Table 11-9** respectively, based on the façade subject to the greatest magnitude of noise change at each receptor. **Figure 11.8** in **Appendix A** presents a long-term noise change contour map showing the areas where noise levels increase and decrease with the Eastern Bypass and Western Relief Road in the long-term. **Figure 11.9** in **Appendix A** presents a long-term noise change contour map showing the areas where noise levels increase and decrease without the Eastern Bypass and Relief Road.

Short-term Noise Level Changes (2024)

11.4.7. **Table 11-8** shows the predicted short-term change in noise level for all modelled receptors within the study area, sorted into the noise change bands following DMRB LA 111 magnitude of impact categories.

11.4.8. **Figure 11.7** in **Appendix A** presents a short-term noise change contour map showing the areas where noise levels increase and decrease with the Eastern Bypass and Western Relief Road in the short-term.

Table 11-8 – Short-term Noise Changes at Dwellings

Change in noise level dB(A)	Change in noise level dB(A)	Magnitude of impact	Do-something Daytime	Do-something Night-time
Increase in noise level $L_{A10,18h}$ / L_{night}	0.1 – 0.9	Negligible adverse	96	121
Increase in noise level $L_{A10,18h}$ / L_{night}	1.0 – 2.9	Minor adverse	659	658
Increase in noise level $L_{A10,18h}$ / L_{night}	3.0 – 4.9	Moderate adverse	157	159
Increase in noise level $L_{A10,18h}$ / L_{night}	≥ 5.0	Major adverse	159	132
No change	0	No change	0	0
Decrease in noise level	0.1 – 0.9	Negligible beneficial	64	75

$L_{A10,18h}$ / L_{night}				
Decrease in noise level $L_{A10,18h}$ / L_{night}	1.0 – 2.9	Minor beneficial	310	368
Decrease in noise level $L_{A10,18h}$ / L_{night}	3.0 – 4.9	Moderate beneficial	233	193
Decrease in noise level $L_{A10,18h}$ / L_{night}	≥ 5.0	Major beneficial	389	361

11.4.9. It can be seen from **Table 11-8** that the magnitude of short-term noise impacts as a result of the Eastern Bypass and Western Relief Road range from major adverse to major beneficial. Broadly the impacts are similar during the day and night. Specifically, there are 316 dwellings with an adverse impact of moderate or major magnitude during the day, whilst nearly double that number of dwellings (622) are predicted to have a beneficial impact of moderate or major magnitude during the day.

11.4.10. A characteristic pattern of noise impacts is anticipated with the Eastern Bypass and Western Relief Road:

- noise decreases for many properties in the centre of Long Stratton; and
- noise increases at relatively fewer properties on the eastern fringe of Long Stratton and at scattered locations to the east.

11.4.11. This pattern is apparent in **Figure 11.10** in **Appendix A**, which shows the location of the properties with short-term do-something daytime noise impacts of major magnitude (159 noise increases and 389 noise decreases).

11.4.12. The following should be considered before drawing conclusions on the likely significance of the adverse impacts:

- where receptors are remote from road traffic sources, predicted noise levels may be lower than they are in reality due to the absence of other contributing sources (e.g. wildlife, agriculture and domestic activity). This in turn means that the predicted noise increases could be greater than they are in reality;
- although relatively large noise increases are predicted with the Eastern Bypass and Western Relief Road, the overall noise levels would not be that high at many properties. For example, of the 159 receptors with an adverse impact of major magnitude, only five are predicted to have a

do-something noise levels in the opening year above the LOAEL, which can be taken as marking the onset of adverse health effects; and

- the noise calculations are based on the situation without any future buildings within the associated development parcels. It is likely that the majority of properties with adverse impacts of moderate and major magnitude would benefit from screening afforded by associated development yet to be constructed in the intervening area between the Eastern Bypass and the eastern fringes of Long Stratton.

Long-term Noise Level Changes (2036)

11.4.13. **Figure 11.8** in **Appendix A** presents a long-term noise change contour map showing the areas where noise levels increase and decrease with the Eastern Bypass and Western Relief Road in the long-term. **Figure 11.9** in **Appendix A** presents a long-term noise change contour map showing the areas where noise levels increase and decrease without the Bypass and Relief Road.

11.4.14. **Table 11-9** shows the predicted long-term change in noise level for all modelled receptors within the study area, sorted into the noise change bands following DMRB LA 111 magnitude of impact categories. The table includes figures for the situation with and without the Eastern Bypass and Western Relief Road.

11.4.15. **Figure 11.8** in **Appendix A** presents a long-term noise change contour map showing the areas where noise levels increase and decrease with the Eastern Bypass and Western Relief Road in the long-term. **Figure 11.9** in **Appendix A** presents a long-term noise change contour map showing the areas where noise levels increase and decrease without the Bypass and Relief Road.

Table 11-9 – Long-term Noise Changes at Dwellings

Change in noise level dB(A)	Change in noise level dB(A)	Magnitude of impact	Do-something Daytime	Do-something Night-time	Do-minimum Daytime	Do-minimum Night-time
Increase in noise level $L_{A10,18h}$ / L_{night}	0.1 – 2.9	Negligible adverse	672	826	2051	2051
Increase in noise level $L_{A10,18h}$ / L_{night}	3.0 – 4.9	Minor adverse	411	283	0	0
Increase in noise level $L_{A10,18h}$ / L_{night}	5.0 – 9.9	Moderate adverse	201	186	0	0
Increase in noise	≥ 10.0	Major adverse	28	9	0	0

Change in noise level dB(A)	Change in noise level dB(A)	Magnitude of impact	Do-something Daytime	Do-something Night-time	Do-minimum Daytime	Do-minimum Night-time
level $L_{A10,18h}$ / L_{night}						
No change	0	No change	0	0	1	1
Decrease in noise level $L_{A10,18h}$ / L_{night}	0.1 – 2.9	Negligible beneficial	293	332	15	15
Decrease in noise level $L_{A10,18h}$ / L_{night}	3.0 – 4.9	Minor beneficial	129	126	0	0
Decrease in noise level $L_{A10,18h}$ / L_{night}	5.0 – 9.9	Moderate beneficial	276	280	0	0
Decrease in noise level $L_{A10,18h}$ / L_{night}	≥ 10.0	Major beneficial	57	15	0	0

11.4.16. It can be seen from **Table 11-9** that the magnitude of long-term noise impacts as a result of the Eastern Bypass and Western Relief Road range from major adverse to major beneficial. Broadly the impacts are similar during the day and night.

11.4.17. The long-term noise impacts without the Eastern Bypass and Western Relief Road are of negligible magnitude, with the vast majority subject to a negligible increase in noise over time.

Noise Changes at Other Sensitive Receptors

11.4.18. The TAG Unit A3 analysis and monetary valuation focusses on residential buildings, but notes that where impacts on other potentially noise sensitive receptors such as schools or hospitals are likely to be significant they should be reported separately.

11.4.19. **Table 11-10** reports the predicted change in noise in the short-term and long-term with the Eastern Bypass and Western Relief Road. The long-term changes without the Bypass and Relief Road are also noted. The noise change and magnitude of impact (beneficial and adverse) are reported.

Table 11-10 – Other Noise Sensitive Receptors – Daytime Noise Change

Receptor	Short-term Do-something	Short-term Do-something	Long-term Do-something	Long-term Do-something	Long-term Do-minimum	Long-term Do-minimum
Community Village Hall	-10.9	Maj ben	-9.2	Mod ben	+0.4	Neg adv
Education Jack in the Box Nursery	+1.9	Min adv	+2.5	Neg adv	+0.5	Neg adv
Education Manor Field Infant & Nursery	+2.4	Min adv	+3.1	Min adv	+0.5	Neg adv
Education St Mary's C of E Junior School	+2.8	Min adv	+4.4	Min adv	+0.5	Neg adv
Education Long Stratton High School	+2.2	Min adv	+2.5	Neg adv	+0.6	Neg adv
Place of Worship St Mary's Church	-11.1	Maj ben	-9.5	Mod ben	+0.5	Neg adv
Place of Worship St Michael's Church	+13.4	Maj adv*	+14.1	Maj adv*	+0.9	Neg adv
Place of Worship Long Stratton Methodist Church	+3.9	Mod adv	+4.7	Min adv	+0.5	Neg adv
Place of Worship Congregational Church	-11.9	Mag ben	-10.1	Maj ben	+0.4	Neg adv
Health / Care Long Stratton Health Centre	-2.1	Min ben	+1.0	Neg adv	+0.4	Neg adv
Health / Care Long Stratton Medical Partnership	+3.1	Mod adv*	+5.0	Mod adv*	+0.5	Neg adv
Health / Care Harker House	-2.2	Min ben	+2.2	Neg adv	+0.4	Neg adv
Health / Care The Mayfields Care Home	+2.2	Min adv	+3.2	Min adv	+0.5	Neg adv
Health / Care Trafalgar Lodge, 70 Swan Lane	+6.0	Maj adv*	+7.9	Mod adv*	+0.4	Neg adv
Health / Care Nelson Lodge, 72 Swan Lane	+7.7	Maj adv*	+9.4	Mod adv*	+0.4	Neg adv

