Lincolnshire County Council

NORTH HYKEHAM RELIEF ROAD

WebTAG Environmental Appraisal

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MARCH 2019

PUBLIC

Lincolnshire County **Council**

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ACRONYMS

Acronym	Description
AADT	Annual Average Daily Traffic
ADMS	Atmospheric Dispersal Modelling Software
AM	Ante-Meridiem
AQMA	Air Quality Management Area
ARN	Affected Road Network
AST	Appraisal Summary Table
BAP	Biodiversity Action Plan
BGS	British Geological Society
CA	Conservation Area
Defra	Department of Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
DM	Do Minimum
DS	Do Something
EA	Environment Agency
EPS	European Protected Species
FBC	Full Business Case
GIS	Geographical Information Systems
GWDTEs	Groundwater Dependent Terrestrial Ecosystems
HER	Historic Environment Record
HSI	Habitat Suitability Index Survey
HA	Highways Agency (now Highways England)
HDV	Heavy Duty Vehicle
IP	Inter Peak
LDF	Local Development Framework
NVZ	Nitrate Vulnerable Zone
LCC	Lincolnshire County Council
LNR	Local Nature Reserve

MAGIC	Multi-Agency Geographical Information for the Countryside
NIA	Noise Important Areas
NPPF	National Planning Policy Framework
NPSNN	National Policy Statement for National Networks
OBC	Outline Business Case
OS	Ordnance Survey
PCM	Pollution Climate Mapping
PM	Post meridiem
pSPA	Potential Special Protection Area
SPA	Special Protection Area
SAC	Special Area of Conservation
SuDs	Sustainable Drainage Systems
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
TAG	Transport Appraisal Guidance
WFD	Water Framework Directive

Units	Description
CO2	Carbon Dioxide
CO2e	Carbon Dioxide Equivalent
KM	Kilometre
M	Metre
MBGL	Metres Below Ground Level
NO2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
PM10	Particulate Matter with an aerodynamic diameter of 10µm or less
PM2.5	Particulate Matter with an aerodynamic diameter of 2.5µm or less
µg/m3	Microgram per cubic metre
µm	Micrometre (Micron)

1. INTRODUCTION

1.1. PURPOSE OF THIS APPRAISAL

1.1.1. This WebTAG Environmental Appraisal has been prepared in support of the Outline Business Case (OBC) for the North Hykeham Relief Road (hereafter referred to as the 'Proposed Scheme'), as described in **Chapter 2**.

1.1.2. This environmental appraisal of the Proposed Scheme has been undertaken as part of the transport appraisal process to identify whether beneficial or adverse environmental impacts are likely to arise. The objective of the transport appraisal process is to inform the OBC. If it is considered that there is reasonable possibility of significant environmental impacts arising, the environmental aspect would be scoped into the business case for further consideration.

1.1.3. The methods used in the undertaking of the environmental appraisal followed the principles set out in the Department for Transport (DfT) guidance Transport Analysis Guidance (TAG) Unit A3 Environmental Impact Appraisal (December 2015). This provides guidance for appropriately qualified environmental practitioners on appraising the impact of transport proposals on the built and natural environment, and on people. This appraisal is not intended to be an alternative to, or a replacement for, a statutory Environmental Impact Assessment (EIA) (if required).

1.1.4. The reporting of the environmental appraisal is provided in the form of a Worksheet for each of the topics and an Appraisal Summary Table (AST), provided in **Appendix A** and **Appendix B** respectively.

1.1.5. The environmental topics covered in this environmental appraisal are:

- Noise;
- Air Quality;
- Greenhouse Gases;
- Landscape;
- Townscape;
- Biodiversity;
- Historic Environment; and
- Water Environment.

1.1.6. This report presents the findings set out in the AST, supported by WebTAG Worksheets, for the environmental topics listed above. It also includes a short account of the impacts associated with each of the environmental topics.

2. DESCRIPTION OF THE PROPOSED SCHEME

2.1. SITE LOCATION AND CHARACTERISTICS

2.1.1. The existing road network in Lincoln consists of a number of regionally important routes through and around the city, as well as major routes into the city centre and local roads.

2.1.2. The main orbital and strategic routes include the A46 Western Relief Road/Northern Relief Road which forms part of the Highways England (HE) network, the A57 Saxilby Road/Carholme Road on the western side of Lincoln which provides a key east–west route into the City, the A15 which provides a major north south route through Lincoln and provides a link to the Humber Ports and the A1434 which again provides a route into the city from the south west and passes through several residential areas including North Hykeham.

2.1.3. There are also several other major routes which provide links to the city centre and the surrounding towns and villages. The network to the south of Lincoln consist of several rural and local routes which connect the villages to the major routes and roads in the area. The routes perform several different roles and in some instances, have several functions including strategically, regionally and locally.

2.1.4. There are a number of physical constraints and features which have an impact on the transport network within Lincoln. The most significant relate to the location of the rivers, watercourses and rail infrastructure. Lincoln is bisected by the River Witham and Fossdyke Navigation which cut through the city in both east-west and north-south direction. In addition, the railway lines also bisect the city. These run east-west through the centre of Lincoln and in a north-south direction through Hykeham.

2.1.5. The existing designated cycle network within the study area consists of Regional Route 93 which is an on-road section along Newark Road up to Bracebridge where the route continues into Lincoln city centre via a traffic-free route. Route 93 additionally diverts on-road up Fosse Lane to Whisby Nature Park. The Lincoln Eastern Bypass (LEB), which is currently under construction will be accompanied along its entirety by shared-use foot/cycleways.

2.2. CONSULTATION & ENGAGEMENT

2.2.1. A large amount of work has already been undertaken in developing the proposals and engaging with stakeholders and the public. The stakeholder and public engagement to date is summarised below. The earlier stages focussed on the need for the scheme, the route corridor alignment and the general principles. The most recent engagement phase (June 2018) focussed on the more detailed design proposals including the highway standard as well as the scheme objectives and requirements – further details are provided in the OBC Strategic Case Section 11.5.

- Option Assessment Report / Initial Stakeholder Engagement (2003);
- Stakeholder Workshop (June 2004);
- Public Engagement One (October 2005);
- Public Engagement Two (October 2006); and
- OAR engagement (Summer 2018).

2.2.2. In addition to the above, the following organisations have been contacted or consulted during this appraisal to gather further information regarding environmental constraints and considerations:

- Lincolnshire County Council (LCC);
- Environment Agency; and

- Upper Witham Internal Drainage Board.

2.3. SCHEME DESCRIPTION

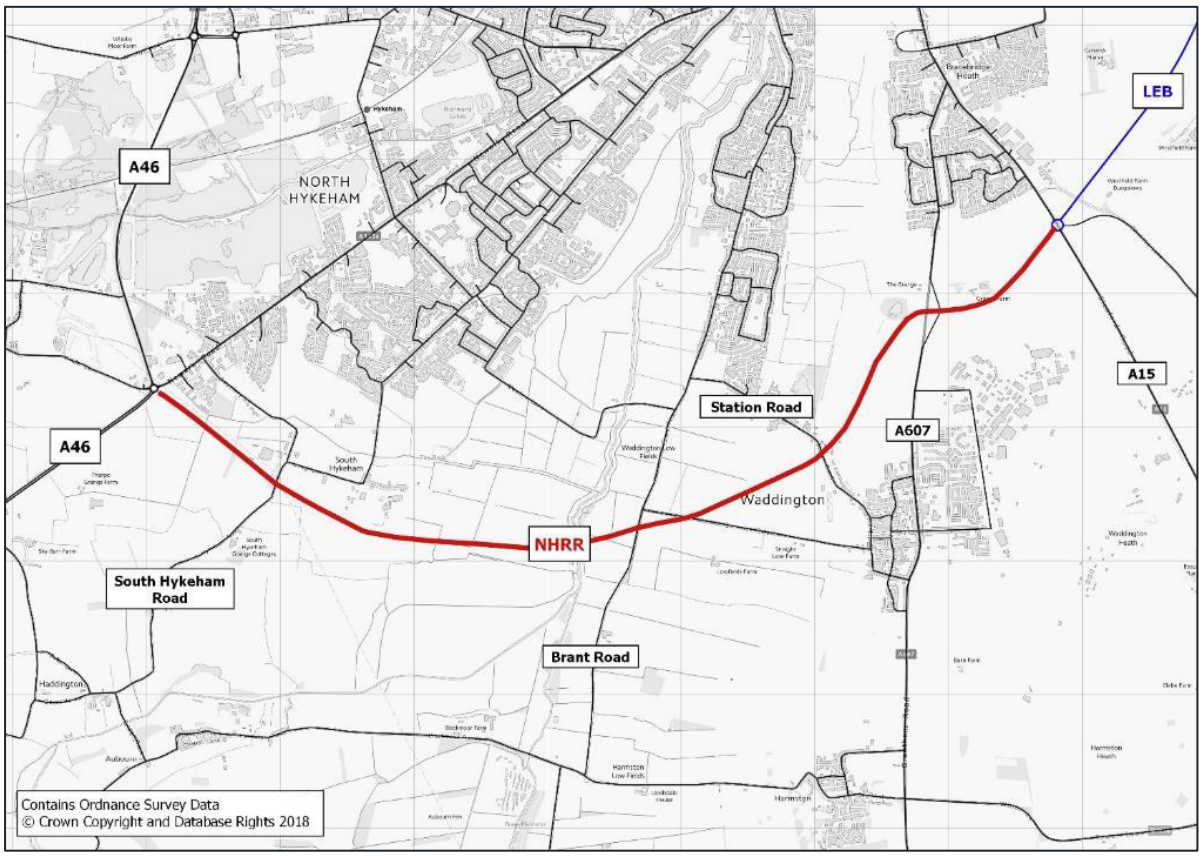
2.3.1. The North Hykeham Relief Road (the 'Proposed Scheme') is a proposed new road link to the south of the Lincoln urban area, which encompasses the City of Lincoln and the suburbs of North Hykeham, South Hykeham, Fosseway and Waddington in North Kesteven district.

2.3.2. The Proposed Scheme will form part of the Lincolnshire Coastal Highway and link the completed LEB, at the A15 Sleaford Road, with the existing A46 Western Bypass, at its junction with A1434 Newark Road, creating a complete orbital ring road around the Lincoln urban area.

2.3.3. It will have roundabout junctions with South Hykeham Road, Brant Road and A607 Grantham Road, and a new road bridge with the Proposed Scheme passing under Station Road and a new crossing of the River Witham. The preferred option is a dual carriageway with a design speed of 70 mph. The Proposed Scheme will introduce new traffic flows along its length and will change the physical alignment of existing traffic links at their junction with the Proposed Scheme. The Proposed Scheme therefore will alter the physical location of vehicles as well as have the potential to alter vehicle flow characteristics such as flow volumes, composition, and speeds on the existing road network.

2.3.4. Figure 1 below shows the Proposed Scheme in relation to North Hykeham and the local road network.

Figure 1 – Proposed Scheme in the context of North Hykeham



3. APPRAISAL METHODOLOGY

3.1. WEBTAG GUIDANCE

3.1.1. The WebTAG guidance for Environmental Impact Appraisals (TAG Unit A3, December 2015) provides guidance on appraising transport options against the Government's objective for transport. There are eight sub-objectives which deal with the impacts upon the environment these are as follows:

- Noise;
- Air Quality;
- Greenhouse Gases;
- Landscape;
- Townscape;
- Biodiversity;
- Historic Environment; and
- Water Environment.

3.1.2. This document presents the findings of the appraisal of the Proposed Scheme against these sub-objectives, where relevant. The methodology adopted for each technical appraisal is informed by the guidance provided in the relevant chapter of TAG Unit A3.

3.1.3. Where a monetary assessment is not feasible, WebTAG provides guidance on the qualitative assessment of the impacts. The impacts are then assessed using the recommended 7-point scale which breaks down impacts into Slight, Moderate or Large (Beneficial or Adverse) and Neutral. The WebTAG units also provide guidelines on the type of evidence to be used when applying this scale. These units may also contain worksheets which allow for a description of the qualitative impacts to be provided and then summarised in the AST to help inform the overall assessment of the Proposed Scheme.

3.1.4. The air quality and noise assessments have undertaken detailed modelling using traffic data to provide a quantitative appraisal of the air quality and noise impacts, including the numbers of sensitive receptors likely to be impacted by the Proposed Scheme and an estimated Net Present Value (NPV) figure.

3.1.5. To inform the environmental appraisals, desk-based data gathering was undertaken for each of the technical disciplines. This data search involved reviewing previous studies / reports and publicly available datasets from sources such as online mapping, local authority websites and GIS digital downloads. This data gathering exercise was supplemented by site visits, where appropriate. An environmental constraints plan has been produced and is shown in Figure A1 in **Appendix C**.

3.1.6. A Phase I Habitat Survey (Preliminary Ecological Appraisal (PEA) report, **Appendix D**) was also undertaken and has informed the appraisal within the biodiversity worksheet (**Appendix A**).

3.1.7. The results of the appraisal for each technical discipline are presented within the appropriate WebTAG worksheets in **Appendix A**. The findings of the appraisal of the Proposed Scheme are summarised in the AST in **Appendix B**.

3.2. SUB-OBJECTIVES TO BE SCOPED OUT

3.2.1. In line with the guidance set out in Chapter 5 (Environmental Capital Approach) of TAG Unit A3, each of the environmental sub-objectives has been subjected to an initial review to determine whether or

not the Proposed Scheme will result in any significant impacts upon the specific sub-objectives. TAG Unit A3 Chapter 5 states that *"Appraisal should be no more detailed than is required to support robust decision making. Where impacts are deemed to be minimal, further analysis may be scoped out"*.

3.2.2. The Proposed Scheme would be located predominantly in open countryside, crossing farmland, with only small settlements or the edge of the outlying villages of Lincoln, for example North Hykeham. In line with the guidance on the Environmental Capital Approach (Chapter 5 of TAG Unit A3), it has accordingly been concluded that, given the rural nature of the Proposed Scheme, the landscape sub-objective adequately considers the potential impacts in relation to the setting and that the townscape sub-objective would not be directly relevant to the decision-making process. Accordingly, the townscape sub-objective has been scoped out of the overall assessment and a more detailed appraisal of this sub-objective has therefore not been undertaken.

4. NOISE

4.1. INTRODUCTION

4.1.1. This chapter presents the noise appraisal for the Proposed Scheme, required to identify any potential constraints in relation to noise to help inform the OBC. This includes a summary of the baseline conditions, methodology and outcome of the WebTAG noise appraisal.

4.1.2. As described in **Section 2.3**, the Proposed Scheme will introduce new traffic flows along its length and will change the physical alignment of existing traffic links at their junction with the Proposed Scheme. The Proposed Scheme therefore will alter the physical location of vehicles as well as have the potential to alter vehicle flow characteristics, such as flow volumes, composition, and speeds on the existing road network, with associated effects on noise likely to be experienced at nearby sensitive receptors.

GUIDANCE AND BEST PRACTICE METHODOLOGIES

TAG Unit A3 Environmental Impact Appraisal, Department for Transport

4.1.3. With regards to noise impacts, the TAG Unit A3 impact appraisal used to focus on annoyance, however this emphasis has now shifted in light of growing evidence on the links between environmental noise and health outcomes. Defra has produced guidance on transport-related noise using an 'impact pathway' approach to include:

- Annoyance;
- Sleep disturbance; and
- Health impact, including heart disease (acute myocardial infarction, or AMI), stress and dementia.