Notes:

All changes are relative to the opening year do-minimum (without the Eastern Bypass and Western Relief Road)

Neg = negligible, Min = minor, Mod = moderate, Maj = major, adv = adverse and ben = beneficial

* the do-something noise level at the position of the stated change is below the daytime SOAEL of 55 dB $L_{A10,18h}$ (façade)

Table 11-11 – Other Noise Sensitive Receptors – Night-time Noise Change

Receptor	Short-term Do-something	Short-term Do-something	Long-term Do-something	Long-term Do-something	Long-term Do-minimum	Long-term Do-minimum
Health / Care Harker House	-2.0	Min ben	+1.9	Neg adv	+0.4	Neg adv
Health / Care The Mayfields Care Home	+2.0	Min adv	+2.9	Min adv	+0.5	Neg adv
Health / Care Trafalgar Lodge, 70 Swan Lane	+5.4	Maj adv	+7.1	Mod adv	+0.4	Neg adv
Health / Care Nelson Lodge, 72 Swan Lane	+7.0	Maj adv*	+8.5	Mod adv*	+0.4	Neg adv

Notes:

All changes are relative to the opening year do-minimum (without the Eastern Bypass and Western Relief Road)

Neg = negligible, Min = minor, Mod = moderate, Maj = major, adv = adverse and ben = beneficial

* the do-something noise level at the position of the stated change is below the daytime SOAEL of 55 dB $L_{A10,18h}$ (façade)

Adverse Effect Levels

11.4.20. Paragraph 2.2.7 of TAG Unit A3 states "*As well as through the monetisation process described in step three below, night noise impacts should be assessed by determining the number of households where the WHO Interim Night Noise Target of 55 dB L_{night} noise level is exceeded for the last forecast year in the with and without scheme cases*".

11.4.21. In **Table 11-12** below, these two values can be found in the right hand column of the last do-minimum scenario (row 4) and the last do-something scenario (row 8).

11.4.22. As noted in paragraph 11.2.15 a different sift mechanism has been used to derive a representative noise level for each dwelling. For this analysis the highest level, rather than the greatest magnitude of change has been used.

Table 11-12 – Numbers of Dwellings Relative to Health Effect Levels

Scenario	Period	Year	Less than LOAEL	From LOAEL to SOAEL	Greater than or equal to SOAEL
Do-minimum	Day	Opening	1351	535	181
Do-minimum	Day	Forecast	1330	549	188
Do-minimum	Night	Opening	1129	761	177
Do-minimum	Night	Forecast	1106	775	186
Do-something	Day	Opening	1484	571	12

Do-something	Day	Forecast	1428	627	12
Do-something	Night	Opening	1275	780	12
Do-something	Night	Forecast	1176	879	12

Notes:
Daytime (06:00-24:00) $L_{A10,18h}$ façade – LOAEL = 55 dB and SOAEL = 68 dB
Night-time (23:00-07:00) $L_{night,outside}$ free-field – LOAEL = 40 dB and SOAEL = 55 dB

11.4.23. It can be seen that there are far fewer dwellings subject to a SOAEL as a result of the Eastern Bypass and Western Relief Road. This is the case for the day and night periods and for opening and forecast years.

Wider Road Network

11.4.24. As noted in paragraph 11.2.33 there is potential for the Eastern Bypass and Western Relief Road to have an impact beyond the main study area. Consequently, a preliminary BNL assessment has been undertaken along the wider road network (i.e. outside the main study area and within the Traffic Reliability Area) using the traffic data used in the development of the OBC.

11.4.25. This BNL assessment has used the 18-hour flow and vehicle mix and speed to estimate the likely change in noise in the short-term and long-term with the Eastern Bypass and Western Relief Road along each individual link within the wider road network. The following limitations apply to this analysis:

- links where flows are below 1,000 in all scenarios, have been excluded from the analysis;
- no low-flow correction has been applied where flows are between 1,000 and 4,000;
- where the flow in one or more scenarios is below 1,000, but above 1,000 in the remaining scenario(s), no adjustment has been made to any of the flows; and
- no correction has been made in the calculations for road gradient or road surface.

11.4.26. This preliminary analysis has identified that the majority of links have changes of no greater than negligible magnitude. However, there are three links where short-term benefits of minor magnitude (i.e. noise decreases between 1 dB and 3 dB) are anticipated:

- Diss Road and Fen Road between Long Row (to the south) and The Turnpike (to the north);
- Hall Road and Goose Green north of Winfarthing; and
- The Street between Fritton (to the south) and the B1527.

Associated Development

11.4.27. As noted in paragraph 11.2.10 associated development is planned adjacent to the Eastern Bypass and Western Relief Road.

11.4.28. Plans are not fully developed and details on the type and layout of future buildings are insufficient to allow meaningful noise predictions. Therefore, associated development has not been included in the TAG Unit A3 monetary valuation presented above.

11.4.29. Nevertheless, the noise level contour plots (**Figure 11.3** to **Figure 11.6** in **Appendix A**) and noise change contour plots (**Figure 11.7** to **Figure 11.9** in **Appendix A**) provide some indication of the noise levels likely to affect the associated development parcels.

11.4.30. It should be pointed out that these are open site noise contours. Once construction has commenced, the pattern of noise across each associated development parcel is likely to change dramatically as buildings can both screen and reflect noise. This means, for example, that new buildings constructed near the Eastern Bypass and Western Relief Road will result in reduced noise levels at new buildings constructed further away.

11.4.31. It is also the case that noise levels at existing receptors will be affected by the Proposed Scheme. So, for example, properties on the eastern fringe of Long Stratton with a major adverse change from the Eastern Bypass and Western Relief Road are likely to benefit as a result of the screening afforded by new buildings constructed in the intervening area.

KEY FINDINGS OF THE APPRAISAL PROCESS

11.4.32. A noise appraisal has been undertaken following the methodology presented in TAG Unit A3, Environmental Impact Appraisal, dated May 2019.

11.4.33. A 3-dimensional digital noise model has been generated based on the guidance contained within CRTN and the DMRB LA 111.

11.4.34. The affected population has been estimated and the monetary valuation of changes in noise impact has been determined using the TAG Unit A3 Noise Appraisal Workbook (see **Appendix C**).

11.4.35. The overall appraisal indicates that the operation of the Eastern Bypass and Western Relief Road, without mitigation, is likely to generate a beneficial noise impact, and the 'net present value of change in noise' is calculated to be £6,075,704.

11.4.36. It is anticipated that the Eastern Bypass and Western Relief Road would generate a characteristic pattern of noise impacts:

- noise decreases for many properties in the centre of Long Stratton; and
- noise increases at relatively fewer properties on the eastern fringe of Long Stratton and at scattered locations to the east.

11.4.37. Mitigation measures will need to be considered at a later stage and as necessary to minimise adverse impacts arising from the operation of the Eastern Bypass and Western Relief Road at residential and other sensitive receptors. The feasibility of implementing noise barriers and a low-noise road surface should be explored. Biodiversity, engineering and landscape constraints may also influence the design of appropriate mitigation measures.

PROPOSED NEXT STEPS

11.4.38. It is understood that with respect to planning the next steps are likely to comprise:

- An update or amendment to the planning applications, which in turn will require:
  - consideration of the noise implications of changes to the design of the Proposed Scheme; and
  - the preparation of an ES addendum.

11.4.39. More specifically, consideration will need to be given, at the appropriate time, to the following:

- the need for a noise survey. The survey could be used in a number of ways, for example, to check output from the noise model, to confirm the difference between daytime and noise-time noise levels and to determine the threshold categories for the construction noise assessment;
- the evolution and refinement of the current noise model. In particular, the model could be updated to reflect the latest alignment of the Eastern Bypass and the earthworks associated with the Western Relief Road. If traffic data change, then these too should be included;
- the need for a construction noise and vibration assessment in line with DMRB LA 111;
- the likely impacts and associated significance of effects arising from the Eastern Bypass and Western Relief Road; and
- the need for mitigation measures to minimise any significant adverse effects.

12 POPULATION AND HEALTH

12.1 INTRODUCTION

12.1.1. This chapter presents an appraisal of the key Population and Health constraints of the Proposed Scheme.

12.2 APPRAISAL METHODOLOGY

OVERVIEW OF METHODOLOGY

12.2.1. This section sets out the study area for the Population and Human health chapter. The methodology used within 2017 ES followed the socio-economics assessment approach without the consideration of Population and Human health. For the purposes of this appraisal the methodology of the assessment has been updated by incorporating the current Design Manual for Roads and Bridges (DMRB) guidance LA 112 Population and Human health[77] with the socio-economic assessment.

STUDY AREA

12.2.2. This section details the study area used to assess each Population and Human health criteria.

12.2.3. The study area used in the 2017 ES was largely based on the Lower Super Output Areas South Norfolk 011D, 011E and 011F (the parishes of Tharston & Hapton, Wacton and Long Stratton). Updated DMRB LA 112 guidance recommends a 500m study area, and therefore the study areas within this appraisal have been revised where relevant to reflect the updates in guidance.

Private property and housing, Community land and assets, Development land and businesses and Walkers, cyclists and horse-riders (WCH)

- Private properties, housing development, community facilities, recreational facilities (including open spaces), businesses, land parcels of employment allocation, Public rights of way (PRoW) and non-designated routes that lie within 500m of the Site, or those which have a direct means of access within the Site.

Agricultural land holdings

- Agricultural land holdings which manage or own land parcels of agricultural land that lie within the Site, or those which have a direct means of access within the Site. It is unlikely that significant effects would occur for land holdings beyond the Site, where access is not affected.

Human Health

12.2.4. The study area for human health has been based on the smallest denomination boundary for the Proposed Scheme where possible. The Proposed Scheme is located within the ward of Stratton and therefore it is the community that is most likely to be impacted by the Proposed Scheme.

[77] DMRB guidance (2020), LA 112 Population and Human health.

12.2.5. However, indirect impacts are still likely to be felt in the wider area and a number of relevant datasets are only available at a district level. Various area profiles have been used for these assessments and they are provided below:

- National: England;
- Region: East of England;
- County: Norfolk County Council;
- Local Authority / District Council: South Norfolk Council; and
- Ward: Stratton.

Socio-economics

12.2.6. The study areas for different sub-categories assessed under socio-economics are listed as follows:

- Employment: East of England;
- Housing: Local authority / district level;
- Education: Primary education of 2km radius of the Site / Secondary education of 4.5km from the Site;
- Primary healthcare: 1km from the Site; and
- Open space and play space: 500m from the Site.

DATA SOURCES

12.2.7. The data sources used in this appraisal comprise:

- 2017 ES Chapter 5 Society and Economy and Chapter 16 Soils and Agriculture;
- Ordnance Survey (OS) Mapping;
- MAGIC Map[78];
- Norfolk interactive maps[79,80];
- South Norfolk Council website;
- Long Stratton Area Action Plan[81];
- Public Health England Public Health Profiles;
- Indices of Multiple Deprivation[82];
- NOMIS[83]; and

[78] DEFRA (2018), MAGIC Map. Available online at: https://magic.defra.gov.uk/MagicMap.aspx [Last accessed: 07/10/2020]
[79] Norfolk County Council (2020), Interactive Map. Available online at: http://maps.norfolk.gov.uk/highways/ [Last accessed: 07/10/2020].
[80] Norfolk County Council (2020), Norfolk Trail Interactive Map. Available online at: http://maps.norfolk.gov.uk/trails/ [Last accessed: 07/10/2020].
[81] South Norfolk Council (2016), Long Stratton Area Action Plan Adoption Version. Available online at: https://www.south-norfolk.gov.uk/sites/default/files/Long_Stratton_Area_Action_Plan_Adopted_May_2016_1.pdf [Last accessed: 06/10/2020]
[82] Indices of Deprivation (2019), Indices of Multiple Deprivation. Available online at: http://dclgapps.communities.gov.uk/imd/iod_index.html# [Last accessed: 07/10/2020].
[83] NOMIS (2020), Labour Market Profile – South Norfolk. Available online at: https://www.nomisweb.co.uk/reports/lmp/la/1946157238/report.aspx [Last accessed: 07/10/2020].

- Government Service[84].

APPRAISAL APPROACH

12.2.8. Regulations and guidance that were used within the 2017 ES Chapter 5 Society and Economy and Chapter 16 Soils and Agriculture have been superseded since the submission of the 2017 ES. An updated approach following DMRB guidance LA 112 Population and Human health, incorporating professional judgement and previous experience in the sector, has been used to update this assessment to inform the OBC. There is no specific guidance available for assessing the effects of a development on socio-economic receptors.

12.2.9. A high-level, qualitative assessment has been undertaken following DMRB guidance LA 112 Population and Human health[85] to identify potential impacts on the land use and accessibility receptors (private property and housing, community land and assets, development land and businesses, agricultural land holdings and WCH). Potential impacts on these receptors and on socio-economics receptors will be assessed based on the following definitions:

- **Beneficial**: indicate an advantageous or beneficial impact;
- **Negligible**: indicate imperceptible impact; and
- **Adverse**: indicate a disadvantageous or adverse impact.

12.2.10. Levels of significance have not been attributed to effects where they were not included within the 2017 ES in accordance with the updated DMRB guidance.

12.2.11. Effects for socio-economics classified as moderate or above are considered to be significant. Effects classified as minor or below are considered to be not significant.

12.2.12. A high-level assessment of human health has been undertaken to identify how changes to health determinants as a result of the Proposed Scheme will in turn affect health outcomes within the population of the study area. The likely health outcome(s) has been identified in line with the categories in **Table 12-1**.

Table 12-1 - Impact Criteria for Human Health

Human Health outcome category	Human Health outcome description
Positive	A beneficial health impact is identified.
Neutral	No discernible health impact is identified.
Negative	An adverse health impact is identified.

[84] Government Service (2020), Get information about schools. Available online at: https://get-information-schools.service.gov.uk/ [Last accessed: 08/10/2020].
[85] DMRB guidance (2020), LA 112 Population and Human health.

Human Health outcome category	Human Health outcome description
Uncertain	Where uncertainty exits as to the overall health impact.

ASSUMPTIONS AND LIMITATIONS

12.2.13. The following assumptions and limitations apply to this appraisal:

- The appraisal has been undertaken as a high-level desk-based study, using publicly available information;
- The methodology used within the 2017 ES followed the socio-economics assessment approach, and did not use a methodology under DMRB guidance. The assessment was also completed in advance of the update to EIA regulations which required the assessment of impacts on human health. Therefore there is limited information to draw from the 2017 ES on land use and accessibility receptors (specifically landowners, business land parcels, agricultural land, user levels of Public Rights of Ways (PRoW) and community facilities) and human health receptors, and the effects of the Proposed Scheme on these values / receptors;
- The appraisal relies, in part, on data provided by third parties (e.g. OS Mapping, Local Authorities, ONS) which are the most up-to-date, available at the time of the assessment. No significant changes or limitations in these datasets have been identified that would affect the robustness of the assessment; and
- The appraisal identifies baseline health indicators down to the lowest defined population group available according to Office for National Statistics survey outputs (lower super output areas); Further granularity of data is not available. No significant changes or limitations in these datasets have been identified that would affect the robustness of the assessment.

12.3 KEY CONSTRAINTS

12.3.1. This section summarises the baseline conditions outlined in the 2017 ES and includes an update of the constraints identified within the study area (see **Section 12.2**).

PRIVATE PROPERTY AND HOUSING

12.3.2. There are numerous private properties within the study area, the majority of which are located in Long Stratton. No existing dwellings are located within the footprint of the proposed Eastern Bypass and Western Relief Road.

12.3.3. Housing allocations of 1,800 dwellings (including an allocation of approximately 1,200 dwellings to the east and south east of Long Stratton and approximately 600 dwelling to the north west of Long Stratton)) are located within the Site, as described under Policy LNGS1 within the long Stratton Area Action Plan[86]. The Proposed Scheme is to be developed in accordance with and to fulfil this policy. As set out in Chapter 1, the planning applications submitted are described as the following:

[86] South Norfolk Council (2016), Long Stratton Area Action Plan Adoption Version. Available online at: https://www.south-norfolk.gov.uk/sites/default/files/Long_Stratton_Area_Action_Plan_Adopted_May_2016_1.pdf [Last accessed: 06/10/2020]

- 1,275 dwellings and development of 8 hectares of employment land (for uses within Class B1, B2 and B8), a 2-hectare primary school site, a community facilities site, associated infrastructure and public open spaces associated with the Eastern Bypass; and
- 387 dwellings and 1.5ha of Class B1 employment land, associated infrastructure and public open space associated with the Western Relief Road.