4.1.4. 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 (presented within the Economic Case Appendix F - Social & Distributional Impacts Report(738233-WSP-T00-XX-RP-TP-0018)).

4.1.5. TAG Unit 3 refers to DMRB 11.3.7 and the Calculation of Road Traffic Noise (CRTN) for the quantification of noise impacts. The estimation of affected population is undertaken applying Defra's noise modelling tool, which contains dose-response functions for each impact pathway. These functions describe the percentage of the population affected at different noise levels for sleep disturbance and annoyance as well as the increase risk of adverse health outcomes for AMI, stroke and dementia.

4.1.6. 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. This part of the appraisal is based on the study 'Environmental noise: valuing impacts on sleep disturbance, annoyance, hypertension, productivity and quiet' (Defra, 2014) and the modelling tool.

4.1.7. The TAG Data Book Table A3.1 (V1.8.2) shows the annual value of the impact of a 1 dB change in exposure at noise levels between $L_{Aeq,16h}$ 45 dB to 81 dB. Values for sleep disturbance are given from L_{night} 45 dB to 81 dB.

Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, 2011

4.1.8. Prepared by the Highways Agency (now Highways England), Transport Scotland, Welsh Assembly Government and The Department for Regional Development Northern Ireland, the DMRB is a comprehensive manual, which contains requirements, advice and other published documents relating to both the design, maintenance, operation and assessment of trunk roads and motorways. It is stated that it may also, in part, be applicable to other roads with similar characteristics.

4.1.9. Volume 11: Environmental assessment, Section 3: Environmental assessment techniques: Part 7: HD 213/11 – Revision 1: Noise and vibration (HD 213/11, published in November 2011) provides guidance on the assessment of road traffic noise and vibration from new road projects.

4.1.10. HD 213/11 advises on the appropriate level of noise and vibration assessment for road schemes. Under DMRB, the procedure to assess impact uses three levels: a) Scoping; b) Simple; and c) Detailed.

4.1.11. Selecting the appropriate level of assessment depends on the following threshold criteria:

- Permanent change in magnitude of 1 dB(A) in the short term (i.e. on opening);
- Permanent change in magnitude of 3 dB(A) in the long term (i.e. between opening and future assessment years); and
- The predicted noise level during night-time, $L_{night,outside}$, is greater than 55 dB in any scenario.

Calculation of Road Traffic Noise (CRTN), 1988

4.1.12. This memorandum describes the procedures for calculating noise from road traffic. It is divided into three sections:

- Section I: A general method of calculation is set out, step by step, for predicting noise levels at a distance from a highway, taking into account different traffic parameters, intervening ground cover, road configuration and site layout;
- Section II: Provides additional procedures that may need to be considered when applying the method given in Section I to specific situations. The aim has been to permit prediction in as many cases as possible; and
- Section III: The procedure and requirements to be met during such measurements are detailed, together with details of a simplified measurement procedure which is acceptable in certain circumstances.

NOISE MODEL

4.1.13. A computer noise model using CadnaA® has been prepared to quantify the likely noise impact during the operational phase of the Proposed Scheme. Calculations in the model follow the methodology in CRTN, as amended by HD 11/213, and include for road traffic noise only. Where receptors are remote from road traffic sources, due to the absence of other contributing sources, predicted levels may be lower than they are in reality. In order to account for the potential contribution from sources not included in the model or excluded from the calculation (for example, as a result of vehicle flow falling below the threshold for valid calculations of LA10, 18h), a correction for existing ambient noise has been applied. A conservative correction of 35dB $L_{A10, 18h}$ has been added. This underlying level is sufficiently low not to affect the noise levels in areas where road traffic noise is dominant, but were applied to help ensure that the existing noise levels in more remote areas are not under-estimated and hence that the future changes in noise levels are not over estimated.

4.1.14. Ordnance survey and topographical data have been entered into the model. The 'with Scheme' (Do-something) noise model has incorporated the current 3D scheme design. It is noted however that junction details are currently available in 2D only with no vertical alignment details being available. Scheme junctions have therefore been incorporated within the noise model at grade with existing topography.

4.1.15. An address database has been incorporated to determine the use and location of properties within the study area in accordance with DMRB.

4.1.16. A total number of 20,179 properties have been included within the assessment. Except for a small number of properties where calculations have been undertaken at height of 1.5 m above ground (ground floor level), noise levels have been calculated at the façade of each receptor at a height of 4 m (first floor, as per the DMRB default height for dwellings), and to account for acoustic reflections, a correction of +2.5 dB has been added.

4.1.17. Noise levels for daytime have been determined using the following calculations:

- Daytime Noise Levels: $L_{A10,18h}$ (06:00 – 24:00 hours) values predicted following the methodology in CRTN have been converted to $L_{Aeq,16h}$ (07:00 – 23:00 hours) using the following expression: $LAeq,16h = LA10,18h - 2\ dB$

4.1.18. It is noted that several address points (from the AddressBase® database) were not necessarily accurately spatially placed within the provided data, with several instances where numerous AddressBase points were attributed to just one set of OS grid coordinates. When compared to provided OS MasterMap base mapping these locations did not have buildings attributed to them. Given the uncertainties associated with the location of these address points, it has not been possible to undertake calculations for these points.

4.1.19. The following road traffic noise scenarios have been modelled:

- Opening Year 2026, Do-minimum (without Scheme);
- Opening Year 2026, Do-something (with Scheme);
- Design Year 2041, Do-minimum (without Scheme); and
- Opening Year 2041, Do-something (with Scheme).

4.1.20. Where a building is predicted to experience different changes in noise level on different facades, the façade applicable to the least beneficial change in noise has been represented.

4.1.21. The calculated noise levels for daytime have been entered into the WebTAG Workbook in order to estimate the likely affected population and monetisation of the impact

4.1.22. Appraisal of night-time impacts has been undertaken on the basis of transformations between predicted daytime noise levels adopting the methodologies inherent within the WebTAG noise workbook.

STUDY AREA

4.1.23. The noise appraisal guidance for WebTAG refers to the methodology defined in the DMRB; therefore, the study area has been defined in accordance with the DMRB operational phase, adopting the following steps:

1. The start and end points of the physical works associated with the Proposed Scheme were identified;

2. The existing routes that are being bypassed or improved, and any new routes between the start and end points were identified;
3. A 1 km boundary from the carriageway edge of the routes identified above was defined;
4. A 600 m boundary from the carriageway edge around each of the routes identified in (2) and also 600 m from any other route within the boundary identified in (3) were identified. An affected route is where there is possibility of a change of 1 dB(A) in the short term and 3 dB(A) in the long term.

4.1.24. The noise study area is shown in **Figure A2 (Noise Study Area and NIA)**.

4.2. BASELINE CONDITIONS

IDENTIFIED SENSITIVE RECEPTORS

4.2.1. 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 20,179 properties have been included within the assessment.

FUTURE SENSITIVE DEVELOPMENTS

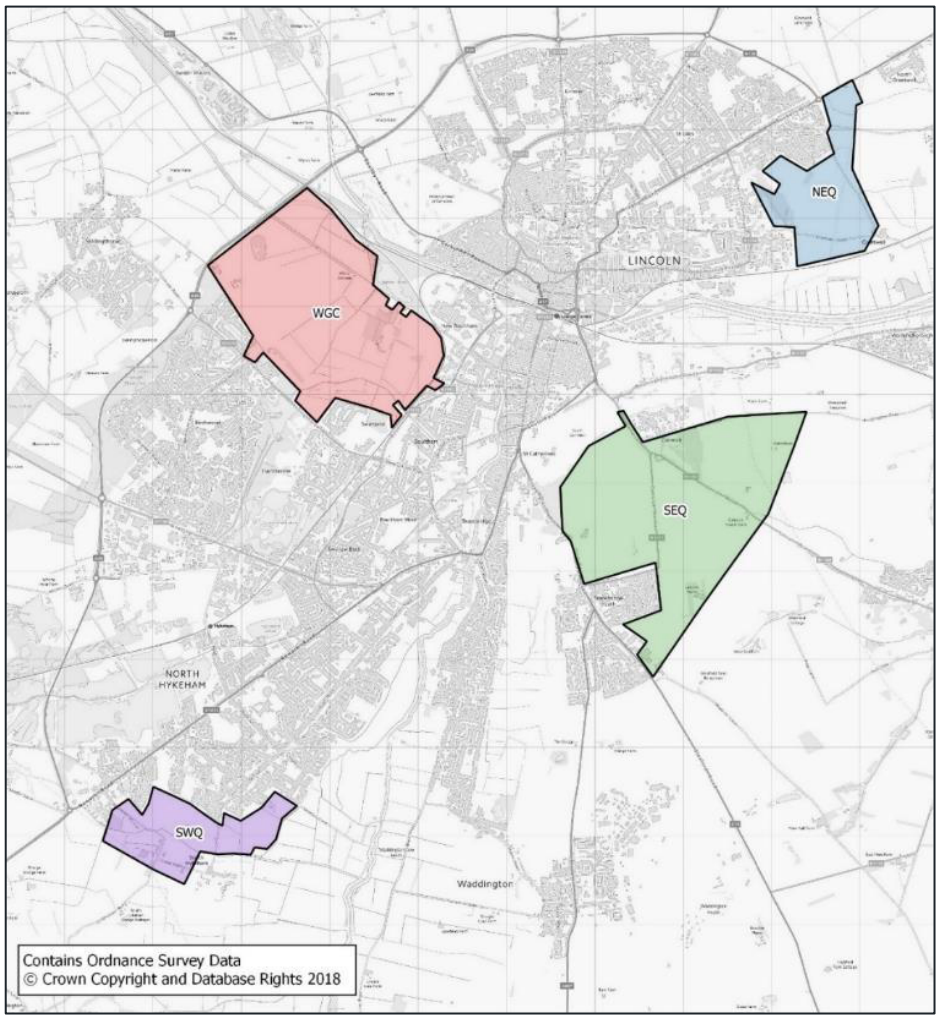
4.2.2. Committed developments incorporating sensitive receptors also have the potential to be affected by the Proposed Scheme and associated changes in road traffic noise levels.

4.2.3. There are four planned sustainable urban extensions (SUE) in the Greater Lincoln area, which may be affected by the Proposed Scheme, and have been included within the traffic model. These include the following, which can be seen within **Figure 2**:

- North East Quadrant (NEQ): Land at Greetwell, north east of Lincoln City Centre, to deliver 1,400 homes during the Plan period and up to 5ha of employment land plus community facilities and green space.
- South East Quadrant (SEQ): Land at Canwick Heath, south east of Lincoln City Centre, to deliver 3,500 homes during the Plan period (up to 6,000 in total) and up to 7ha of land for employment, community facilities and open space.
- South West Quadrant (SWQ): Land at Grange Farm, south west of Lincoln City Centre, to deliver 1,600 homes during the Plan period (up to 2,000 in total) and up to 5ha of land for employment, community facilities and open space.
- Western Growth Corridor (WGC): Land to the west of Lincoln City Centre to deliver 3,200 homes during the Plan period and up to 20ha of land for mixed-use development including commercial, leisure, retail, community facilities and open space.

4.2.4. In addition to the four SUEs, there are currently 90 residential development sites and 19 employment sites identified within the transport model area, covering Lincoln and part of North Hykeham and West Lindsey districts.

Figure 2 – SUE Locations



DEFRA IMPORTANT NOISE AREAS

4.2.5. 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 or nIAs).

4.2.6. The NIAs falling within the noise study area are listed below and are illustrated in **Figure A2**.

- NIA11158 – A section of the A1434 Newark Road at a distance of approximately 2.8 km to the north of the Proposed Scheme;
- NIA11157 – A section of Newark Road at a distance of approximately 3.2 km to the north of the Proposed Scheme;
- NIA11156 – A section of the A15 South Park at a distance of approximately 3.7 km to the north of the Proposed Scheme;

4.2.7. At this stage a baseline noise survey has not been undertaken.

4.3. MITIGATION

4.3.1. Mitigation measures will be considered at a later stage as appropriate to minimise any impact arising from the operation of the Proposed Scheme, both on residential and other sensitive receptors within proximity to the scheme. The feasibility of implementing noise barriers and low-noise road surface will be explored; however, constraints related to ecology, structural and landscape may also feed into the design of appropriate measures.

4.3.2. Implementation of noise barriers has the potential to achieve noise attenuation up to 10 dB(A) when the line-of sight to the receptor(s) is broken. The implementation of a low-noise surface has the potential to achieve a noise attenuation in the order of 3.5 dB(A) where speeds are greater than 75 km/h. This may seem a small degree compared to the potential performance of noise barriers, but should provide a noticeable improvement, depending on traffic speed, whilst it's not unusual for the performance of barriers to be limited to a similar degree due to various factors.

4.4. APPRAISAL SUMMARY

4.4.1. The results of the noise appraisal are presented in **Appendix A**, and are summarised as follows. These have been generated adopting least beneficial noise changes calculated at each residential receptor and thus represent a worst case:

- In the Opening Year (2026), a total of 970 properties would be subject to an increase in daytime noise levels and 712 properties would experience a reduction.
- In the Design Year (2041), a total of 748 properties would be subject to an increase in daytime noise levels and 3158 properties would experience a reduction.
- The overall appraisal indicates that the operation of the scheme is likely to generate a beneficial noise impact and that the 'net present value of change in noise' is calculated to be £5,212,053.
- The impact pathways described earlier in the report have been assessed, and the scheme is likely to generate a beneficial effect for all pathways. The following net present values have been calculated:
  - Sleep disturbance: £2,129,572
  - Amenity: £2,172,988
  - AMI: £427,416
  - Stroke: £192,055
  - Dementia: £290,022

4.4.2. The following should also be taken into consideration:

- In the Opening Year if the Proposed Scheme does not go ahead, then 822 properties would be subject to a daytime noise level $L_{Aeq,16h}$ of 66 dB or higher (equivalent to $L_{A10,18h}$ 68 dB or higher). Conversely, if the Proposed Scheme goes ahead, then the number of properties subject to 66 dB(A) or above would reduce slightly to 796.
- In the Design Year, if the Proposed Scheme does not go ahead, then 710 properties would be subject to a daytime noise level $L_{Aeq,16h}$ of 66 dB or higher (equivalent to $L_{A10,18h}$ 68 dB or higher). Conversely, if the Proposed Scheme goes ahead, then the number of properties subject to 66 dB(A) or above would decrease slightly to 603.

4.5. CONCLUSION

4.5.1. The noise appraisal has been undertaken following the methodology presented in WebTAG Unit A3, Environmental Impact Appraisal, dated December 2015.

4.5.2. A computer noise model has been generated following the guidance contained within CRTN and the DMRB.

4.5.3. The estimated affected population and the monetary valuation of changes in noise impact have been determined using the TAG Noise Appraisal Workbook (**Appendix A**).

4.5.4. The overall appraisal indicates that the operation of the Proposed Scheme, without mitigation, is likely to generate a beneficial noise impact, and that the 'net present value of change in noise' is calculated to be £5,212,053.

4.5.5. Mitigation will be considered at a later stage, where consideration will be given to both residential and other sensitive receptors within proximity to the scheme.

5. AIR QUALITY

5.1. INTRODUCTION

5.1.1. The Proposed Scheme will change the physical arrangement of the local road network and therefore result in changes to vehicle flow volumes, composition, and speeds. As such, there is the potential for local and regional concentrations and mass emissions of air pollutants to be affected by changes in vehicle emissions associated with the Proposed Scheme.