COMMUNITY LAND AND ASSETS

12.3.4. There are no areas of community land located within the Site. However, there are four areas of community land within the study area. These comprise[87]:

- One recreation ground (tennis court and football pitch) on Manor Road (approximately 500m west of the Site); and
- Three play areas on Field Acre Way, Oakfield Road and Wheatfield Way (approximately 20m, 100m and 110m west of the Site respectively).

12.3.5. There are no areas of community assets located within the Site. However, there are 23 community assets within the study area and beyond the Site. These comprise:

- Long Stratton Village Hall (approximately 120m west of the Site);
- Long Stratton Library (approximately 100m west of the Site);
- Long Stratton Leisure Centre on Swan Lane (approximately 150m south of the Site);
- Public toilets on Swan Lane[88] (approximately 600m west of the Site);
- One nursery (Manor Field Infant School and Nursery located approximately 25m south of the Site);
- Two primary schools (Manor Field Infant School and Nursery and St Mary's Church of England Junior School are located approximately 25m south and 440m south of the Site respectively);
- One secondary school (Long Stratton High School is located approximately 300m south of the Site);
- One GP practice (Long Stratton Medical Partnership is located approximately 50m south of the Site);
- One pharmacy (Well Long Stratton – The Angel Site is located approximately 130m west of the Site);
- Two dental practices (Manor House Dental Surgery and Netherton Dental Practice are both located approximately 130m west of the Site);
- Four places of worship (St Michaels Church, St Mary's Church, Congregational Church Long Stratton and Long Stratton Methodist Church are located approximately 50m north, 95m west, 200m west and 400m west of the Site respectively);
- One fire station (Long Stratton Fire Station is located approximately 200m west of the Site);
- Two care homes (The Mayfields Care Home and Harker House are located 140m south and 380m west of the Site respectively); and

[87] South Norfolk Council (2020), Play areas, open spaces and public assets. Available online at: https://www.south-norfolk.gov.uk/residents/communities/play-areas-open-spaces-and-public-assets [Last accessed: 07/10/2020]
[88] South Norfolk Council (2020), Play areas, open spaces and public assets. Available online at: https://www.south-norfolk.gov.uk/residents/communities/play-areas-open-spaces-and-public-assets [Last accessed: 07/10/2020]

- Three food stores (One Stop, Est of England Co-op Supermarket and Cooper Court Food & Wines are located approximately 230m west, 180m west and 180m west of the Site respectively).

DEVELOPMENT LAND AND BUSINESS

12.3.6. There are no businesses premises within the Site (agricultural land holdings are addressed below). However, there are various business premises located within the study area and beyond the Site. These comprise six types of businesses predominantly located along the A140, including catering, retail, industrial shops (e.g. builders merchants), convenience stores, health services and office services.

12.3.7. There are 9.5 hectares (ha) of employment allocations (including Class B1 business, B2 general industrial and B8 distribution or storage uses) located within the Site as described under Policy LNGS1[89]. The Proposed Scheme is to be developed in accordance with and to fulfil this policy.

AGRICULTURAL LAND HOLDINGS

12.3.8. There are two agricultural land holdings located within the Site. There is also one agricultural land holding's direct access is located within the Site. The baseline conditions of the agricultural land holdings are summarised in **Table 12-2**.

Table 12-2 - Agricultural Land Holding Existing Conditions

Agricultural Land Holding	Location	Type of Use
Hall Farm, Long Stratton and Church Farm, Stratton St Michael	Within the Site	Hall Farm, Long Stratton: Arable (approximately 201.9ha) Cropped in rotation with barley, oil seed rape, wheat and sugar beet (with occasional crops of oats and triticale), except for 2 hectares which is intensively farmed grass for hay/silage making and usually grazed over-winter by sheep. The area contains a wooded plantation of 0.8 ha. Church Farm, Stratton St Michael: Arable (approximately 123.1ha) Cropped in rotation with barley, oil seed rape, wheat and sugar beet (with occasional crops of oats and triticale).

[89] South Norfolk Council (2016), Long Stratton Area Action Plan Adoption Version. Available online at: https://www.south-norfolk.gov.uk/sites/default/files/Long_Stratton_Area_Action_Plan_Adopted_May_2016_1.pdf [Last accessed: 06/10/2020]

Agricultural Land Holding	Location	Type of Use
Wild Rose Farm ABN	Direct access of the farm is located within the Site	A poultry farm (approximately 11.0ha[90]).

WALKERS, CYCLISTS AND HORSE-RIDERS (WCH)

12.3.9. There are a number of WCH routes located within the study area. These comprise:

- 31 designated footpaths (six of which are located within the Site)[91];
- The Boudicca Way Walking Trail (within the study area)[92]; and
- A number of footways located within Long Stratton.

12.3.10. There are 30 bus stops located within the study area, two of which are located within the Site.

12.3.11. There are no National Trails or cycle routes within the study area.

HEALTH

12.3.12. **Table 12-3** breaks down the total population into five age groups and shows data from a ward, county and national level. Stratton ward has a larger proportion of the population aged under 16 and 25-64, but a smaller proportion of the population aged 16-24, 65-84 and 85+ when compared with Norfolk.

Table 12-3 - Population by Age Group (2018)[93]

Ward/Area	Aged under 16 (%)	Aged 16-24 (%)	Aged 25-64 (%)	Aged 65-84 (%)	Aged 85+ (%)
Stratton ward	19.0	9.3	51.3	20.5	2.6
Norfolk	16.9	10.2	48.9	24.1	3.4
England	19.1	10.9	51.9	18.0	2.4

[90] The size of Wild Rose Farm ABN was not recorded in the 2017 ES. The approximate size of the farm has been calculated based on aerial image at this stage.
[91] Norfolk County Council (2020), Interactive Map. Available online at: http://maps.norfolk.gov.uk/highways/ [Last accessed: 07/10/2020].
[92] Norfolk County Council (2020), Norfolk Trail Interactive Map. Available online at: http://maps.norfolk.gov.uk/trails/ [Last accessed: 07/10/2020].
[93] Public Health England (2018), Local Health. Available online at: https://www.localhealth.org.uk/#bbox=601234,316107,33697,42837&c=indicator&i=t1.pop_under_16&selcodgeo=E05005908&view=map15 [Last accessed: 07/10/2020]

12.3.13. Stratton ward has a higher life expectancy at birth for males (83.1 years) when compared with Norfolk (79.9 years) and England (79.5 years) averages. However, life expectancy at birth for females in Stratton ward (83.3 years) is marginally lower when compared with Norfolk average (83.7 years), yet marginally higher when compared with England average (83.1 years).[94]

12.3.14. The 2020 Public Health England (PHE) Health Profile for Norfolk County Council[95] compares a range of population and human health indicators for a number of statistics across the local authority area with the national average. Overall, the health of people in Norfolk is either similar or better when compared to the national average (see **Table 12-4**).

Table 12-4 - Norfolk Health Indicators (Norfolk versus England averages) [96]

Significantly Better	Similar	Significantly Worse
▪ Life expectancy at birth (males) ▪ Life expectancy at birth (females) ▪ Under 75 mortality rate from all causes ▪ Mortality rate from all cardiovascular diseases ▪ Mortality rate from cancer ▪ Emergency hospital admission rate for intentional self-harm ▪ Infant mortality rate ▪ Year 6: Prevalence of obesity (including severe obesity) ▪ Percentage of children in low income families ▪ Violent crime – hospital admission rate for violence (including sexual violence)	▪ Suicide rate ▪ Emergency hospital admission rate for hip fractures ▪ Estimated diabetes diagnosis rate ▪ Estimated dementia diagnosis rate ▪ Hospital admission rate for alcohol-specific conditions ▪ Hospital admission rate for alcohol-related conditions ▪ Percentage of adults classified as overweight or obese ▪ Smoking prevalence in adults ▪ Percentage of physically active adults ▪ Teenage conception rate	▪ Killed or seriously injured on the roads ▪ Percentage of smoking during pregnancy ▪ GCSE attainment (average attainment 8 score) ▪ Statutory homelessness rate – eligible homeless people not in priority need

[94] Public Health England (2018), Local Health. Available online at: https://www.localhealth.org.uk/#bbox=601234,316107,33697,42837&c=indicator&i=t4.le_nm_f&selcodgeo=E05005908&view=map15 [Last accessed: 07/10/2020]
[95] Public Health England (2020), Local Authority Health Profiles - Norfolk. Available online at: https://fingertips.phe.org.uk/profile/health-profiles/data#page/1/gid/1938132701/pat/6/par/E12000006/ati/202/are/E10000020/iid/90366/age/1/sex/1/cid/4 [Last accessed: 07/10/2020]
[96] Public Health England (2020), Local Authority Health Profiles - Norfolk. Available at: https://fingertips.phe.org.uk/profile/health-profiles/data#page/1/gid/1938132701/pat/6/par/E12000006/ati/202/are/E10000020/iid/90366/age/1/sex/1/cid/4 [Last accessed: 01/10/2020]

Significantly Better	Similar	Significantly Worse
▪ New STI diagnoses rate (excluding chlamydia aged <25) ▪ TB incidence rate	▪ Smoking prevalence in adults in routine and manual occupations ▪ Percentage of people in employment ▪ Excess winter deaths index	

12.3.15. The Site falls within Lower-layer Super Output Areas (LSOAs) South Norfolk 011D, 011E and 011F[97]. In terms of overall deprivation, South Norfolk 011F (50% most deprived neighbourhoods in the country) is the most deprived when compared with the other two LSOAs, whereas South Norfolk 011D (30% least deprived neighbourhoods in the country) is the least deprived.

12.3.16. The Site falls within the South Norfolk Clinical Commissioning Group (CCG)[98,99], which includes residents living within the study area. The percentage of patients recorded on practice disease registers with chronic obstructive pulmonary disease (COPD) in South Norfolk CCG (1.9%) is in line with the regional (1.8%) and national (1.9%) averages, with no significant change to the trend. The admissions for children (under 19) with asthma within the South Norfolk CCG (138.9 per 100,000) is better than the national (176.8 per 100,000) average. Whilst there is no significant change in admission in the South Norfolk CCG, England is showing an improving trend with a reduced number of hospital admissions for asthma.

SOCIO-ECONOMICS

Employment

12.3.17. In terms of labour supply, ONS annual population survey results in 2019[100] show that South Norfolk has an economically active population (aged 16-64) of 81,500. This represents a lower rate (57.8%) when compared to the national (England) average (62.5%).

12.3.18. The NOMIS data[101] shows that the South Norfolk and East of England economies comprise a broad range of industries, with the “human health and social work activates” sector being the largest

[97] Indices of Deprivation (2019), Indices of Multiple Deprivation. Available online at: http://dclgapps.communities.gov.uk/imd/iod_index.html# [Last accessed: 07/10/2020].
[98] Public Health England (2020), Inhale – Interactive Health Atlas of Lung conditions in England. Available online at: https://fingertips.phe.org.uk/inhale#page/0/gid/8000008/pat/46/par/E39000046/ati/165/are/E38000219/iid/92780/age/220/sex/4/cid/1/tbm/1/page-options/tre-ao-0_car-do-0_ovw-do-1 [Last accessed: 07/10/2020].
[99] Clinical Commissioning Groups (CCGs) commission most of the hospitals and community NHS services in the local areas for which they are responsible. This is also one of the health indicator groupings on Public Health England website.
[100] NOMIS (2020), Labour Market Profile – South Norfolk. Available online at: https://www.nomisweb.co.uk/reports/lmp/la/1946157238/report.aspx [Last accessed: 07/10/2020].
[101] NOMIS (2020), Labour Market Profile – South Norfolk. Available online at: https://www.nomisweb.co.uk/reports/lmp/la/1946157238/report.aspx [Last accessed: 07/10/2020].

employment industries within the district (28.3%). This sector also has a considerably higher proportion of employees than the regional (12.0%) and national (England) (13.2%) averages.

Housing

12.3.19. There were approximately 52,809 dwellings in South Norfolk in 2011. In terms of tenure, Census data in 2011[102] reveals that 86.1% of dwellings were privately owned or rented, a slightly higher proportion compared with 80.2% in England. Levels of affordable housing in South Norfolk (11.3%) were lower than the levels for England (17.7%). Housing need in South Norfolk was assessed in the 2016 "Central Norfolk Strategic Housing Market Assessment (SHMA)", which determined that there is a need of approximately 3,400 affordable homes over the period 2012-2036. This equates to approximately 142 dwellings annually.

Education

12.3.20. There are four primary schools within the study area, including Manor Field Infant and Nursery School; St Mary's Church of England Junior School; Shelton with Hardwick Community School; and Preston Church of England Voluntary Controlled Primary School. There is limited primary school capacity to accommodate the needs within the catchment[103].

12.3.21. There is one secondary school within the study area, Long Stratton High School. There is capacity within Long Stratton High School to accommodate the needs of its immediate catchment[104].

Primary healthcare

12.3.22. There is one GP practice (Long Stratton Medical Partnership) and two dental practices (Manor House Dental Surgery and Netherton Dental Practice) within the study area. The capacity for Long Stratton Medical Partnership is below the England average ratio (one FTE GP to 1,800 patients), with a ratio of 1 FTE GP to 1,627 patients[105]. There is no publicly available information on current capacity for the dental practises. However, the 2017 ES stated that the capacity for the two dental practices were at their full capacity at the time of writing. Overall, the healthcare services appear to be sufficient to meet the needs of the existing population, with limited capacity to accept new patients.

12.4 APPRAISAL

RESULTS

12.4.1. The results below for private property and housing, community land and assets, development land and businesses, agricultural land holdings, WCH and human health are derived from this high level

[102] NOMIS (2011), Tenure – Households. Available online at: https://www.nomisweb.co.uk/census/2011/qs405ew [Last accessed: 12/10/2020]
[103] Government Service (2020), Get information about schools. Available online at: https://get-information-schools.service.gov.uk/ [Last accessed: 08/10/2020].
[104] Government Service (2020), Get information about schools. Available online at: https://get-information-schools.service.gov.uk/ [Last accessed: 08/10/2020].
[105] NHS (2020), General Practice Workforce. Available online at: https://app.powerbi.com/view?r=eyJrIjoiNmY4NGNiMWQtMGVkZi00MzU2LThiZGMtMTFlZjY2NGE0NTZmIiwidCI6IjUwZjYwNzFmLWJiZmUtNDAxYS04ODAzLTY3Mzc0OGU2MjllMiIsImMiOjh9 [Last accessed: 12/10/2020].

appraisal of the Proposed Scheme. The results for socio-economics are summarised from the 2017 ES, and are considered to remain similar for the Proposed Scheme.

Private property and housing

12.4.2. There is the potential for temporary adverse impacts on private properties, where disruption to access is likely to occur during construction work if the direct access to private properties is located within the Site. The Proposed Scheme is not likely to have a direct impact on private properties within the Site as no demolition has been proposed. The Proposed Scheme is to be developed in accordance with and to fulfil Policy LNGS1 under the Long Stratton Neighbourhood Plan, therefore a beneficial effect on housing allocation and availability is anticipated.

Community land and assets

12.4.3. There is the potential for temporary adverse impacts on community land and assets, where disruption to access is likely to occur during construction work if the direct access of community land and assets is located within the Site.

Development land and businesses

12.4.4. There is the potential for temporary adverse impacts on businesses, where disruption to access is likely to occur during construction work if the direct access of businesses is located within the Site. The Proposed Scheme is to be developed in accordance with and to fulfil Policy LNGS1 under the Long Stratton Neighbourhood Plan, therefore a beneficial effect on employment allocation and development land is anticipated.

Agricultural land holdings

12.4.5. There is the potential for significant temporary adverse impacts on agricultural land holdings where temporary land take is required during constriction works.

12.4.6. There is the potential for significant permanent adverse impacts on agricultural land holdings where the loss of farm buildings or introduction of new land uses is required within the Proposed Scheme.

WCH

12.4.7. There are potential not significant temporary and permanent adverse impacts on WCH using PRoW and other routes affected by the Proposed Scheme or accessing community and recreational facilities.

Human health

12.4.8. There is the potential for temporary negative human health outcomes during construction on the wider community. This is due to potential for temporary adverse impacts to arise from obstruction and disruption of PRoW due to potential closures and diversions, which could alter people's ability to follow healthy pursuits and partake in physical activity.