5.1.2. This chapter presents the air quality appraisal for the Proposed Scheme, required to identify any potential constraints in relation to air quality in order to help inform the OBC. This includes a summary of the baseline data utilised, methodology and impacts identified.

LEGISLATION

European Legislation

5.1.3. Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008[1] on ambient air quality and cleaner air for Europe sets out the obligations and limits values for EU governments with regards to air quality, and consolidates earlier legislation into a single piece of legislation. The directive sets the limit values for nitrogen oxides (NO_x) for the protection of vegetation, and the values of nitrogen dioxide (NO_2) for the protection of human health, and particulate matter at 10µm and 2.5µm for the protection of human health.

National Legislation

5.1.4. Directive 2008/50/EC is transposed into English law by the Air Quality Standards Regulations 2010[2] as amended which sets the limits for exposure to certain pollutants. The government is required under the Environment Act 1995 to produce a National Air Quality Strategy (AQS) which summarises limit and objective values for a variety of pollutants and recognises that action at a national, regional or local level may be required to ensure the objectives are met.

The relevant national air quality standards and objectives, as prescribed through the Air Quality Strategy[3] and most applicable for the appraisal of air quality, are presented in **Table 2**.

[1] European Parliament and Council (2008) Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 [online] accessed February 2019

[2] UK Government (2010) The Air Quality Standards Regulations 2010 [online] accessed February 2019

[3] Department for the Environment, Food and Rural Affairs (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland [online] accessed February 2019

AIR QUALITY STRATEGY OBJECTIVES

Table 1 - Relevant air quality limit and objective values

Pollutant	Objective/ Limit Value	Measure as	Date to be achieved by and maintained thereafter		
			AQS	Regs	2008/50/EC
NO_2	200 µg/m³ Not to be exceeded more than 18 times a year	1-hour mean	31-Dec-05	31-Dec-05	1-Jan-10
	40 µg/m³	Annual mean	31-Dec-05	31-Dec-05	1-Jan-10
NOx	30 µg/m³	Annual mean	31-Dec-00	31-Dec-00	19-Jul-01
PM_{10}	40 µg/m³	Annual mean	31-Dec-04	31-Dec-04	01-Jan-05
	50 µg/m³ Not to be exceeded more than 35 times a year	24-hour mean	31-Dec-04	31-Dec-04	01-Jan-05
$PM_{2.5}$	25µg/m³	Annual mean	2020	01-Jan-15	2010 (Target value)
	Percentage reduction in exposure		15% reduction between 2010 and 2020	Concentration based reduction by 2020	20% reduction between 2010 and 2020

5.1.5. In 2019 the government published its Draft Clean Air Strategy as a final document[4]. The strategy recognises the value of the natural environment and its susceptibility to air pollution. The strategy details current actions to reduce emissions from transport and reduce nitrogen deposition from a variety of pollutant sources.

[4] Department for the Environment, Food & Rural Affairs (2019) Clean Air Strategy 2019 [online] accessed February 2019

5.2. APPRAISAL METHODOLOGY

5.2.1. The appraisal methodology followed section 3 of TAG Unit A.3[5]. This methodology requires the use of the Design Manual for Roads and Bridges (DMRB) Volume 11 Section 3 Part 1 HA 207/07 Air Quality[6]. Where appropriate, DMRB Interim Advice Notes (IAN) were used for the assessment. Relevant IANs are:

- 170/12 v3 Updated air quality advice on the assessment of future NO_x and NO_2 projections;
- 175/13 Updated air quality advice on risk assessment related to compliance with the EU Directive.

5.2.2. Air quality modelling was undertaken using the ADMS-Roads Extra 4.1.1 dispersion modelling software using traffic data provided by WSP, emissions represented by the Defra Emissions Factor Toolkit (EFT) v8.1 and meteorological data for RAF Waddington.

5.2.3. Modelling provides predicted concentrations for each link at distances of 20m, 70m, 115m and 175m from the link centre. Geographical Information System (GIS) software was used to identify the centre of each traffic link and plot representative points for the concentration calculations at the prescribed distance from each link.

5.2.4. The WebTAG assessment makes use of the following calculation workbooks:

- Local Air Quality Workbook;
- Air Quality Valuation Workbook; and
- TAG Data Book[7].

5.2.5. The Distributional Impact (DI) analysis was undertaken according to the methodology from section 4 of TAG Unit A4.2[8] using data obtained through GIS analysis and the WebTAG assessment. The workbooks required for this assessment are:

- Air Quality DI Worksheet;
- Air Quality Appraisal Matrix; and
- Air Quality DI Output Summary.

LOCAL AIR QUALITY APPRAISAL

5.2.6. Traffic data on modelled links were screened according to the criteria outlined in HA 207/07 for local air quality assessment. Modelled traffic links should meet any one of the following criteria to be included as 'affected' roads in the assessment:

- Road alignment will change by 5m or more; or
- Daily traffic flows will change by 1,000 AADT or more; or

[5] Department for Transport (2015) TAG Unit A3 Environmental Impact Appraisal [online] accessed February 2019

[6] Highways Agency (2007) Design Manual for Roads and Bridges Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 1 HA207/07 Air Quality

[7] Department for Transport (2018) WebTAG Data Book November 2018 v1.11 [online] accessed February 2018

[8] Department for Transport (2015) TAG Unit A4.2 Distributional Impact Appraisal [online] accessed February 2019

- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more; or
- Daily average speed will change by 10 km/hr or more; or
- Peak hour speed will change by 20 km/hr or more.

5.2.7. The Greater Lincoln Transport Model (GLTM) was used in the forecasting and appraisal. This includes a highway assignment model in SATURN version 11.3.12W which determines journeys travelling on the highway network including traffic flows, speed, delays, route choice and journey costs.

5.2.8. The GLTM suite also includes a public transport assignment model and a variable demand model, both developed in CUBE Voyager v6.4. Variable demand modelling is applied in the forecast years to predict the changes in traveller behaviour from a scheme of this size, with respect to mode choice and destination choice. The choices are facilitated based on changes to travel cost derived from the models. The public transport assignment model provides dynamic journey costs for bus and rail to facilitate mode shift in the variable demand forecasting. There are three modelled time periods:

- AM Peak Hour: 08:00 – 09:00;
- Inter Peak Average Hour: between 10:00 – 16:00; and
- PM Peak Hour: 17:00 – 18:00.

5.2.9. The number of potentially sensitive receptors, as defined in DMRB HA207/07, within 200m of the affected road centreline was identified through the use of Ordnance Survey (OS) AddressBase data[9] joined to OS Mastermap topography data to obtain façades. Receptors were separated according to four prescribed distance bandings from the link centreline (0-50m, 50-100m, 100-150m and 150-200m) and joined to the nearest affected road. These data were used for the WebTAG assessment and valuation, and for the DI analysis.

5.2.10. Concentrations were calculated using the ADMS-Roads Extra software at the mid-point of the prescribed distance bands at distances of 20m, 70m, 115m and 175m from each link centre for NO_x, PM_{10} and $PM_{2.5}$. Additional processing of the predicted NO_x concentrations was undertaken using the Defra NO_x to NO_2 Calculator v6.1 to obtain concentrations of NO_2.

5.2.11. The Defra NO_2 Adjustment for NO_x Sector Removal Tool v6.0 was used to correct background concentrations of NO_x, PM_{10} and $PM_{2.5}$ by removing the road generated component thereby avoiding double counting of road generated emissions.

5.2.12. Base year traffic data (2016) was growthed to match the latest available air quality monitoring data (2017) with the National Trip End Model Presentation Program (TEMPro) v7.2[10] software and relevant regional database available from the Department for Transport. A growth factor of 1.01 was applied to all affected links.

[9] Ordnance Survey (2019) Addressbase Premium, coverage SK87, SK97, TF07, TF17, SK86, SK96, TF06, TF16.

[10] Department for Transport (2019) Trip End Model Presentation Program (TEMPro) [online]

5.2.13. Traffic data on modelled links were screened according to the criteria outlined in HA 207/07 for the regional air quality assessment. Modelled traffic links should meet any one of the following criteria to be included in the regional air quality assessment:

- A change of more than 10% in AADT; or
- A change of more than 10% to the number of heavy duty vehicles; or
- A change in daily average speed of more than 20 km/hr.

5.2.14. An assessment of the regional air quality impact was undertaken using output data from EFT v8.0 which is annual mass emissions of NO_x, PM_{10}, $PM_{2.5}$ and CO_2 from the modelled traffic data.

LIMITATIONS

5.2.15. The TAG Unit A3 guidance was written with the assumption that the DMRB Screening Tool v1.03c would be available, however this is no longer the case as the tool has been withdrawn. The DMRB screening tool relies on a simple decay with distance equation into which emission factors for different vehicle categories are input. To perform this analysis, it was necessary to use the ADMS-Roads Extra v4.1.1 programme which uses a more complex Gaussian plume model with modules to account for additional factors such as meteorological conditions and traffic wake disturbance. As a result, the concentrations obtained may be more reflective of actual conditions, however are likely to be significantly different from those obtained using the withdrawn DMRB Screening Tool v1.03c.

5.2.16. Verification of the modelled output was undertaken using diffusion tube information provided in the ASRs of the various local authorities affected by the Proposed Scheme. One of the tubes used was confirmed as having an erroneous location reported in the relevant ASR and was subsequently corrected. It was not possible to visually confirm the locations of other diffusion tubes used in the verification.

5.2.17. Some local authority diffusion tubes are located at junctions. This can be a useful location for local air quality management, however the elevated concentrations and traffic conditions in such areas can affect the performance of models and the accuracy of model verification.

5.2.18. This section provides a brief review of local air quality associated with the Proposed Scheme location and surrounding area within the context of relevant national air quality standards and objectives.

5.2.19. To inform the assessment and obtain appropriate baseline information for the area of the Proposed Scheme, a desk-based review of the following available air quality information was undertaken:

- Collation and review of the most recent local monitoring data and Local Air Quality Management (LAQM) Review and Assessment report available for North Kesteven District Council (NKDC) and City of Lincoln Council (CLC), including the presence of any known Air Quality Management Areas (AQMAs);

- Review of additional air quality data available for the area surrounding the Proposed Scheme, including data available from Defra's online LAQM support pages[11];
- A review of local mapping OS AddressBase and Openmap Local[12] data available for the study area to identify existing receptors that may be sensitive to a change in local air quality with the operation of the Proposed Scheme;
- A review of information available regarding the presence of any ecological receptors from the Multi-Agency Geographic Information for the Countryside (MAGIC) on-line mapping website[13]; and
- A review of Defra's Pollution Climate Mapping (PCM) Model.

REVIEW AND ASSESSMENT OF AIR QUALITY

5.2.20. The physical extent of the Proposed Scheme is located within the administrative boundary of NKDC. Modelled road links scoped in to the assessment are located within the administrative boundaries of NKDC, CLC, Newark and Sherwood District Council (NSDC) and West Lindsay District Council (WLDC).

5.2.21. The latest Local Air Quality Management Review and Assessment document produced by NKDC is the 2018 Annual Status Report (ASR) 2018[14]. The report provides an overview of air quality in North Kesteven District, actions to improve air quality and priorities and challenges that the local authority face.

5.2.22. The 2018 ASR provides the following narrative:

- *"In 2017 there were no recorded exceedances of the Air Quality Strategy objectives at any of the monitored sites and there are currently no Air Quality Management Areas (AQMAs) designated within the District;*
- *With continued levels of development being experienced across the country, an emphasis on air quality is important to ensure areas of poor air quality are identified and acted upon. Across the District air quality continues to be assessed through the monitoring network whereby any areas of poor air quality would be identified; and*
- *Significant housing developments within the District will lead to an increase in population and therefore in vehicle usage."*

5.2.23. At its closest point, the Proposed Scheme is situated to within 1 km of the jurisdiction of the City of Lincoln where there is one AQMA, designated in 2001 (revised 2014), covering the road network of the city centre for the annual NO_2 objectives. A citywide AQMA designated in 2008 for both PM_{10}

[11] Department for environment, Food & rural affairs (2019) Local Air Quality Management (LAQM) Support [online] accessed February 2019

[12] Ordnance Survey (2019) Openmap Local, coverage SK, TF

[13] Department for Environment, Food and rural Affairs and MAGIC partner organisations (2019) Multi-Agency Geographic Information for the Countryside (MAGIC) [online] accessed February 2019

[14] North Kesteven District Council (2018) 2018 Annual Status Report [online] accessed February 2019

objectives was recommended for revocation in 2017 as measured concentrations were consistently below the objective and limit values, and was revoked on 3rd August 2018[15].

5.2.24. The 2018 ASR for CLC[16] reports that all automatic and passive monitoring in the city recorded concentrations below the short-term and long-term objective and limit values for NO_2 except for one site located at Drill Hall, Broadgate. This site recorded a concentration of 45.3µg/m³, which is over 10µg/m³ higher than the next highest concentration recorded.

5.2.25. Information from the NSDC 2018 ASR[17] indicates that concentrations in the local authority area are below the limit and objective values. Diffusion tube and automatic monitoring indicates that concentrations in the local authority area are below the objective and limit values.

5.2.26. The 2018 ASR for WLDC[18] states that there are currently no AQMAs declared in the local authority area due to monitored concentrations being historically well below the objective and limit values.

AIR QUALITY MONITORING

5.2.27. There is no automatic monitoring undertaken by any of the four affected local authorities that is within the scope of the affected roads.

5.2.28. Non-automatic passive diffusion tube monitoring was undertaken by NKDC and CLC within the scope of the affected roads, with the relevant locations and concentrations, are shown in **Table 2**.

Table 2 – Local authority air quality monitoring relevant to the affected roads

Site ID	Local Authority	Site Type	OS X	OS Y	Height (m)	Valid DC 2017 (%)	Annual Mean Concentration (µg/m³)		
							2015	2016	2017
A	NKDC	Roadside	493845	366567	2.5	83	33.8	36.6	33.4
B	NKDC	Kerbside	498000	367544	2.1	78	-	-	21.7
St. Nick	NKDC	Roadside	497718	363898	2.5	75	-	-	18.6
Canwick	NKDC	Roadside	489561	369494	2.5	75	-	-	10.6
BH	NKDC	Roadside	498000	369544	2.5	78	-	-	26.8
Waddington	NKDC	Roadside	497718	363898	2.5	75	-	-	10.6

[15] Defra (2018) List of local authorities with AQMAs [online] https://uk-air.defra.gov.uk/aqma/list?la=L&country=england&pollutant=pm10 accessed February 2019

[16] City of Lincoln Council (2018) Air Quality Status Report 2018 [online] accessed February 2019

[17] Newark and Sherwood District Council (2018) Annual Status Report 2018 [online] accessed February 2019

[18] West Lindsey District Council (2018) Air Quality Report 2018 [online] accessed February 2019

A46-1	NKDC	Roadside	489328	363195	1.9	8	24.3	25.6	-
A46-2	NKDC	Roadside	488328	362525	1.8	17	39.9	32.3	-
8	CLC	Roadside	497190	370080	2.5	100	31.6	31.8	28.2
9	CLC	Roadside	497112	369351	2.75	100	25.6	28.4	25.1
13	CLC	Roadside	196464	368187	2.6	100	24.4	25.6	27.8

5.2.29. The highest monitored NO_2 concentration observed in 2017 relevant to the assessed links was 33.4 µg/m³ at the 'A' diffusion tube site. The site is situated approximately 1.9 km to the north east of the Proposed Scheme, at the junction of A1434 Newark Road, Moor Lane and Station Road, in North Hykeham.