12.4.9. There is the potential for permanent adverse impacts on visual amenity, which may have a negative human health outcome during construction and operation. There is the potential for positive and negative human health outcomes due to potential increase and decrease in noise and air quality level around residential properties. There is the potential for negative human health outcomes due to potential permanent PRoW diversions, which may increase journey time and discourage WCH journeys and therefore reducing levels of physical activity.

Socio-economics

12.4.10. The potential effects on socio-economics receptors are summarised as follows based on the assessment undertaken in the 2017 ES:

- There is the potential for not significant temporary minor beneficial impact on employment at the local and regional level, due to the need for construction workers;
- There is the potential for significant permanent moderate beneficial impact on employment at the local and regional level, due to the provision of 9.5ha employment land for uses within Class B1, B2 and B8 during operational phase;
- There is the potential for significant permanent moderate beneficial impact on housing provision due to the new housing provision within the Proposed Scheme;
- There is the potential for not significant permanent minor beneficial impact on primary and a significant permanent moderate adverse impact on secondary education space provision, due to the introduction of a 2ha primary school within the Proposed Scheme during operational phase;
- There is potential for significant permanent moderate adverse impact on primary healthcare services, due to the introduction of a potential significant number of residents within the Proposed Scheme during operational phase; and
- There is potential for significant moderate beneficial impact on open space and play space provision, due to the introduction of community facilities and public open spaces within the Proposed Scheme during operational phase.

KEY FINDINGS OF THE APPRAISAL

12.4.11. The Proposed Scheme is likely to have an adverse impact on access to private properties, business premises and recreation facilities; agricultural land holdings; WCH; human health; education space provision; primary healthcare provision; and open space and play space provision.

12.4.12. The Proposed Scheme is likely to have a beneficial impact on employment and housing provision.

12.4.13. There are no mitigation measures accounted for this appraisal for those elements covered by DMRB LA 112. This will need to be considered further in the next stage to mitigate adverse impacts identified where reasonably possible and where they are likely to result in significant effects.

PROPOSED NEXT STEPS

12.4.14. The following scope of works is proposed to be completed:

- Further assessment may be required to update the 2017 ES assessment in line with updated EIA regulations and new DMRB guidance (according to criteria within DMRB LA 112, Tables 3.11 and 3.12, and Table 3.8.1 of DMRB LA 104[106]);
- Further assessment on air quality and noise impact during construction is required to capture the potential impact on human health;
- Further assessment to be undertaken in the next stage to account for potential mitigation measures to minimise potential significant adverse impacts;

[106] DMRB guidance (2020), LA 104 Environmental Assessment Methodology.

- Further data collection on WCH routes and agricultural land holdings is recommended to inform detailed design; and
- Appropriate mitigation should be included in any further assessment to minimise impact on receptors.

13 WATER ENVIRONMENT

13.1 INTRODUCTION

13.1.1. This chapter presents the appraisal of the Proposed Scheme on the water environment which includes surface water, groundwater and flood risk.

13.2 APPRAISAL METHODOLOGY

STUDY AREA

13.2.1. The study area for surface water features includes the Site and up to 500m from the Site, although other surface features within hydraulic connectivity with the Site (up to approximately 1km) have also been considered. The study area for groundwater receptors includes the Site and up to 1km from the Site. These areas are shown by the buffer distances presented in **Figure 1.3** in **Appendix A**.

DATA SOURCES

13.2.2. The data sources used in this appraisal comprise:

- Environment Agency's (EA) online Flood Map for Planning[107];
- EA's online Updated Map for Surface Water Flooding[108];
- EA's online Catchment Data Explorer[109];
- Ordnance Survey Mapping[110];
- Environment Agency LiDAR Digital Terrain Model[111];
- DEFRA Magic Map online GIS portal[112];
- British Geological Survey (BGS) Geology of Britain Viewer[113];
- BGS Geoindex online database[114];
- Flood Estimation Handbook Web Service[115];
- Historic mapping[116];
- Site Investigation Factual Report Long Stratton Bypass[117];
- Site Investigation Factual Report Long Stratton Housing (East area)[118];

[107] Environment Agency (2020) available online: https://flood-map-for-planning.service.gov.uk/
[108] Environment Agency (2020) available online: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map
[109] Environment Agency (2020) available online:
[110] Ordnance Survey (2020) available online: https://osmaps.ordnancesurvey.co.uk/
[111] Environment Agency (2020) available online: https://environment.data.gov.uk/DefraDataDownload/?Mode=survey
[112] DEFRA (2020) available online: https://magic.defra.gov.uk/MagicMap.aspx
[113] British Geological Survey (2020) available online: http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[114] British Geological Survey (2020) accessed online: http://mapapps2.bgs.ac.uk/geoindex/home.html
[115] Centre for Ecology and Hydrology (2020) accessed online: https://fehweb.ceh.ac.uk/GB/map
[116] National Library of Scotland (2020), accessed online: https://maps.nls.uk/
[117] Norfolk Partnership Laboratory (2018) Site Investigation Factual Report Long Stratton Bypass
[118] Norfolk Partnership Laboratory (2018) Site Investigation Factual Report Long Stratton Housing (East area)

- A140 Long Stratton Bypass Environmental Statement (Vol 2) Supporting background report for Geology and Soils[119]; and
- 2017 Environmental Statement[120].

APPRAISAL APPROACH

13.2.3. The potential impacts of the Proposed Scheme on the water environment have been assessed in accordance with TAG[121]. This comprises a qualitative assessment of the impacts of the Proposed Scheme upon various features of the water environment.

13.2.4. The general approach to the appraisal involves the following (as completed in the TAG worksheet):

- Identifying potential surface water and groundwater receptors within the study area and the associated resource that would be potentially impacted (such as water supply, water quality, transport, biodiversity, recreation etc);
- Determining the importance of the receptors (based on characteristics such as quality, scale, rarity and substitutability);
- Consider the magnitude of the potential impacts upon each receptor (ranging from negligible to large adverse / beneficial);
- Assess the significance of a potential impact on each affected feature using the matrix provided in the TAG[121]; and
- Conclude by providing an overall assessment score.

13.2.5. The criteria used to assign importance, magnitude of potential impact and significance of impact is provided in Chapter 10 of Unit A3.10 of the TAG[121].

13.3 KEY CONSTRAINTS

13.3.1. The key constraints are shown on **Figure 1.3** in **Appendix A** where possible.

SURFACE WATER FEATURES

13.3.2. There are no main rivers within the study area. There are several ordinary watercourses which flow through or adjacent to the Site. Review of OS mapping indicates there are five mapped watercourses that would be traversed by the Eastern Bypass and Western Relief Road or located in the wider Site area. Aerial imagery indicates that land adjacent to these watercourses is used for crops and there is minimal riparian habitat between the watercourse and the crops. Historic mapping shows that the watercourses were straightened and realigned along field boundaries before 1880. There are likely to be other smaller land drains located within the Site that are not identified by OS mapping.

13.3.3. A review of surface water flood mapping indicates that the watercourses in the Site generally flow north-west, most likely outfalling to Picton Stream or Hempnall Beck.

[119] Technical Group (2004) A140 Long Stratton Bypass Environmental Statement (Vol 2) Supporting background report for geology and soils
[120] Norfolk Homes Ltd and Norfolk Land Ltd (2017). Long Stratton Environmental Statement – Main Report.
[121] Unit A3.10 Impacts on the Water Environment, DfT, November 2014

13.3.4. The Picton Stream is an ordinary watercourse under the jurisdiction of Norfolk County Council (NCC) located approximately 500m to the west of Long Stratton, flowing northwards along the western boundary of the Site. It is tributary of the River Tas (a main river under the jurisdiction of the Environment Agency), and their confluence is approximately 2.2km downstream of the Site. The River Tas is a monitored waterbody under the Water Framework Directive (WFD) and is currently performing with Moderate overall WFD status.

13.3.5. The Hempnall Beck is a main river under the jurisdiction of the Environment Agency located approximately 2km to the north of Long Stratton. The Hempnall Beck is a monitored waterbody under the WFD and is currently performing with Poor overall WFD status. The Hempnall Beck also discharges to the River Tas.

13.3.6. A minor tributary of the Picton Stream flows westwards from the centre of Long Stratton, along the southwestern boundary of the Site. This watercourse is heavily shaded by tree cover along Swan Lane. There is a sewage treatment works located to the west of the Site and adjacent to the Picton Stream, assumed to discharge to Picton Stream.