BACKGROUND POLLUTANT CONCENTRATIONS

5.2.30. Defra provide empirically-derived national background maps[19], which provide estimates of background pollutant concentrations on a 1 km x 1 km grid square resolution for years 2015 to 2030 from a base year of 2015. These were reviewed and the relevant year background concentrations were used for the local air quality calculations.

5.2.31. The 2019 NO_2 concentrations are generally low, with slightly elevated values concentrated around Lincoln City Centre and suburbs around North Hykeham. Background concentrations are below the limit and objective value of 40µg/m³.

5.2.32. Mapped background NO_x concentrations for 2019 in rural Lincolnshire are generally low, however there are higher concentrations predicted in Lincoln City Centre and on the existing bypass to the west of North Hykeham that are up to 90% of the limit and objective value of 30µg/m³.

5.2.33. The 2019 mapped background concentrations of PM_{10} are low, being not more than 50% of the limit and objective values, and are evenly spread across this area of Lincolnshire.

5.2.34. Mapped background concentrations of $PM_{2.5}$ are generally low in this area of Lincolnshire for 2019, being not more than 50% of the objective. $PM_{2.5}$ is shown to be evenly spread without obvious areas of elevated concentrations.

POLLUTANT CLIMATE MAPPING MODEL CONCENTRATIONS

5.2.35. Information on areas that are exceeding the European Union limit value thresholds can be sourced from Defra's Pollution Climate Mapping (PCM) model whereby projections for concentrations of annual mean NO_x and NO_2 have been calculated across the UK between 2017 and 2030 inclusive. The data were generated in support of Defra's UK Plan for tackling roadside NO_2 concentrations[20].

[19] Defra (2018) Background Mapping data for local authorities – 2015 [online] accessed February 2019

[20] Department for the Environment Food & Rural Affairs (2017) Air Pollution in the UK 2017 [online] accessed February 2019

5.2.36. The PCM road links overlapped by the assessed links, for which a roadside pollutant concentration is produced by PCM modelling, were identified. The relevant modelled roadside NO_2 concentration for the 2017 base year are shown in **Table 11**.

5.2.37. Based on the 2017 reference year data for NO_2 roadside NO_2 concentrations modelled within the PCM model for those road links that are situated within 2 km of the Proposed Scheme are below limit and objective value of 40 µg/m^3. The highest roadside annual mean NO_2 concentration for 2017 is 26.4µg/m^3 along the A15 South Park avenue in the City of Lincoln, Defra census link 48447.

STATUTORY ECOLOGICAL DESIGNATIONS

5.2.38. DMRB HA207/07 states that statutory designated conservation sites may be sensitive to NO_X and nitrogen deposition, which can have direct and indirect impacts upon vegetation, affecting species composition and ecosystem health.

5.2.39. The Greetwell Hollow Quarry SSSI (ID 1003018) is located within 200m of an affected road, however as this is designed for its geological characteristics[21] it is scoped out of the assessment.

5.2.40. There are no further statutory designated sites within 200m of the affected roads.

5.3. APPRAISAL SUMMARY

5.3.1. The results of the air quality appraisal Workbook are presented in **Appendix A** and they can be summarised as follows:

LOCAL AIR QUALITY APPRAISAL

5.3.2. **Table 3** provides a breakdown of the number of sensitive receptor locations that are situated within 200m of the affected road centrelines for the Do-Minimum and Do-Something scenarios. The locations of receptors are shown in Figure A3 and Figure A4.

Table 3 Sensitive Receptors within 200m of the Affected Road Centreline

Distance	0-50m	50-100m	100-150m	150-200m	Total
Do-Minimum Receptors	6,276	4,726	4,361	4,045	19,408
Do-Something Receptors	6,273	4,722	4,366	4,047	19,408

5.3.3. The air quality sensitive receptors within 200m of the road centreline of the Proposed Scheme include residential properties, the closest of which are on Station Road in Waddington. Seven of these properties are estimated to be demolished as part of the Proposed Scheme.

NO_2 Assessment

5.3.4. The results of the WebTAG assessment for NO_2 for the opening year 2026 are shown in **Table 4**.

[21] Natural England (2019) Designated Sites View: Greetwell Hollow Quarry [online] accessed February 2019

Table 4 – Assessment summary for NO_2 for the opening year 2026

Assessed Element	Value
Net total assessment for NO_2 for all routes	**-454.9**
Number of properties with an improvement	*16345*
Number of properties with no change	*86*
Number of properties with a deterioration	*2977*

5.3.5. The property weighted net total assessment for NO_2 across all routes of -454.9 shown in **Table 4** indicates an overall predicted improvement in exposure to NO_2 within 200m of the affected links for the opening year 2026. Additional interpretation on the numbers of properties predicted to experience improvements or deteriorations in air quality is included after **Table 8**.

5.3.6. The results of the WebTAG assessment for NO_2 for the operating year 2041 are shown in **Table 5**.

Table 5 - Assessment summary for NO_2 for the opening year 2041

Assessed Element	Value
Net total assessment for NO_2, all routes (II-I)	**1221.9**
Number of properties with an improvement	*12979*
Number of properties with no change	*39*
Number of properties with a deterioration	*6390*

5.3.7. The property weighted net total assessment across all routes of 1221.9 shown in **Table 5** indicates an overall predicted deterioration in exposure to NO_2 within 200m of the affected links for the operating year 2041.

5.3.8. The number of properties with predicted improvements or deteriorations is inconsistent with the overall score of a deterioration in property weighted concentrations. This is interpreted following **Table 8**.

PM_{10} Assessment

5.3.9. The results of the WebTAG assessment for PM_{10} for the opening year 2026 are shown in **Table 6**.

Table 6 - Assessment summary for PM_{10} for the opening year 2026

Assessed Element	Value
Net total assessment for PM_{10}, all routes (II-I)	**3129.9**
Number of properties with an improvement	*15430*
Number of properties with no change	*0*
Number of properties with a deterioration	*3978*

5.3.10. The property weighted net total assessment across all routes of 3129.9 shown in **Table 6** indicates an overall predicted deterioration in exposure to PM_{10} within 200m of the affected roads for the opening year 2026.

5.3.11. The number of properties with predicted improvements or deteriorations is inconsistent with the overall score of a deterioration in property weighted concentrations. This is interpreted following **Table 8**.

5.3.12. The results of the WebTAG assessment for PM_{10} for the operating year 2041 are shown in **Table 7**.

Table 7 - Assessment summary for PM_{10} for the operating year 2041

Assessed Element	Value
Net total assessment for PM_{10}, all routes (II-I)	**3550.4**
Number of properties with an improvement	*13044*
Number of properties with no change	*0*
Number of properties with a deterioration	*6364*

5.3.13. The property weighted net total assessment across all routes of 3550.4 shown in **Table 7** indicates an overall predicted deterioration in exposure to PM_{10} within 200m of the affected links for the operating year 2041.

5.3.14. The number of properties with predicted improvements or deteriorations is inconsistent with the overall score of a deterioration in property weighted concentrations. This is interpreted following **Table 8**.

Additional Interpretation

5.3.15. For the NO_2 and the PM_{10} results it is apparent that the number of properties predicted to experience improvements or deteriorations in air quality is inconsistent with the overall scenario year score. Further analysis on average score of the links with relevant properties is shown in **Table 8**.

Table 8 – Links with an improvement or deterioration in air quality

		NO_2 2026	NO_2 2041	PM_{10} 2026	PM_{10} 2041
Links with improvement	No. links	267	253	276	262
	Absolute Average Score	10.6	7.6	5.3	5.1
Links with deterioration	No. links	128	143	126	140
	Absolute Average Score	18.6	22.1	36.4	34.9

5.3.16. **Table 8** shows that the absolute average scores for improvements in air quality are less for each of the scenarios with overall deterioration scores, NO_2 2041, PM_{10} 2026 and 2041, than for NO_2 2026. A similar situation is present for the absolute average score for deteriorations in air quality, where the score for NO_2 2026 is less than for NO_2 2041, and PM_{10} 2026 and 2041.

REGIONAL AIR QUALITY APPRAISAL

5.3.17. Mass emissions of regional pollutants are shown in **Table 9**.

Table 9 – Regional total mass emissions

Pollutant (tonnes/year)		Without scheme		With scheme		Change in emissions	
		Opening year	Forecast year	Opening year	Forecast year	Opening year	Forecast year
NO_x emissions	Areas not exceeding limit values	111.3	95.4	125.2	107.4	13.9	12.0
	Areas exceeding limit values	1.5	0.00	1.6	0.00	0.1	0.00
PM_{10} emissions		19.0	21.2	21.3	24.1	2.3	2.9
$PM_{2.5}$ emissions		10.4	11.5	11.7	13.1	1.3	1.6
CO_2 emissions		78,869.4	85,910.0	88,295.1	97,648.6	9,425.7	11,738.6

5.3.18. The total NO_x emissions shown in **Table 9** show that there are increases in total emissions in both the opening year and the forecast year. The data also show that there are areas exceeding the NO_x objective and limit values in the opening year, but that these exeedances are no longer present in the forecast year. This is expected to be as a result of predicted traffic volumes, improvements in vehicle technologies and reductions in Defra background concentrations.

5.3.19. All other pollutants shown in **Table 9** show increases in total emissions with the Proposed Scheme in place for both the opening year and forecast year. Whilst the change in NO_x emissions is predicted to be less in the forecast year than the opening year as a likely result of improvements in vehicle technologies and fleet composition changes, the change in PM emissions is predicted to be greater in the forecast year than the opening year. This is likely to be due increases in traffic volumes and PM emissions from increased volumes of tyre and brake wear as a result.

AIR QUALITY VALUATION

5.3.20. The net change in NO_x over the 60-year appraisal period is reported at 741 tonnes, which has a Net Present Value (NPV) dis-benefit of £349,092. The change in the route assessment relevant to emissions of PM_{10} is reported to have a NPV dis-benefit of £8,803,338.

5.3.21. The total NPV of the impact on air quality as a result of the Proposed Scheme is a dis-benefit of £9,152,430, with an upper NPV estimate of £10,412,716 and a lower NPV estimate of £4,886,753.

DISTRIBUTIONAL IMPACT ANALYSIS

5.3.22. The results of the distributional impact analysis for NO_2 and PM_{10} for the opening year and operating year are shown in **Table 10**, and discussed in more detail in the social and Distributional Impacts Report.

Table 10 – Distributional impact analysis results

Scenario	Distributional impact of income deprivation					Are the impacts distributed evenly?
	0-20%	20-40%	40-60%	60-80%	80-100%	
2026 NO_2	✓✓✓	✓✓✓	✓✓	✓	✓	No
2026 PM_{10}	✓✓✓	✓✓✓	×××	✓✓	✓✓	No
2041 NO_2	✓✓✓	✓✓✓	O	✓	✓✓	No
2041 PM_{10}	✓✓✓	✓	×××	✓✓	✓✓✓	No

5.3.23. The results of the distributional impact analysis shown in **Table 10** show that the majority of benefits are concentrated in the more deprived two quintiles of the population within 200m of the affected roads. Where there are negative impacts in the 3rd quintile, these will have a disproportionate benefit on the two quintiles below this.

5.3.24. Based on the distribution of the population of young people within 200m of the affected roads, it is predicted that there will be a large benefit on this section of the population.

DIRECTIVE 2008/50/EC COMPLIANCE

5.3.25. The results of the assessment for compliance with the EU directive are shown in **Table 11**.

Table 11 – EU Directive 2008/50/EC compliance assessment results

Inputs				Defra PCM Model and Compliance Information					HA Receptor Result			
Scheme Link ID	Defra's PCM Data			Total NO_2 ($\mu g/m^3$)			Compliance Info (see Annex B IAN 175/13)		Annual Mean NO_2 Concentration ($\mu g/m^3$) (Nearest Receptor to Defra Link)			
	Defra Link Census ID	Zone / Agglo. Ref No	Compliant Zone?	Preceding year NO_2	Following Year NO_2	Equivalent Opening Year NO_2	Maximum Modelled Conc in Zone	Projected Compliance Year	DM	DS	Change (DS-DM)	Equivalent PCM DS ($\mu g/m^3$)
10436_10379	26223	UK0032	N	10.8	0.9	8.8	65	<2025	17.8	16.0	-1.8	7.0
10055_10439	38464	UK0032	N	13.9	1.2	11.4	65	<2025	18.9	17.2	-1.8	9.6
10054_10442	48447	UK0032	N	15.6	1.3	12.7	65	<2025	19.8	18.5	-1.3	11.4
10113_10210	77386	UK0032	N	9.5	0.8	7.8	65	<2025	8.4	9.0	0.6	8.3
10425_10424	77388	UK0032	N	9.5	0.8	7.7	65	<2025	11.6	8.5	-3.1	4.7
10423_10433	77390	UK0032	N	10.1	0.8	8.2	65	<2025	7.4	6.9	-0.5	7.7

5.3.26. The results in **Table 11** show that the Proposed Scheme will not have an effect on the ability of the East Midlands zone to achieve compliance with the Directive 2008/50/EC by the stated deadline.

5.4. CONCLUSION

5.4.1. Initial benefits are predicted in the overall property weighted concentrations of NO_2, however these will decrease over the life of the Proposed Scheme, with a deterioration in property weighted concentrations predicted by the operating year of 2041. Overall property weighted concentrations of PM_{10} are predicted to deteriorate as a result of the proposed scheme in both years. However, in all cases, more properties are predicted to experience improvements in concentrations than a deterioration. This suggests that where there are deteriorations these are greater in magnitude than the improvements experienced by the majority of receptors.

5.4.2. The air quality valuation is for a dis-benefit due to the Proposed Scheme as a result of overall increases in the mass emissions of both NO_x and PM_{10} over the valuation period. Any proposed air quality mitigation measures should be planned taking account of these figures.

5.4.3. Initial reductions in the predicted concentrations of NO_2 are not expected to have a negative impact on the ability of the East Midlands zone to become compliant with EU Directive 2008/50/EC within the required period.

5.4.4. The distributional analysis shows that where there are improvements these are predominantly located in areas that suffer high levels of social and income deprivation with a greater proportion of residents in these areas experiencing improvements than the share of that income group in the overall population.

5.4.5. Conversely, a new dual carriageway is to be in operation, coupled with new roundabout configurations at strategic points and may attract road vehicles to utilise the Proposed Scheme. With a possible increase and intensification of traffic volume and composition (such as increased use by HGVs) that bypasses the city of Lincoln, on a regional level, total mass emissions of NO_x are predicted to increase as a result of the Proposed Scheme.

6. GREENHOUSE GASES

6.1. INTRODUCTION

6.1.1. This chapter considers the potential changes in GHG emissions caused by the Proposed Scheme with respect to the WebTAG appraisal method for greenhouse gases (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 GHG, which forms the focus of this appraisal.

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

6.2. LEGISLATIVE BACKGROUND

6.2.1. The UK is legally bound by the Climate Change Act 2008[22] to achieve a target to reduce GHG emissions to at least 80% below base year (1990) levels by 2050.

6.2.2. The Act introduced 'carbon budgets'[23], 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.

6.2.3. The budgets are set as follows:

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

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

6.2.5. The chemical species within the Climate Change Act, for which road traffic is a source, are;

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

6.3. APPRAISAL METHODOLOGY

6.3.1. TAG Unit A3 presents the methodology for assessing and valuing GHG emissions (as tCO_2e) associated with the operation of the Proposed Scheme Options for a defined appraisal period.