13.3.7. A larger ordinary watercourse is located south of the Site, approximately 150m south of the tie-in on the Eastern Bypass with the A140. The watercourse flows in a north-easterly direction towards the Hempnall Brook in the north and appears to be largely outside of the natural drainage catchment of the Site.

13.3.8. There are several ponds within and adjacent to the Site and most are in direct hydrological connection to the ditch network. Previous site visits recorded the ponds to be overgrown, and some dry, at the time of survey.

13.3.9. Information regarding surface water abstractions (licensed and non-licensed) has not yet been obtained. It is unlikely that the surface water features in the study area would support significant supply although the Picton Stream may have the potential to support local abstractions.

FLOOD RISK

13.3.10. The Site is not located within Flood Zone 2 or 3 and is therefore at very low risk of fluvial flooding. Most of the Site is also at very low risk of surface water flooding, however there are isolated areas at high risk of surface water flooding. These areas lie within overland flow paths which follow the ditch network. There are two main overland flow routes crossing the Site: one flowing east to west from Mill Lane to Star Lane and the other flowing south-east to north-west from Parker's Lane to Hall Lane. These two flow routes meet in the centre of Long Stratton and are indicated to flow westwards towards Picton Stream, although would most likely be intercepted by drainage infrastructure. There is also an overland flow route from St Michaels Road to Kates Hole which bisects the Site.

HYDROGEOLOGY

13.3.11. The main characteristics of the geology (superficial and bedrock) that underlies the Proposed Scheme are described in **Chapter 7: Geology and Soils** and considers published information and the findings of the Ground Investigation (GI) completed in 2003 and 2018.

13.3.12. The Site is underlain by the Lowestoft Formation comprising chalky till, sands, gravels, silts and clays. The formation is characterised by its chalk and flint content. The thickness of the Lowestoft Formation is variable across the Site and recorded in the 2003 GI at approximately 1.20m (WS47) and 29.0m (BH16). Head Deposits comprising clay, silt, sand and gravel are confined to the tributary of the River Tas (approximately 2.2km north) that transects the site.

13.3.13. The superficial deposits are low productivity aquifers with limited or local potential where borehole yields are expected to be small. The EA designates these superficial deposits as *Secondary (Undifferentiated) Aquifers* assigned in cases where it is not possible to attribute a Category A or Category B aquifer designation rock type.

13.3.14. The White Chalk Subgroup underlies the superficial deposits and is designated a *Principal Aquifer* by the EA. The depth to the Chalk is variable across the Site and has been recorded at approximately 1.20mBGL (below ground level) in some areas and up to 29.0mBGL. Principal Aquifers are deemed capable of supporting water supplies at a regional scale meaning they usually provide a high level of water storage, and support water supply and/or river baseflow on a strategic scale.

13.3.15. GI data are available for the Proposed Scheme and were completed in two separate GI campaigns, September 2003 and June to October 2018. There is limited GI data for the Proposed Scheme in the north-west relating to the Western Relief Road. The GI consists of window samples and trial pits to depths with a focus on understanding ground conditions along the proposed route including groundwater level and infiltration testing. Note that not all GI data has been received and appears to have some missing data (e.g. missing exploratory hole logs). Only records available to WSP at the time of writing this report were assessed.

13.3.16. Groundwater level monitoring was undertaken during the 2003 and 2018 GI[122]. Monitoring was undertaken in the Lowestoft Formation (superficial deposits) and the average depth to groundwater level was around 4.0mBGL. It was noted in the 2003 GI that a rapid rise in water levels during the winter months was recorded and may have been a result of shallow ephemeral water tables[120]. Localised perched and discontinuous groundwaters were also present as confirmed by the GI along the Site. Groundwater levels from the historical GIs (2003 and 2018) found water levels to be variable across GI locations due to the variability of the superficial deposit composition. The deepest groundwater level was recorded at 12.9mBGL (BH15) and the shallowest at 0.95mBGL (E06) (a borehole plan extracted from the reports is provided as **Appendix D**).

13.3.17. No groundwater level monitoring data exists for the north-west extent of the Proposed Scheme however, the depth to groundwater is assumed to be similar to records available of the Site and described above.

13.3.18. In-situ permeability testing (i.e. soakaway testing) was completed in the Lowestoft Formation at thirty-three (33 no.) trial pits along the route at depths of approximately 1.60mBGL for the 2003 and 2018 GI. A range of permeability was recorded between $1.32E^{-03}$ m/sec (TP106 – gravelly clay) and $5.7E^{-08}$ m/sec (TP173 – gravelly clay). An average of $4.26E^{-05}$ m/sec is calculated for the Lowestoft Formation[117,118,120]. There is some uncertainty in calculated permeability from the GI as indicated by the variable results.

13.3.19. The groundwater vulnerability map shows the vulnerability of groundwater to a pollutant discharge at ground surface based on the hydrological, geological and hydrogeological properties within a single

[122] Norfolk Homes Ltd and Norfolk Land Ltd (2017). Long Stratton Environmental Statement – Main Report. Volumes 1 & 2 Supporting background report for Geology and Soils (September 2004). TE/R2C091

square kilometre. The Lowestoft Formation is classified *Medium* and the Head Deposits *Medium to Low* which means that these units can transmit pollution to groundwater relatively easily. The northern and north-western extent of the Site is classified *Medium* groundwater vulnerability with a *soluble rock risk,* which identify areas where solution features that enable rapid movement of a pollutant may be present.

13.3.20. The Site does not fall within a Source Protection Zone (SPZ). SPZ are defined around a groundwater abstraction site used for public water supply. SPZ Total Catchment Zone 3 is located approximately 1.30km south from the southern-most extent of the Proposed Scheme and 3.6km east from the northern-most extent of the Proposed Scheme. SPZ Zone 3 (Total Catchment) is defined as the total area needed to support the abstraction or discharge from the protected groundwater source.

13.3.21. Under the WFD, the EA has determined the Site lies within the *Broadland Rivers Chalk and Crag* groundwater body (GB40501G400300) classified as holding 'Poor' quantitative and chemical classifications based on the 2019 dataset. The main pressures for not achieving 'Good' status and reasons for deterioration are from agricultural and rural land management and no sector responsible. The groundwater body is linked to protected areas under the Drinking Water and Nitrates Directive.

13.3.22. The 2017 ES identifies three licenced groundwater abstraction points known within 2.0km of the Study Area. No further details on location, yield and type of supply was provided.

13.3.23. No Groundwater Dependent Terrestrial Ecosystems are present within or surrounding the Site.

13.4 APPRAISAL

13.4.1. The water environment TAG sheet is provided in **Appendix C**.

KEY FINDINGS OF THE APPRAISAL PROCESS

13.4.2. The appraisal process for both the Eastern Bypass and the Western Relief Road and associated development concludes with an assessment score of **Neutral** and the Proposed Scheme is not expected to pose any significant impacts to the water environment (surface water and groundwater). Negligible impact to low or medium quality receptors results in an insignificant effect upon water environment receptors.

13.4.3. In summary, the main surface water receptors are ephemeral ordinary watercourses mostly located at field boundaries providing drainage for agricultural land. These are deemed to have low quality in all feature attributes assessed.

13.4.4. The Picton Stream flows adjacent to the Western Relief Road associated development. This is deemed to be low quality in most feature attributes but medium quality in potential for water supply and dilution of waste products, due to the presence of the sewage treatment works on the watercourse (and assumed discharge).

13.4.5. The watercourses identified in the study area may receive surface water runoff from the Proposed Scheme, however with appropriate treatment and attenuation this is unlikely to adversely affect water quality or increase flood risk associated with these watercourses or downstream receptors. The Proposed Scheme will also cross a number of small watercourses and land drains that will likely remove natural channel bed and banks. The impacts will however be local and can be mitigated through the provision of appropriate crossings that maintain connectivity and flow conveyance.

13.4.6. Local impacts are expected to groundwater receptors with the highest risk relating to construction phase impacts where intrusive works and dewatering activities may be proposed. Residual risks may remain at operational phase if below ground structures are considered and extend below the groundwater table.

13.4.7. There is limited data relating to public and private (non-licenced) abstractions for the study area and further consultation with stakeholders and regulators is required.