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

23 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

6.3.2. For the purposes of the OBC, the Transport User Benefit Appraisal (TUBA) software program was used for the Proposed Scheme, accounting for a 60-year appraisal period (2026 – 2085).

6.3.3. The TUBA output provided the net present value of the estimated change in CO_2e emissions from road-based fuel consumption that is in the non-traded sector only.

6.3.4. The net present value was calculated based on the central cost estimates (£/tCO_2) for traded CO_2e emissions.

6.4. BASELINE GREENHOUSE GASES

6.4.1. The National Atmospheric Emissions Inventory (NAEI) is operated by the Department for Energy and Climate Change (DECC) and provides outputs of UK emissions of GHG. The latest national statistics were published in June 2018[24] and are made available for 2005 until 2016.

6.4.2. Total national GHG emissions as $ktCO_2e$ are presented in **Table 12**, in addition to national emissions from the road transport sector, for the most recent annual inventory (2016).

6.4.3. Total and sector-specific emissions of CO_2e from within Lincolnshire and North Kesteven are also provided in **Table 12** for comparison with national figures and to provide regional context with respect to the Proposed Scheme.

Table 12 Summary of Air Quality WebTAG Appraisal

CO_2 Emission	Road Transport Emissions 2016 ($ktCO_2e$)	Total Emissions 2016 ($ktCO_2e$)	Road Transport Emissions as % of Total
North Kesteven	241.6	614.1	39.3%
Lincolnshire	1,505.2	4,049.1	37.2%
England	106,657.8	292,249.4	36.5%

6.4.4. At a national level, GHG emissions from the transport sector account for 36.5% of total emissions, with transport emissions within Lincolnshire equating to 37.2% of total regional emissions. Regarding the North Kesteven district, road transport accounted for 39.3% of the total emissions generated for the area.

6.5. APPRAISAL SUMMARY

6.5.1. The results of the greenhouse gas appraisal Workbook are presented in **Appendix A** and they can be summarised as follows:

[24] UK local authority and regional carbon dioxide emissions national statistics: 2005-2016 (2018) [online] https://www.gov.uk/government/collections/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics

- Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be higher over the appraisal period relative to the Do Minimum case.
- The change in CO2e emissions (+181,041 tCO2e) equates to a NPV dis-benefit of £7,849,390 for the assessed appraisal period.
- It is predicted that there will be an increase of GHG emission from road-based fuel consumption, based on the TUBA analysis, thus resulting in a NPV dis-benefit. The increase in GHG emissions is attributed to a predicted increase in fuel consumption in the Do Something scenario.

7. LANDSCAPE

7.1. INTRODUCTION

7.1.1. This chapter provides a high-level description and evaluation of the existing landscape resource receptors in the vicinity of the North Hykeham to understand potential landscape and visual constraints associated with the proposed improvement Scheme.

7.1.2. DfT TAG Unit A3, Environmental Impact Appraisal (December 2015)[25] defines landscape as:

'Landscape means more than just 'the view'. It is both the physical and cultural characteristics of the land itself (i.e. its use and management) and the way in which we perceive those characteristics. It is this mix of characteristics and perceptions that make up and contribute to landscape character and give a 'sense of place'[26].

7.1.3. The study area is predominantly open countryside, crossing farmland, with only small settlements or the edge of the outlying villages of Lincoln for example North Hykeham, therefore as stated in **section 3.2** the Townscape appraisal has been scoped out.

7.2. STUDY AREA

7.2.1. A study area of 2 km from the Proposed Scheme extents has been identified for the landscape assessment. Beyond this 2-km study area it is considered that the likelihood of a significance effect arising as a result of the Proposed Scheme would be low.

7.3. APPRAISAL METHODOLOGY

7.3.1. The assessment has been carried out in accordance with the guidelines as set out within the TAG Unit A3 with additional guidance being sought from Interim Advice Note; IAN 135/10[27].

7.3.2. Whilst it is noted that the guidance states that a 'Landscape Appraisal Worksheet' be filled in for each of the key landscape resources identified, this appraisal summarises the characteristics of the various landscape resources into a singular landscape resource, providing one standalone worksheet.

ASSESSMENT OF SIGNIFICANCE

7.3.3. The DfT's WebTAG methodology focuses on the preparation of summary impact appraisal Worksheets, which break down the main landscape and townscape features (under five headings for landscape and seven for townscape). The principle objective at this stage is to undertake sufficient assessment to identify landscape/townscape constraints associated with the Proposed Scheme.

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[25] Department for Transport (DfT) (2015) TAG Unit A3 Environmental Impact Appraisal [online] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/638648/TAG_unit_a3_envir_imp_app_dec_15.pdf Accessed November 2018

26 DfT- TAG Unit A3 Environmental Impact Appraisal Section 6, para 6.1.1 p38

[27] DMRB, http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/ian135.pdf (Sourced November 2018)

ESTABLISHING MAGNITUDE OF IMPACT

7.3.4. All impacts on the landscape are identified along with predicted magnitude. The significance of each impact is then appraised and scored. The magnitude of impact (which could be either adverse or beneficial) is estimated. In assessing the magnitude of any landscape impact due regard is given to the scale, nature and duration of the impact. The following indicative criteria will be used when identifying the magnitude of impact.

Table 13 Indicative Criteria for determining magnitude

Magnitude	Size, Scale and Nature	Geographical Extent	Duration and Reversibility
Major	Considerable change to the majority of, or many, existing landscape elements and / or landscape character; fundamental changes the surroundings and baseline to a large extent. Very noticeable.	Ranging from notable change over extensive area to intensive change over a more limited area.	Permanent / non-reversible or partially reversible.
Moderate	Some considerable change to existing landscape elements and /or landscape character; discernibly changes the surroundings of a receptor, such that its baseline is partly altered. Readily noticeable.	Moderate changes in a localised area.	Semi-permanent or partially reversible.
Minor	Small change to existing landscape elements and / or landscape character; slight, but detectable impacts that do not alter the baseline of the receptor materially. Not readily noticeable.	Minor changes in a localised area.	Partially reversible or reversible.
Negligible	Limited /no change in existing landscape elements and / or landscape character; barely distinguishable change from baseline conditions. Hardly noticeable.	No change discernible.	Reversible.

DEFINING SIGNIFICANCE OF EFFECT

7.3.5. The terminology used for the overall assessment of landscape effects is based on a standard seven-point scale taken from TAG Unit A3.

OVERALL ASSESSMENT SCORE

7.3.6. To arrive at an overall assessment score for landscape it is necessary to appraise significance of each of the individual impact scores for each landscape feature. However, an important indicator is the impact score for 'summary of character' as this best demonstrates how well the Proposed Scheme would fit with the landscape.

7.3.7. The appraisal is based on the baseline survey year of 2018.

7.4. BASELINE CONDITIONS

7.4.1. The landscape resources applicable to the study area have been identified from a desk top study which reviews both published landscape character assessments at a national regional and local level in combination with an initial site walk-over survey undertaken by an appropriately qualified and experienced landscape architect.

LANDSCAPE BASELINE

7.4.2. The Proposed Scheme is located to the south of the city of Lincoln. To the west, the topography of the study area is predominantly uniform in elevation, whilst to the east there is a steep change to the topography, referred to locally as the 'Lincoln Cliff'.

7.4.3. The study area is predominantly undeveloped, with settlement principally restricted to its periphery. Within the study area the land use is predominantly a mix of arable and pastoral fields, due to the fertile alluvium soils of the River Witham floodplain, bound by hedgerows. Isolated copses of broadleaved woodland are infrequent within the landscape.

7.4.4. Roads cross the study area, radiating away from the centre of Lincoln, in a broadly north to south direction, linked by a network of local roads in an east to west direction, creating a grid like pattern. A number of public rights of way (PRoWs) are located within the study area including the long-distance trail referred to as the 'Viking Way', that skirts along the edge of the Lincoln Cliff. In addition to those PRoWs shown on Figure A1 (Environmental Constraints Plan, **Appendix C**) and Figure A2 (Preliminary General Arrangement Plan: 738233/WSP/GEN/XX/D2/CH/0007 – 0011, **Appendix C**), PRoWs are located on either side of the River Witham, associated with the levees. A shared cycleway/footpath is located to the east of the A46, approximately 3 m below the height of the carriageway. From here, views to the west are screened by the carriageway embankments, whilst to the east, views of the floodplain and the Proposed Scheme, would be screened from view by the intervening landscape features, comprising hedgerows, pockets of woodland and local road corridors.

7.4.5. RAF Waddington is located within the eastern extent of the study area. The RAF base, contributes to the areas unique sense of place due to its cultural significance and the frequency of which aircraft can be seen to be flying at low altitude over the study area prior to landing.

7.4.6. Views of Lincoln Cathedral are discernible throughout the study area, including from Station Road, at the southern extent of the study area, highlighting the presence of the city to the north

7.4.7. To the east, views of the western end of the Proposed Scheme will be clearly visible within views from areas of higher ground, including Station Road and the Viking Way between Waddington and Bracebridge Heath. Further to the south views of the Proposed Scheme are screened from view by the intervening plateau and intervening features of the settlement of Waddington and Harmston themselves. To the west of the study area, views looking in an easterly direction of the Proposed Scheme will be visible from the A46 (Roman Road), due to the carriageway being raised on embankments (c.3 m high), allowing long distance views to the east, above the hedgerow / linear belt of screen planting immediately to its east. In addition to these, elevated views looking in a north-easterly direction will be possible from the fly over, at Cross Ways Farm. From the west, views of the eastern tie in will be screened from view due to the change of topography (Lincoln Cliff).

7.4.8. Within the existing view, the B-roads that traverse the landscape at right angles to the receptors are predominately screened from view, by hedgerow planting on either side, forming relatively discrete elements within the landscape, even from areas of higher ground.

7.4.9. It is anticipated that the visual influence of the Proposed Scheme is unlikely to extend beyond that of the 2-km study area, with the exception of potential views from Lincoln Cathedral located approximately 5.5 km north of the Proposed Scheme alignment.

LANDSCAPE DESIGNATIONS

7.4.10. There are no statutory, or non-statutory, landscape designations located, within the 2-km study area. At its closest point the Lincolnshire Wolds Area of Outstanding Natural Beauty (AONB) is located approximately 22 km to the east of the Proposed Scheme.

7.4.11. There are two policy led designations within the study area of relevance to landscape character and visual amenity; identified as an Area of Great Landscape Value, and Green Wedge.

NATIONAL CHARACTER AREA PROFILES

7.4.12. The Proposed Scheme is located within two of the 159, National Character Areas (NCA), within England, identified as: -

- NCA No.47 Southern Lincolnshire Edge[10]; and
- NCA No.48 Trent & Belvoir Vales[10]

7.4.13. The Proposed Scheme is predominantly located within NCA No.48 Trent & Belvoir Vales, at the western end of the Proposed Scheme, with only the most eastern extent being located within the neighbouring NCA, No.47 Southern Lincolnshire Edge, where the Proposed Scheme, crosses Station Road.

7.4.14. The key characteristics of each of the NCAs, located within the study area, have been extracted below:

NCA No.47 Southern Lincolnshire Edge

7.4.15. The landscape of the Southern Lincolnshire Edge National Character Area is one of an elevated, gently sloping plateau with a sharply defined western boundary in the form of a north–south cliff of Jurassic Limestone. It is an open landscape with far-reaching views over the Trent and Belvoir Vales and up to Lincoln Cathedral. On the free draining higher ground, landcover is primarily arable, in large geometric fields divided by limestone walls, with few trees or woodland. On the wetter, heavier clay soils to the east and south-west, pasture is more prevalent; hedgerows are the predominant boundary and the landscape has a more intimate, enclosed feel, with more trees, woodland and parkland. Cropping is predominantly cereals, but also sugar beet and potatoes. Watercourses occur along the cliff edge where the porous limestone meets seams of less permeable clay. Streams also rise on the dip slope and drain into the fenland to the east, the River Slea being the biggest of these. The River Witham cuts through the limestone cliff just south of Lincoln. Dry valleys indicate the free-draining nature of the underlying geology. The cliff and the high land to the east of it retain numerous prehistoric and Roman sites, such as the bronze-age triple ditch system at Honington and Ermine Street Roman road. Settlement is concentrated around the perimeter of the NCA, along the cliff foot, where villages have been founded on springlines, and at the foot of the dip slope, where the larger conurbations such as Sleaford lie. The area is moderately tranquil; less-disturbed areas include the more remote parts of the sparsely settled areas, the open landscape of the dip slope and the more sheltered, enclosed, traditional landscapes of the claylands, with the area around Sleaford being the most disturbed.

NCA No 48 Trent and Belvoir Vales

7.4.16. The Trent and Belvoir Vales National Character Area is characterised by undulating, strongly rural and predominantly arable farmland, centred on the River Trent. A low-lying rural landscape with

relatively little woodland cover, the NCA offers long, open views. Newark-on-Trent (generally referred to as Newark) lies at the centre with Grantham, Nottingham, Lincoln and Gainsborough on the peripheries. The area's generally fertile soils and good quality agricultural land have supported a diversity of farming over a long period but, because of this, little semi-natural habitat remains. Agriculture is the dominant land use, with most farmland being used for growing cereals, oilseeds and other arable crops. While much pasture has been converted to arable use over the years, grazing is still significant in places, such as along the Trent and around settlements. Extensive use of red bricks and pantiles in the 19th century has contributed to the consistent character of traditional architecture within villages and farmsteads across the area. Stone hewn from harder courses within the mudstones, along with stone from neighbouring areas, also feature as building materials, especially in the churches. Lincoln Cathedral and Belvoir Castle are prominent landmarks on the skyline as are the substantial church spires of Newark and Bottesford. The flood plains are distinctive features, especially that of the Trent; however, the rivers themselves are not visually prominent in the wider landscape and are often completely hidden from view by levees. Rural tranquillity is still a feature over much of the area; however significant residential and infrastructure development pressures exist from the main settlements and major roads that traverse the area.

LOCAL CHARACTER AREAS

7.4.17. The description of local character areas has used the North Kesteven Landscape Character Assessment (2007)[11].

7.4.18. The study area, falls within three of the four character types, found within the North Kesteven, area. These are further divided into thirteen sub-area. Of these the study area, resides within the following character types (sub-areas) from west to east.

- Trent & Witham Vales Regional Landscape Character Type – Witham and Brant Vales Sub-Area;
- Trent & Witham Vales Regional Landscape Character Type – Lincoln Fringe Sub-Area;
- Lincoln Cliff Regional Landscape Character Type – Lincoln Cliff Sub-Area; and
- Central Plateau Regional Landscape Character Type – Limestone Heath Sub-Area.

7.4.19. The majority of the study area resides within the Trent & Witham Vales Regional Landscape Character Type – Witham and Brant Vales Sub-Area, to the west.

7.4.20. A brief description of each of the four sub-areas is noted below.

Trent & Witham Vales Regional Landscape Character Type

Witham and Brant Vales Sub-Area

7.4.21. The Sub-area is defined by the base of the Lincoln Cliff to the east, the district boundary to the south, the terrace sandlands to the west and the southern outskirts of Lincoln City to the north. Extensive low lying, generally flat valley of twin rivers Witham and Brant. Across the sub-area tree cover is limited, but has a disproportionately high influence on the landscape as the level terrain allows hedgerow and copse trees to foreshorten views across the vale. The impact of roads upon the landscape is generally low once away from the A17 and A46. Pressure for change within the vale predominantly relates to minerals operations, intensive agricultural practice and flood alleviation works.