13.4.8. All potential impacts to receptors are anticipated to be negligible based on mitigation measures embedded into the design and other best practises assumed to be adopted as the Proposed Scheme progresses, including the following:

- Providing attenuation basins for controlling peak runoff rate and runoff volume of surface water runoff from impermeable surfaces up to the 1 in 100 year rainfall event, plus a 40% climate change allowance;
- Providing treatment for highway runoff through SuDS and spillage containment measures;
- Steering areas of development away from surface water flow paths. Implementing green infrastructure along watercourses and on overland flow as set out in the masterplan relied upon in the 2017 ES;
- Avoid culverting of watercourses where possible through the layout of development areas; and
- Minimising the length of necessary culverts.

PROPOSED NEXT STEPS

13.4.9. The following scope of works is proposed:

- Further development and appropriate design of watercourse crossings and, if required, watercourse realignment;
- Further development of sustainable surface water drainage strategies;
- Further assessment of risk to water quality and design appropriate mitigation using methods set out in the Design Manual for Roads and Bridges (DMRB) LA 113;
- Consultation with stakeholders and regulators for additional information (including public and private (non-licenced) groundwater abstractions) and agreement in principle of key design elements;
- No groundwater water quality data are available for the 2003 and 2018 GI. Consultation with NCC and the EA should be undertaken to identify additional groundwater quality and groundwater level data for the Site; and
- Gaps in information identified will be considered and addressed, with regards to specific mitigations, as the project progresses.

14 SUMMARY

14.1 INTRODUCTION

14.1.1. This chapter presents a summary of the Appraisal undertaken for the Proposed Scheme. This chapter sets out:

- A summary of the identified environmental constraints;
- A summary of the key findings of the appraisal process; and
- The proposed next steps.

14.2 SUMMARY OF ENVIRONMENTAL CONSTRAINTS

14.2.1. The key environmental and social constraints identified include the following:

- High and moderate quality trees;
- Biodiversity constraints including:
  - Habitats of Principal Importance (HPI): grassland, hedgerows and ponds;
  - Bats;
  - Badger (*Meles meles*);
  - Breeding and wintering birds;
  - Great crested newt (GCN) (*Triturus cristatus)*;
  - Reptiles;
  - Water vole (*Arvicola amphibious*); and
  - Terrestrial invertebrates.
- The elements of the Proposed Scheme susceptible to climate change;
- The climate (as susceptible to greenhouse gas emissions);
- Geology and hydrogeology, including underlying White Chalk Subgroup Principal Aquifer;
- Surface water features, including several ordinary watercourses;
- Areas at risk of surface water flooding
- Soil resources, agriculture and agricultural land holdings;
- Human receptors, including nearby residents, users of walking, cycling and horse-riding routes, users of local roads, and users of community facilities;
- Heritage assets including (but not limited to):
  - Long Stratton Conservation Area;
  - Grade listed buildings including the Grade I listed Church of St Michael and Grade II* listed The Old Rectory;
  - Archaeological assets;
- Material assets and landfill void capacity; and
- Noise important areas.

14.3 SUMMARY OF KEY FINDINGS

14.3.1. The key findings of the TAG appraisal are as follows:

- Noise: Net Present Value of £6,075,704;
- Air Quality: Net Present Value of £477,851;

- Greenhouse Gases: Net Present Value of £4,684,090;
- Landscape: Slight adverse;
- Historic Environment: Large adverse;
- Biodiversity: Slight adverse; and
- Water Environment: Neutral.

14.3.2. A summary of the findings of the topics not subject to a TAG appraisal is provided below.

CLIMATE RESILIENCE

14.3.3. The appraisal has highlighted that there are a number of Proposed Scheme receptors during the operation phase which have the potential to be sensitive to changes in climate and therefore require further consideration. These include the potential for:

- Deformation and melting of the carriageway and roundabouts;
- Increase in thermal expansion of bridge joints of structures;
- Drying out, cracking and subsidence of structures' foundations;
- Increase in wind loading on bridges;
- Loss of vegetation of soft verges due to high temperatures or waterlogging;
- Destabilisation of soils on soft verges;
- Subsidence of buildings due to extreme precipitation events and drying out of ground from extreme temperature;
- Vegetation and planting failure on areas of open space due to waterlogging or scorching; and
- Increased maintenance of vegetation required on areas of open space.

GROUND CONDITIONS AND CONTAMINATED LAND

14.3.4. The following key findings have been identified:

Geology

- No significant constraints relating to geology have been identified.
- The 2017 Environmental Statement identified the impact on geology to be neutral.

Hydrogeology

- Based on the hydrogeological conditions identified at the Site, it is not anticipated that significant quantities of groundwater will be encountered during the construction of the Proposed Scheme. However, should piles be required to be founded within the Chalk bedrock, a Piling Risk Assessment may be required to assess the risks from piling activities to the chemical quality of groundwater within the Principal Aquifer.
- A controlled waters risk assessment, including groundwater sampling and analysis has not been undertaken.

Hydrology

- No significant constraints relating to hydrology in the context of contamination have been identified, however consideration should be given to protecting surface water courses from contamination during construction of the Proposed Scheme.

Soil Resources and Agriculture

- Given that the agricultural land in the vicinity of the Proposed Scheme is classified as Grades 2, 3a and 3b there will be a loss of this land during the construction and operation of the road. Based on

the 2017 Environmental Statement, the Proposed Scheme will result in the loss of approximately 148 hectares of agricultural land which will have a permanent, adverse moderate/major effect.

- The 2017 Environmental Statement suggested that the handling and storage of soils are subject to a Construction Environmental Management Plan (CEMP) and/or Defra's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009). By following this best practice the long term effect on soil resources is minor adverse to negligible.

Contamination

- Based on the previous ground investigations and assessment, a limited risk to human health has been identified. It is noted that no assessment of controlled waters has been undertaken.
- The 2017 Environmental Statement the residual risks from contamination to be none/negligible.

MATERIALS AND WASTE

14.3.5. A high-level overview of the key impacts from resources consumed and waste generated is provided in **Table 14-1**. Assessment findings are presented based on professional judgement in the absence of quantified data.

Table 14-1 – Assessment of key impacts

Key Receptor	Summary of Key Impacts	Assessment
Material assets/ resources	An estimate of the volume of bulk materials (steel, concrete, asphalt) required is not available at the time of writing. The percentage of recycled content across these materials has not yet been determined, therefore a worst-case scenario has been used to assess impacts. This assumes that imported aggregates comprise reused/recycled content *below* the regional percentage target of 31%. A worst-case scenario applied to material recovery suggests that less than 70% overall material recovery / recycling (by weight) of non-hazardous Construction and Demolition Waste (CDW) (to substitute use of primary materials) would be achieved. The Proposed Scheme does not sterilise one or more MSA and/or peat resource. The sand and gravel MSA identified is present beneath an existing road and the proposed associated development for the Western Relief Road is not anticipated to further and adversely impact the deposit.	**Moderate (adverse)**
Landfill void capacity	The completion date for the Proposed Scheme construction is expected to be Q3/Q4 2024. The available total landfill capacity (based on existing trends) is anticipated to be 34.9 Mm^3. A worst-case scenario applied to generation of waste has the potential for more than 1% reduction or alteration in the regional capacity of landfill as a result of accommodating waste from the Proposed Scheme. In addition, it is anticipated there may be a requirement to dispose of hazardous waste outside of the region, although the estimated volume is not known. However, it not anticipated to exceed 50% of the total waste from the Proposed Scheme.	**Moderate (adverse)**

POPULATION AND HEALTH

14.3.6. The Proposed Scheme is likely to have an adverse impact on access to private properties, business premises and recreation facilities; agricultural land holdings; WCH; human health; education space provision; primary healthcare provision; and open space and play space provision.

14.3.7. The Proposed Scheme is likely to have a beneficial impact on employment and housing provision.

14.3.8. There are no mitigation measures accounted for this appraisal for those elements covered by DMRB LA 112. This will need to be considered further in the next stage to mitigate adverse impacts identified where reasonably possible and where they are likely to result in significant effects.

14.4 PROPOSED NEXT STEPS

14.4.1. In general, the following next steps are proposed:

- Determine the planning approval pathway for the various elements of the Proposed Scheme (to determine what environmental work is required to support planning application processes);
- Updates to baseline surveys and baseline data collection, where required, to provide a robust description of baseline conditions;
- Update and refine the designs to avoid environmental constraints identified in this, and previous environmental reports;
- Update the environmental impact assessments for the elements of the Proposed Scheme;
- Develop the environmental mitigation strategies and mitigation designs for inclusion in the environmental assessments and planning applications, to be carried forward into design and construction phases.

14.4.2. Chapters 2 through to 13 provide more detailed technical guidance on the proposed next steps for the various technical studies.

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