Lincoln Fringe Sub-Area

7.4.22. The sub-area is split into three discernible urban areas, along the northern extent of the district boundary, separated from each other by discernible green wedges. Combined, the urban areas and green wedges define the interface between the urban and rural areas. The sub-area, has very little landscape character and is characterised by development areas along Lincoln City's periphery. To the east, the area land use is predominantly residential comprising of post war low density housing interspersed with local services, whilst to the west the sub-area comprises of mixed large and small-scale businesses, light industrial, commercial and leisure uses. The A46 presents a clear delineation between the urbanised area to the east and the openness of the Terrace Sandlands to its west.

Lincoln Cliff Regional Landscape Character Type

Lincoln Cliff

7.4.23. The sub-area is defined by the limestone escarpment that runs from north to south, through the district boundary. Villages along the scarp are generally located along its crest, taking advantage of extensive panoramic views over the Witham and Brant Vale. The sub-area is one of the most obviously distinctive within North Kesteven, consisting of the more-or-less unbroken slope or 'Cliff' between the lower vale and high plateau. It is defined by its topographical characteristics and its transitional qualities. At a height of between 80 – 100 m, the cliff is a considerable feature when compared to the low-lying Witham and Brant Vale at around 10 m elevation.

Central Plateau Regional Landscape Character Type

Limestone Heath sub-area

7.4.24. The sub-area is located to the east of the Lincoln Cliff, and is the largest of the district landscape character sun-areas. It is predominantly an open landscape with wide views in all directions. As a result of this the scattered woodland copses stand out within the landscape as prominent features. The central plateau area is generally undeveloped, with the exception of isolated farmsteads and hamlets along the A15. Larger settlements are situated on the edge of the sub-area characterised by having historic cores with limestone buildings surrounded by significant levels of 20th Century development. The dominant land use within the area is almost entirely arable farming, consisting of cereal and root crops, grown in large rectangular fields. Pressures for change upon the plateau predominantly relate to minerals operations, decline of field boundaries, particularly walls, and intrusive agricultural practices. RAF establishments are a current and important historic feature of the area, due to the areas open and largely flat landscape being suitable for airfields. RAF Waddington is located within the sub-area, a defining feature of the character. The road pattern is distinctive with the A15, running from north to south, dividing the character sub-area in two, acting as a central communications spine, with straight and parallel minor roads dissecting the area.

7.5. APPRAISAL SUMMARY

CONSTRAINTS

7.5.1. Constraints in respect of landscape applicable to the study area include:

- The River Witham, flows from south to north, through the study area, directly below the footprint of the Proposed Scheme. PRoWs follow the course of the river on either side of the river corridor, raised on embankments / levees. A flood barrier and pumping station is located directly to the

south of the proposed PRW Under New Bridge. The confluence of the River Witham and River Brant is also just to the south of this.

- Topography, 'Lincoln Cliff' – grade difference, and long reaching views over the flood plain to the west and south,
- Potential views of the floodplain, from Lincoln Cathedral, however given the distance in separation between the receptor and the Proposed Scheme, the significance of effect is likely to be significantly reduced.
- Overhead pylons, cross the alignment of Proposed Scheme, at its western end; directly above the proposed roundabout at the junction of South Hykeham Road and Long Lane.
- The proximity of the Proposed Scheme to RAF Waddington, at the eastern end of the study area, may pose potential restrictions to the nature of the mitigation planting along the road corridor at this point. Screen planting on either side of the Proposed Scheme is likely to be restricted to reduce the risk of bird strike within the affected area.
- The Proposed Scheme will require the demolition of approximately four properties along Station Road.
- An aircraft viewing area is located to the south of the Proposed Scheme, off the A15 Sleaford Road. Potential views of the Proposed Scheme may detract from the visitor's experience at this location particularly during the construction phase of the works.
- At the western end of the Proposed Scheme, the road corridor is currently shown as being raised on embankment increasing its visual prominence within the surrounding area. The eastern end of the Proposed Scheme is currently shown to be located within cutting, reducing the visual prominence of the Proposed Scheme from visually sensitive receptors including users of the Viking Way.
- The Proposed Scheme may result in visual intrusion for nearby visually sensitive receptors including those residential properties located along Station Road, Pottergate Close, Appian Way, Sycamore Grove, King Drive, and isolated farm steads, on either side of the route alignment. It is considered that the visual impact will be more intrusive during the construction phase of the works, reducing over time following the establishment of screen / landscape integration mitigation planting along the Proposed Scheme.
- The Proposed Scheme will result in the pattern of the receiving environment permanently changing.
- The Proposed Scheme will permanently sever linear features within the landscape of cultural significance resulting in a change to their current alignment.
- The Proposed Scheme, will directly dissect an 'Area of Great Landscape Value' as identified upon the adopted 2017 Central Lincoln Local Plan – LP17;
- The Proposed Scheme, will directly dissect an area identified as a Green Wedge, identified upon the 2017 Central Lincoln Local Plan – LP22.

MITIGATION

7.5.2. To reduce impacts during both construction and operation, mitigation planting should be prepared as part of the Proposed Scheme design, however this may not mitigate fully the visually intrusive nature of the Proposed Scheme, from areas of higher ground, where long distance views are perceivable. An Indicative Outline Mitigation Masterplan has been produced, at this time the general principles of the landscape mitigation include:

- Where possible plant stock should be of local provenance, and reflect the riparian nature of the existing species mix;
- Where feasible, existing vegetation within the receiving environment should be retained in order to reduce impacts relating to habitat loss, ecosystem services, screening and landscape integration;
- Provide replacement hedgerows with incidental trees along field boundaries, where larger fields have been severed by the proposed route;
- Where required, provide replacement avenue tress along Somerton Gate Lane, retaining landscape character, where affected by the Scheme;
- Integration of the proposed detention basins within the landscape / view through the inclusion of perimeter hedgerows, scattered groups of trees, and species rich wet grassland. It is proposed that the detention basins themselves be seeded with a wet grassland seed mix, with the inclusion of marginal plants where they are intended to maintain a proportion of standing water all year round. Within the surrounding area, incidental groups of trees should be considered, planted within an area of species rich dry grassland;
- Inclusion of linear belts of shrub and tree planting on either side of the carriageway / road corridor where vehicle movement will be clearly discernible detracting from the nature of the view. Principally this would be restricted to planting on either side of the road corridor where the Proposed Scheme is located upon embankment;
- Proposed scattered groups of trees located upon cutting slopes; scattered groups of trees should be used in order to reduce the visual influence of vehicle movement along the road corridor where not screened in its entirety by the cutting slopes themselves;
- Woodland screen planting should be used sparingly, along the alignment of the Scheme, in close proximity to areas of existing woodland to be retained, or where significant visual effects from the Scheme cannot be mitigated via other means.

SUMMARY

7.5.3. The results of the landscape appraisal Workbook are presented in **Appendix A**.

7.5.4. The Proposed Scheme, is at odds with the pattern of similar features within the landscape, creating an arc as opposed to a straight linear feature. It is not considered that the Proposed Scheme will be integrated within the landscape, due to the western end of the road corridor being raised on embankment, through an otherwise predominantly flat landscape. In addition to this, the inclusion of structures in the form of bridges, will further detract from the landscape setting. The Proposed Scheme will permanently alter the pattern of the landscape, in addition to creating a permanent change to the nature of the land use along the road corridor itself. The Proposed Scheme will permanently sever linear features within the landscape of cultural significance resulting in a change to their current yep alignment. The Proposed Scheme will also sever a number of policy lead designations as identified upon the adopted Central Lincoln Local Plan, including an ‘Area of Great Landscape Value’ and a ‘Green Wedge’. Based on the above a **large adverse** impact is anticipated.

8. BIODIVERSITY

8.1. INTRODUCTION

8.1.1. This chapter of the describes the existing ecological baseline and the anticipated impacts of the Proposed Scheme under consideration on ecological features present within the study area. It is particularly important to read this chapter in conjunction with the Preliminary Ecological Appraisal (PEA)[28] Report which is included in **Appendix D**.

8.1.2. Ecological features include species and habitats of nature conservation importance. For the purposes of this appraisal, nature conservation importance is defined as sites, species and habitats that are legally protected and/or listed on the annexes or schedules of the regulatory frameworks listed below:

- Council Directive 92/43/EEC (Habitats Directive, 1992) on the Conservation of Natural Habitats and of Wild Fauna and Flora;
- Directive 2009/147/EC (Birds Directive, 2009) on the Conservation of Wild Birds (the codified version of the Council Directive 79/409EEC as amended);
- The Conservation of Habitats and Species Regulations 2017 (as amended);
- The Wildlife and Countryside Act 1981 (as amended);
- Natural Environment and Rural Communities (NERC) Act 2006 (Habitats and Species of Principal Importance and Section 41 List);
- The Protection of Badgers Act 1992;
- Countryside and Rights of Way (CRoW) Act 2000;
- The Hedgerow Regulations 1997;
- The Environment Act 1995; and,
- The Wild Mammals (Protection) Act 1996.

8.1.3. In addition to the legislative provision described above, nature conservation priorities for species and habitats are also informed by:

- Central Lincolnshire Local Plan (adopted April 2017);
- Highways England Biodiversity Action Plan; and,
- Joint Nature Conservation Committee (JNCC) Birds of Conservation Concern 2015 (“Green”, “Amber” and “Red” list species).

8.2. APPRAISAL METHODOLOGY

8.2.1. The Biodiversity appraisal has been undertaken with reference to the following guidance:

- TAG Unit A3 Chapters 5 and 9 (which also references DMRB Volume 11 Section 3 Part 4);
- ‘Guidelines for Ecological Impact Assessment in the UK’ (Chartered Institute for Ecological and Environmental Management (CIEEM), 2006);
- Good practice guidance published by the Chartered Institute for Ecology and Environmental Management (CIEEM, 2013 and 2015);

[28] WSP (2018). Lincolnshire County Council. *Lincoln Southern Bypass Preliminary Ecological Appraisal*

- Good practice guidance published by Joint Nature Conservation Committee (JNCC, 2010);
- British Standard - Code of Practice for Biodiversity and Development BS 42020:2013 (British Standards Institute (2013); and
- DMRB Volume 11 Section 4 Assessment of the Implications (of Highways and/or Road Projects) on European Sites (including Appropriate Assessment).

8.2.2. The appraisal has considered two study areas:

- **Main study area** – The study area consists of the footprint of the Proposed Scheme, extending to 150m either side of the road and associated earthworks and junctions.
- **Broad study area** – The study area for desktop searches was based on records of legally protected and notable species within 5 km; records of non-statutory sites designated for nature conservation value within 2 km and freely downloadable datasets (available from Natural England) were consulted for information regarding the presence of statutory designated habitats[29] within 2 km and information regarding Habitats of Principal Importance (HPI)[30] within 1 km and woodland listed on the Ancient Woodland Inventory[31]. This search was extended to 10 km for Natura 2000 sites (Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) of European importance and internationally designated Ramsar sites. In addition, open source [1:25,000] OS mapping was used to identify any mapped water bodies and watercourses within 500m of the footprint of the Proposed Scheme.

8.2.3. The PEA, undertaken in February 2018, has been supplemented by a desk study based on information available from online resources (MAGIC on-line mapping website) and aerial imagery. These have been used to assess the layout of the site and provide context for the PEA, in addition to a broad assessment of habitat types and locations.

PRELIMINARY ECOLOGICAL APPRAISAL

8.2.4. The PEA, included in **Appendix D**, provides a detailed description of the baseline conditions in proximity to the Proposed Scheme. The PEA, undertaken in February 2018 for Route 2c, and was based on the following data sources:

- an ecological desk study;
- a Phase 1 habitat survey;
- a protected/notable species assessment; and,
- great crested newt habitat suitability surveys of accessible ponds.

8.2.5. A data request was sent to Lincolnshire Environmental Records Centre to obtain species records and details of statutory or locally designated sites and is summarised the PEA baseline information.

[29] Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR) and Local Nature Reserves (LNR).

[30] Mapped locations of HPI are usually not available, but HPI aligns in the most part with UKBAP habitats. Inventories of UKBAP habitat have been prepared by a variety of organisations and at a national (Natural England priority habitat inventory) and local scale (e.g. by local records centres). In some instances these are primarily based on aerial photograph analysis rather than field survey.

[31] The ancient woodland inventory in England lists areas over two hectares in size which have been continuously wooded since at least 1600.

8.2.6. The Phase 1 Habitat survey was undertaken at all areas within the survey area that were safely accessible from public rights of way, on 3rd and 4th January 2018. The aim was to identify habitat types within the survey area, and areas of habitat likely to be suitable for use by protected or notable species, along with any signs of those species.

8.2.7. Habitat information and the results of the PEA were used in conjunction with the desk study information to assess the potential for the survey area to support protected species, and identify their likely distribution, if present.

8.2.8. At the time of writing, an extended Phase 1 Habitat Survey has been undertaken alongside a Habitat Suitability Assessment (H.S.I) for great crested newt (GCN) *Triturus cristatus* at waterbodies Pond A, Pond B, Pond C1 and Pond C2. It has been recommended that further surveys are undertaken for bats, GCN, otter *Lutra*, badger *Meles*, water vole *Arvicola amphibius*, breeding birds, reptiles, hedgerows and invasive non-native plant species.

8.3. BASELINE CONDITIONS

The Proposed Scheme is located within the Swanholme Lakes Local Nature Reserve (LNR) and Site of Special Scientific Interest (SSSI) Impact Risk Zone (IRZ), which is a buffer area designated by Natural England to make a rapid initial assessment of the potential risks posed by development proposals.

Whisby Nature Park LNR is the only identified statutory nature conservation site within 2km of the proposed scheme. It is located approximately 1.4km north west of the proposed scheme. There is one further LNR, Cross O'Cliff Orchard, outside 2km, approximately 2.5km north of the proposed scheme. Both LNRs are illustrated in Figure A1, **Appendix C.**

There are 19 non-statutory designations within 2km of the Scheme, the closest two, Waddington Grassland (Viking Way) LWS and River Whitham, Bracebridge to South Hykeham LWS, are within the footprint of the proposed scheme. A full list of the non-designated sites is shown in the PEA (**Appendix D**).

Although there are no protected habitats or AWI woodland present within the Survey Area there are habitats present which may qualify a Habitat of Principal Importance (HPI), including rivers, ponds, hedgerows and arable field margins. No assessment has yet been carried out to see if these habitats meet the criteria to be classified as HPI in accordance with Section 41 of the NERC Act 2006. Under Section 40 of this legislation, every public body (including planning authorities) must, '*in exercising its functions, have regard so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity*'.

The results of the desk study, Phase 1 Habitat Survey and protected species assessment highlighted the potential presence of several protected species or species of conservation concern within the Survey Area, or within the immediate surroundings of the Survey Area. These include bats, badger, otter, water vole, birds, reptiles and amphibians.

Potential ecological constraints for all the ecological receptors can be found in Table 6 of the PEA report, presented as **Appendix D**.

8.3.1. To enable compliance with relevant legislation and planning policy, as described above, general environmental protection measures, such as Construction Industry Research and Information Association guidance (CIRIA, 2015), must be implemented during the construction phase and appropriate mitigation measures should be designed in to the Proposed Scheme. These will be refined following completion of further survey requirements, however could include:

- Bats: Further assessment of trees and buildings to determine presence, potential presence or likely absence of roosting bats are required. Features with potential to support roosting bats should be subject to an aerial inspection by a licensed bat ecologist. If the climbing surveys cannot confirm likely absence of roosting bats, dusk emergence and dawn re-entry surveys will be required. Walked transects (activity surveys) should be undertaken to assess the level of usage of the landscape by bats. This will also provide information on which species of bats are present. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.
- Great Crested Newt: Initial scoping of ponds using HSI assessment methodology identified two 'poor' ponds, one below average pond and one average pond. Presence/likely absence surveys of ponds using bottle trapping, torching, netting and hand searching or eDNA testing of water samples from ponds is required. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.
- Otter: Land along the banks of the River Witham, adjacent to the crossing point of the Proposed Scheme should be searched for signs of otters and potential resting places. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.
- Badger: Areas of suitable habitat within the study area, including field boundaries, woodland and scrub, should be searched for signs of badger occupation. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.
- Water Vole: Drains should be searched a suitable distance either side of where the Proposed Scheme crosses field drains to search for signs of water vole occupancy. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.
- Birds: Breeding bird surveys should be undertaken to identify which species and numbers of birds are holding territories and breeding within the study area. Wintering bird surveys should be undertaken to identify which species and numbers of birds are using land within the study area during the winter months and within which areas wintering birds are concentrated. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.
- Birds: Woody vegetation clearance should be undertaken outside the bird breeding season (March to August inclusive) to avoid the risk of damaging or destroying nests, eggs or young birds. If clearance is to take place during the breeding season all woody vegetation should be checked prior to removal. If active nests are found removal should be discontinued, and an exclusion zone put in place until the young birds have fledged.
- Reptiles: Reptile surveys of suitable habitat to determine presence / likely absence using artificial refugia are recommended. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.
- Plants: All accessible land and waterbodies should be searched for Schedule 9 plant species prior to vegetation clearance to avoid the risk of spreading these non-native invasive plant species. If required based on the findings of the survey, a mitigation plan e.g. an appropriate

exclusion zone put in place (up to 7m for Japanese knotweed *Fallopia japonica*) should be designed and implemented as appropriate and a plan with locations stand size for Schedule 9 plants. A management remediation plan for Schedule 9 plants should be sought from a specialist contractor.

- Plants: Hedgerows which are beneath the footprint of the Proposed Scheme should be surveyed to count the number of native woody species within measured sections of hedge to provide an assessment of species-richness. When undertaking vegetation clearance excessive amounts of woody vegetation should not be removed. Only the minimum number of trees and scrub should be removed to enable the accommodation of the proposed scheme.

8.3.2. The results of the Biodiversity Appraisal Workbook are presented in **Appendix A** and they can be summarised as follows:

8.3.3. The Proposed Scheme alignment passes through habitat that could support national and European species, then these species could be affected (including the presence of any built structures on site) therefore a **moderate adverse** impact is anticipated.

9. HISTORIC ENVIRONMENT

9.1. INTRODUCTION

9.1.1. This chapter identifies and assess the potential impacts upon cultural heritage resources as a result of the Proposed Scheme. The heritage resource consists of archaeology, historic buildings and the historic landscape and covers both designated and non-designated assets.

9.1.2. Should the Proposed Scheme move forward to the FBC a Cultural Heritage Desk-Based Assessment (DBA) will be undertaken for the Proposed Scheme. The DBA will assess the impacts on the Historic Environment and present mitigation methods to reduce the effect upon the finite resources. The DBA will identify any changes to known heritage resources including designated and non-designated heritage sites and will be supplemented by a walkover survey by an appropriately qualified and experience archaeologist to understand the overall cultural heritage context of the area.

9.2. APPRAISAL METHODOLOGY

9.2.1. The appraisal has been undertaken in accordance with TAG Unit A.3.

9.2.2. A desktop study has been undertaken to inform the appraisal of the Proposed Scheme on the Historic Environment for the OBC. The Lincoln Historic Environment Record (HER), for all records relating to known heritage assets and secondary source material including archaeological reports, OS maps and Defra's MAGIC maps have been interrogated to inform the appraisal.

9.2.3. The historic environment assets will focus on a 1 km study area for designated heritage assets and a 500m study area for potential impacts upon the non-designated heritage assets. This is to account for any impacts upon the setting of the heritage assets.

9.3. BASELINE CONDITIONS

9.3.1. There are no designated heritage assets located within the Proposed Scheme. In addition, no World Heritage Sites, Scheduled Monuments, Registered Parks and Gardens or Battlefields were identified within 1km study area.

9.3.2. There are 17 Listed Buildings within 1km Study Area. The Listed Buildings comprise of one Grade II* Listed Buildings and 16 Grade II. The nearest listed building is 90m from the proposed scheme, this is Grade II Gates and Walls to the Manor House (NHLE 1360604). Four others lie within 500m of the scheme include Grade II* Church of St Michael (NHLE 1061957), Grade II Farm buildings at the Manor House (NHLE 1061753), Church Farmhouse (NHLE 1164588), The Manor House (NHLE 1305031).

9.3.3. There are numerous non-designated heritage assets within the 500m study area. There are four non-designated heritage assets located within the scheme. These comprise medieval ridge and furrow (HER 62576), the site of an Avro Manchester Bomber aircraft crash in World War II (HER 65789), a sher of Romano-British Pottery (HER 61267) and a Roman site (HER 61259).

9.3.4. As the Proposed Scheme is over an area of arable land, therefore there is potential for the known (noted above in paragraph 9.3.3) and unknown below-ground heritage remains.

9.4. APPRAISAL SUMMARY

9.4.1. The results of the historic environment appraisal Workbook are presented in **Appendix A** and can be summarised as follows:

9.4.2. There is potential for below-ground archaeological remains to be damaged or destroyed as a result of the Proposed Scheme. The Proposed Scheme is over an area of arable land, therefore there is potential for the known and unknown below-ground heritage remains to be impacted during the construction of the Proposed Scheme.

9.4.3. There is also potential for impacts on the setting of built heritage assets within the area. As there is no infrastructure within the current landscape the construction of a new road is likely to cause changes to the visual landscape, levels of noise and introduce movement in the area.

9.4.4. Should the Proposed Scheme move forward to the FBC a DBA will be undertaken to assess the impacts on the Historic Environment and present mitigation methods to reduce the effect upon the finite resources.

9.4.5. The Proposed Scheme alignment would have minor adverse impacts upon designated heritage assets due to the impact being indirect, on setting, and moderate to major adverse impacts on below ground non-designated heritage assets due to the impact being direct and there being a high potential for survival. The overall assessment score is **moderate adverse.**

10. WATER ENVIRONMENT

10.1. INTRODUCTION

10.1.1. This chapter provides an assessment of the potential impacts of the Proposed Scheme on the water environment and considers: surface hydrology and quality; flood risk; groundwater quality and hydrogeology; and fluvial geomorphology. It describes the existing water environment baseline condition and the anticipated likely significant impacts of the Proposed Scheme on the water environment within the study area.

10.2. APPRAISAL METHODOLOGY

10.2.1. The appraisal has been undertaken in accordance with TAG Unit A.3, which promotes the following approach:

- Identification of key water environment receptors;
- Assessment of importance of the identified receptor, judged based on its quality, scale, rarity and substitutability;
- Determining of the magnitude of the potential impact; and
- Assessment of the significance of the impact.

10.2.2. Details of how each of the above components are derived are provided in TAG Unit 3.

10.2.3. A desk study of the hydrological and hydrogeological features associated with the Proposed Scheme has been undertaken and a site walk-over of the River Witham was carried out on 09/11/2018 to supplement the desk study.

10.2.4. The study area has been defined as the physical area of the Proposed Scheme and a buffer of 1km on either side of the Proposed Scheme.

10.3. CONSULTATION

10.3.1. Consultation has been undertaken with the relevant authorities specifically relating to the water environment and is detailed in **Table 14** below.

Table 14 Consultation to date

Organisation	Date	Summary of Consultation
Lincolnshire County Council	November 2018	Consultation with the Senior Project Leader for the Proposed Scheme to understand content of previous consultation with relevant authorities and request data held by LCC regarding watercourses and drains in the surrounding area
Upper Witham Internal Drainage Board	October 2018	IDB recommended that attenuation and discharge of surface water runoff to watercourses and land drains should be to the north of the site to avoid affecting the Lincoln Washlands Flood Alleviation Scheme.
Environment Agency	June 2018	Written consultation response from the EA (dated 13/06/2018) that highlighted the main water environment constraints to the Proposed Scheme were with regards to flood risk and obstruction to floodplain flows with requirement to not impede flows in the

		event of the reservoir spillway overflowing and allowing for sufficient flood culverts. Consultation also conformed requirement for a Water Framework Directive assessment to accompany the EIA and that mammal passage should be incorporated into the bridge design over the River Witham. Suggestion of potential tie in of the Proposed Scheme with the reservoir spillway to increase the capacity of the reservoir to account for climate change.
Environment Agency	December 2018	Consultation to discuss the operation of the washlands, availability of flood data, and key water environment and flood risk constraints. The EA highlighted that the main issues to consider are to ensure flood flows can pass under the Proposed Scheme without posing unacceptable risk to the Proposed Scheme or to people and property elsewhere, and that the Proposed Scheme does not impact the reservoir embankment. Breach analysis of the reservoir embankment and the river bank was recommended. Minutes from this consultation are provided in **Appendix E**.

10.3.2. Further consultation with the EA and Upper Witham IDB will be undertaken as part of the FBC to inform the detailed assessments to discuss the assessment of flood risk and proposed mitigation, requirements of WFD assessment, and the discharge and attenuation of surface water runoff.

10.4. BASELINE CONDITIONS

SURFACE WATER FEATURES

Main rivers

10.4.1. The Proposed Scheme crosses the River Witham immediately downstream of the Lincoln Washlands FAS. The catchment of the Upper River Witham covers the River Witham and its tributaries from its source at South Witham to Stamp End Sluice in Lincoln. Grantham, North Hykeham and Lincoln are the significant urban areas within this largely rural catchment. The River Witham is classified as a main river and is therefore under the jurisdiction of the Environment Agency. A photograph of the River Witham looking downstream is provided in Photo 1 below.

10.4.2. The River Brant flows in a northerly direction towards the Proposed Scheme and confluences with the River Witham approximately 300m upstream of the Proposed Scheme. The current alignment of the Proposed Scheme has no direct interaction with the catchment of the River Brant. The River Brant is also classified as a main river and is under the jurisdiction of the EA.

10.4.3. The Beck flows in an easterly direction to the north of the Proposed scheme, discharging to the River Witham approximately 600m downstream of the Proposed Scheme. The Beck is also classified a as a main river under the jurisdiction of the EA.

Drainage Features

10.4.4. Several drains are located within the study area under the jurisdiction of the Upper Witham IDB. The most notable of these drains that are crossed by the Proposed Scheme include South Hykeham Catchwater and South Hykeham Catchwater Branch No.3 which are crossed by the Proposed Scheme close to the A46. Green Lane Drain, Hykeham Pump Drain South and Washland Soke Drain are also crossed by the Proposed Scheme to the west of the River Witham. Directly to the east of the River Witham the Proposed Scheme crosses Waddington Dyke South. All the aforementioned drains

convey water to the River Witham. Photographs of the Green Lane Drain, Hykeham Pump Drain South and Washland Soke Drain are provided in Photos 2, 3 and 4 below.

Photo 1 - River Witham looking downstream

Photo 2 - Hykeham Pump Drain South looking south towards Lincoln Washlands FAS

Photo 3 - Washland Soke Dyke looking west

Photo 4 - Green Lane Drain looking north-east

10.4.5. The existing roads which currently serve Lincoln and North and South Hykeham (namely the A46, Meadow Lane, South Hykeham Road, Brant Road, Station Road and Grantham Road) are served by drainage gullies located within the carriageway. Details of this system, including the size/alignment of the below ground system, provision of attenuation and treatment systems, and outfall to the receiving water environment are unknown at this stage.

Water Quality

10.4.6. The Proposed Scheme is located within the Anglian River Basin District, within the Witham operational catchment. There are several protected areas in the catchment including drinking water protected areas, urban waste water directive sensitive sites and nutrient sensitive zones. There are no known statutory or non-statutory designations within 1km of the Proposed Scheme.

10.4.7. The quality of the River Witham, River Brant and South Hykeham Catchwater is monitored against the objectives of the Water Framework Directive (WFD). A summary of the WFD 2016 Cycle 2 status reporting is provided in **Table 15**.

Table 15 Summary of WFD Monitoring

Waterbody name	Distance to Proposed Scheme	Number	Ecological status and reason	Chemical status
Witham (confluence of Brant to confluence of Catchwater Drain)	Crossed by Proposed Scheme	GB105030062370	Moderate: due to phosphate, fish and mitigation measures assessment from agriculture and rural land management, the water industry, urban and transport	Good
Witham (confluence Cringle Brook to confluence Brant)	400m upstream	GB105030056780	Moderate: phosphate and mitigation measures assessment from water industry (continuous sewage discharge), agriculture and rural land management and local and central government	Good
Lower Brant	300m upstream	GB105030056770	Moderate: phosphate, dissolved oxygen, macrophytes and phytobenthos, mitigation measures assessment from industry (specifically continuous sewage discharge), domestic general public for sewage discharge, and agriculture and rural land management	Good
South Hykeham Catchwater	Crossed by Proposed Scheme	GB105030062460	Moderate: phosphate, dissolved oxygen and invertebrates from industry (specifically continuous sewage discharge), agriculture and rural land management.	Good

FLOOD RISK

10.4.8. The most significant flood risk within the study area is associated with fluvial flooding from the River Witham. This affects approximately 1.3km of the Proposed Scheme between South Hykeham and Brant Road.

10.4.9. The Flood Map for Planning indicates that the Proposed Scheme passes through Flood Zone 3 that is defined as land having a 1 in 100 or greater annual probability of river flooding, although highlights that this area benefits from flood defences.

10.4.10. The flood defences that serve this area include the Lincoln Washlands FAS that comprises two off-line flood storage areas upstream of Lincoln: one on the River Witham immediately to the south of the Proposed Scheme and the other on the River Till near Saxilby approximately 12km to the north-west of the Proposed Scheme. At both locations, under normal conditions the river flows unimpeded through control gates erected across the river channel. In a flood event the gates are partially closed restricting the flow through the channel, thereby impounding the water and diverting it through an inlet/outlet sluice in the river bank into a flood storage reservoir which has been created by an earth embankment across the river floodplain. The inlet/outlet sluice that is located on the left bank of the River Witham is illustrated in Photo 5.

10.4.11. The Proposed Scheme crosses immediately to the north of the earth embankment and flood storage area adjacent to the River Witham (illustrated in Photo 6). The embankment comprises an earth embankment with concrete core and is a designated reservoir structure.

10.4.12. The area is further protected by earth embankments located immediately upstream of the Proposed Scheme (to the south) and along the banks of the River Witham and The Beck watercourse to the north of the Proposed Scheme. The upstream embankments are designated as flood defence structures but not as reservoir structures.

Photo 5 - Lincoln Washlands FAS inlet/outlet sluice

Photo 6 - Lincoln Washlands FAS embankment

10.4.13. The FAS was constructed from 1984 to 1990. Consultation with the EA indicates that the washlands were designed to accommodate a 1 in 100 annual probability event. Recent analysis undertaken by the EA indicates that the washlands can accommodate events larger than those previously considered, with likely capacity for an equivalent 1 in 130 annual probability event or 1 in 100 annual probability event with climate change allowance.

10.4.14. During extreme events the control gates can be lifted further to push more water from the river channel into the washlands. During these events the washlands may overtop the embankment spillway and flood waters will flow to the north in the direction of the Proposed Scheme.

10.4.15. It is understood that the IDB drainage network operates independently to the FAS. During a flood event the drains that are located within and upstream of the washlands are shut off, although it is understood that drains downstream of the FAS will continue to operate and pump water to the River Witham.

10.4.16. Review of the EA's Risk of Flooding from Surface Water map indicates potential fluvial flood risk associated with the rhyne network which is not currently indicated by the Flood Map for Planning. In addition, there are localised areas of increased surface water flooding at various locations across the study area. To the east of the study area there are surface water flow paths highlighting small gullies coming down from Waddington Heath towards the River Witham. These flowpaths do not appear to be associated with any watercourses on mapping. Significant surface water ponding also occurs to the east of Brant Road.

10.4.17. Review of the EA's Risk of Flooding from Reservoirs map indicates that the area of the Proposed Scheme between South Hykeham and Brant Road to the east of the River Witham is at risk of flooding from reservoirs. The source of this flood risk is the Lincoln Washlands FAS.

GROUNDWATER

10.4.18. The geology present on site was assessed using the BGS Geoindex Webtool. The interactive BGS map and BGS borehole logs show that the west of the study area is underlain by Scunthorpe Mudstone Formation (mudstone and limestone interbedded), Charmouth Mudstone Formation and Whitby Mudstone Formation; and that the east of the study area is underlain by Grantham Formation and Northampton Sand Formation (sandstone and ironstone), Lower Lincolnshire Limestone Member and Upper Lincolnshire Limestone Member. The BGS map shows that much of the study area is not underlain by superficial deposits, with no superficial geology overlying the limestone bedrock geology. Where these are present, the superficial geology comprises of Balderton Sand and Gravel Member, and Alluvium (Clay, silt, sand, and gravel). The Alluvium is associated with watercourses (River Witham & River Brant) and the Balderton Sand and Gravel Member occurs sporadically throughout the site at South Hykeham, South Hykeham Road and north of Stone Lane. The strata are dipping to the east.

10.4.19. The Lower Lincolnshire Limestone Member and Upper Lincolnshire Limestone Member bedrock are designated by the EA a Principal aquifer, defined as 'layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer'. Therefore, the limestone units are likely to be an important water bearing source rock. The limestone deposits have high permeability, karstic structures and historically have been used as a potable water supply.

10.4.20. The Mudstone formations in the west of the study area are designated by the EA as Secondary B aquifers defined as 'predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers'.

10.4.21. The superficial Alluvium and Balderton Sand and Gravel Member are designated by the EA as Secondary A aquifers defined as 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers'. The superficial deposits are likely to contain substantial levels of groundwater and groundwater storage. The Balderton Sand and Gravel Member in particular is likely to provide base flow to surface water features in close proximity to the deposit.

10.4.22. Review of the Defra MAGIC Groundwater map shows that the Lincolnshire Limestone Formation in the east of the study area is classified as a Major Aquifer with High Groundwater Vulnerability Zone. The Cranfield University Soilscape Viewer describes the soils in the east of the study area as freely draining shallow lime-rich soils over chalk or limestone.

10.4.23. Review of the MAGIC Groundwater map shows that the superficial Balderton Sand & Gravel Member and Alluvium deposits are classified as a Minor Aquifer with High Groundwater Vulnerability Zone.

10.4.24. The Cranfield University Soilscape Viewer describes the soils in the west of the study area as naturally wet very acid sandy and loamy soils; slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils; and loamy and clayey floodplain soils with naturally high groundwater.

10.4.25. Discrete pockets of groundwater may be presents in the Charmouth Mudstone Formation and also within the interbedded limestone horizons of the Scunthorpe Mudstone Formation.

10.4.26. The superficial and bedrock aquifers are not considered to be in hydraulic connectivity. Historic BGS borehole SK19SE16 recorded a 45.72m thick aquitard layer composed of clay, separating the superficial aquifer from the bedrock aquifer. However, due to the unavailability of additional deep BGS borehole logs and on-site boreholes, the lateral extent and thicknesses of such units across the site are unknown.

10.4.27. Groundwater may be pressurised within the higher permeability interbedded limestone units that are confined by the overlaying mudstone units. Groundwater pressures may also vary within interbedded limestones where there is a lack of connectivity between adjacent 'beds'. Ground investigations may be required to confirm groundwater pressures if excavations are proposed below the water table, e.g. near the drainage ponds, cuttings and underground storage tanks.

10.4.28. Ground investigations works should be carried out to determine site specific geology and unit thicknesses. Groundwater level monitoring should be completed for at least one full winter (October - February) to determine groundwater level maxima, as recommended in the ICE Earthworks (2015) guidance. This will help inform upon detailed design and the performance of the proposed balancing ponds.

10.4.29. The quality of groundwater bodies within the study area are monitored against the objectives of the WFD. A summary of the WFD 2016 Cycle 2 status reporting is provided in **Table 16**. The Witham Lias U groundwater body is located to the west of the River Witham, and the Witham Limestone Unit A is located to the east of the River Witham.

Table 16 Summary of groundwater WFD Monitoring

Waterbody name	Distance to Proposed Scheme	Number	Quantitative status	Chemical status
Witham Lias U	0m	GB40502B401400	Good	Good
Witham Limestone Unit A	0m	GB40501G444800	Poor: quantitative water balance and quantitative depends surface water body surface	Poor: general chemical test

10.4.30. Review of the Defra MAGIC Groundwater map shows that there are designated Groundwater Source Protection Zones within the east of the study area classified as Zone II which is defined by a 400-day travel time from a point below the water table, and Zone III which is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

10.4.31. No groundwater abstractions have been identified at the time of writing this report. Further consultation will be undertaken with the Environment Agency during the detailed assessment of the Proposed Scheme to identify private and public water supply licences present in close proximity of the Proposed Scheme.

APPRAISAL SUMMARY

10.4.32. The results of the water environment appraisal Workbook are presented in **Appendix A** and they can be summarised as follows:

10.4.33. It is likely that the risks to the quality of the water environment can largely be mitigated during construction through the implementation of a construction environmental management plan (CEMP). However, the Proposed Scheme will require a new bridge across the River Witham and will cross numerous drains within the Witham floodplain. The construction of the Proposed Scheme may also require temporary dewatering or groundwater control for the excavation of drainage ponds and storage tanks. The risks to water quality during construction will therefore be difficult to mitigate entirely. Effects to surface water quality will be temporary and are unlikely to pose long term impact. Effects to groundwater quality could pose long term impact and are slight to moderate adverse at this stage.

10.4.34. During the operation of the Proposed Scheme the risks to water quality in the River Witham, other drains and groundwater that may receive the discharge of runoff from the Proposed Scheme will be mitigated by a surface water drainage system that will include appropriate pollution control measures and, if required, attenuation.

10.4.35. Within the lowlands adjacent to the River Witham infiltration of runoff to ground is unlikely due to high groundwater levels and low soil permeability. It is therefore intended that surface water will be discharged to adjacent land drains that discharge to the River Witham. The residual impact to surface water quality is likely to be negligible. The current drainage design for the Proposed Scheme in the east of the study area indicates that there may be discharge of surface water runoff to groundwater within the Source Protection Zone II. The runoff will be treated prior to discharge to ground, however a residual risk would remain. Effects to groundwater quality are moderate adverse at this stage.

10.4.36. The new crossings over the River Witham and smaller drains may cause slight impact to the hydromorphological and ecological quality of the watercourse and drains by removing bankside habitat and the natural bed and severing connectivity. The proposed crossing of the River Witham will comprise a bridge that will maintain the existing alignment and bed of the River Witham and have minimal effect to flow dynamics within the river, although a new bridge pier within the channel may be required. The residual impact is therefore considered to be minor adverse at this stage of the assessment. The proposed crossings of drains are likely to comprise box or pipe culverts, although at this stage the design of these crossings is unknown. The design will be informed by consideration of hydraulic capacity requirements and ecological requirements and the post mitigation impact is minor adverse at this stage of the assessment.

10.4.37. The Proposed Scheme is located within an area currently indicated to be defended up to the 1 in 100 annual probability event by the Lincoln Washlands FAS, however may be at risk in the event of a breach or when updated climate change allowances are applied. The Proposed Scheme could therefore increase flood risk elsewhere during these potential scenarios through the loss of fluvial floodplain storage and severance of flood conveyance routes. It will be important for the Proposed Scheme to not affect the operation of the Lincoln Washlands FAS and not encroach to within the flood storage area, reduce the current standard of protection, affect the stability of the existing earth embankments or increase flood risk elsewhere during a breach event.

10.4.38. It is considered likely that the connectivity and flow capacity of the existing land drains that will be crossed by the Proposed Scheme can be maintained as part of the design which will assist in

maintaining flood flow conveyance, although additional flood relief culverts may be required through the Proposed Scheme embankment to reduce the impact further. It will also be important to maintain the hydraulic capacity of the River Witham. This should be achievable by providing a bridge over the river and minimising the size of structures required within the river.

10.4.39. Although considered unlikely flood compensation may be required to mitigate for any lost fluvial flood storage associated with the footprint of the Proposed Scheme or new structure within the channel of the River Witham. This could be achieved by designating and potentially reprofiling land on the periphery of the current flood extents as Flood Zone 3 and/or Flood Zone 2.

10.4.40. The magnitude of the impact of the Proposed Scheme of flood risk will be heavily dependent on the characteristics of flooding in the area, the operation of the Lincolns Washlands FAS, the flood outlines from the defended scenario with updated climate change allowance and the detailed design of the Proposed Scheme. Hydraulic analysis or the operational scenario will be required and, potentially, of the temporary (construction) scenarios. Discussions with the EA are ongoing regarding the potential effects of the Proposed Scheme, the required scope of more detailed analysis and likely mitigation requirements. At this stage of the assessment the Proposed Scheme is considered to have a moderate adverse effect to flood flow conveyance and loss of flood storage.

10.4.41. Following consultation with the EA, further assessment will be required of potential breach scenarios of the reservoir embankment and the river banks in close proximity of the Proposed Scheme. The risk of a river bank breach just upstream of the Proposed Scheme is relatively high and will required further assessment, potentially informed by hydraulic modelling. Costs associated with providing structural reinforcements to the river bank in the area of structural weakness could be high.

10.4.42. There may be an impact on groundwater flow due to subsurface structures, such as founding structures for the embankment. There may additionally be a reduction in baseflow due to reduced infiltration from the introduction of impermeable road surfaces. These may result in a permanent impact on catchment hydrogeology caused by the introduction of a barrier to subsurface flow and changes to local groundwater dynamics.

10.4.43. The design and construction of the drainage ponds and cuttings proposed should consider the effect of groundwater pressures: the potential for inflow to excavations and the potential loss of surface water storage where the ponds extend below the water table. As no site-specific groundwater level data is available, historic third-party data from the BGS were used to review the location of the water table. Groundwater is assumed to range between surface and 1.8mBGL based on expected high groundwater levels during the winter period (worst case scenario) and historic BGS borehole log SK96SE20. Therefore, groundwater management is likely to be required during both the construction and operation phases of the Proposed Scheme.

10.4.44. The overall assessment score is **moderate adverse.**

Appendix A

TOPIC WORKSHEETS

Noise Workbook - Worksheet 1

Proposal Name:	NHRR
Present Value Base Year	2010
Current Year	2019
Proposal Opening year:	2026
Project (Road, Rail or Aviation):	road

Net present value of change in noise (£):	£5,212,053

positive value reflects a **net benefit** (i.e. a reduction in noise)

Net present value of impact on sleep disturbance (£):	£2,129,572
Net present value of impact on amenity (£):	£2,172,988
Net present value of impact on AMI (£):	£427,416
Net present value of impact on stroke (£):	£192,055
Net present value of impact on dementia (£):	£290,022

Quantitative results

Households experiencing increased daytime noise in forecast year:	748
Households experiencing reduced daytime noise in forecast year:	3158
Households experiencing increased night time noise in forecast year:	n/a
Households experiencing reduced night time noise in forecast year:	n/a

Qualitative Comments:

Data Sources:

Air Quality Valuation Workbook - Worksheet 3

Scheme Name: North Hykeham Ring road Lincoln Bypass

Present Value Base Year	2010
Current Year	2017
Proposal Opening year:	2026
Project (Road/Rail or Road and Rail):	road

Overall Assessment Score:

Present value of change in NOx emissions (£):	-£349,092
Present value of change in PM10 concentrations (£):	-£8,803,338
Total value of change in air quality (£):	-£9,152,430

*positive value reflects a **net benefit** (i.e. air quality improvement)

Quantitative Assessment:

Net total route assessment (opening year) for PM10 : (between 'with scheme' and 'without scheme' scenarios)	3,130
Change in NOX emissions over 60 year appraisal period: (between 'with scheme' and 'without scheme' scenarios)	741

Qualitative Comments:

Initial benefits are predicted in the overall property weighted concentrations of NO2, however these will decrease over the life of the Proposed Scheme, with a deterioration in property weighted concentrations predicted by the operating year of 2041. Overall property weighted concentrations of PM10 are predicted to deteriorate as a result of the proposed scheme in both years. However, in all cases, more properties are predicted to experience improvements in concentrations than a deterioration. This suggests that where there are deteriorations these are greater in magnitude than the improvements experienced by the majority of receptors.
The air quality valuation is for a dis-benefit due to the Proposed Scheme as a result of overall increases in the mass emissions of both NOx and PM10 over the valuation period. Any proposed air quality mitigation measures should be planned taking account of these figures.
Initial reductions in the predicted concentrations of NO2 are not expected to have a negative impact on the ability of the East Midlands zone to become compliant with EU Directive 2008/50/EC within the required period.
Conversely, a new dual carriageway is to be in operation, coupled with new roundabout configurations at strategic points and may attract road vehicles to utilise the Proposed Scheme. With a possible increase and intensification of traffic volume and composition (such as increased use by HGVs) that bypasses the city of Lincoln, on a regional level, total mass emissions of NOx are predicted to increase as a result of the Proposed Scheme.

Sensitivity Analysis:

Upper estimate net present value of change in air quality (£):	-£10,412,716
Lower estimate net present value of change in air quality (£):	-£4,886,753

Data Sources:

Collation and review of the most recent local monitoring data and Local Air Quality Management (LAQM) Review and Assessment report available for North Kesteven District Council (NKDC) and City of Lincoln Council (CLC), including the presence of any known Air Quality Management Areas (AQMAs);

Review of additional air quality data available for the area surrounding the Proposed Scheme, including data available from Defra's online LAQM support pages ;

A review of local mapping OS AddressBase and Openmap Local data available for the study area to identify existing receptors that may be sensitive to a change in local air quality with the operation of the Proposed Scheme;

A review of information available regarding the presence of any ecological receptors from the Multi-Agency Geographic Information for the Countryside (MAGIC) on-line mapping website ; and

A review of Defra's Pollution Climate Mapping (PCM) Model.

Greenhouse Gases Workbook - Worksheet 1

Scheme Name: NHRR - OBC

Present Value Base Year 2010

Current Year 2018

Proposal Opening year: 2026

Project (Road/Rail or Road and Rail): road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): -£7,849,390

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): 181,041
(between 'with scheme' and 'without scheme' scenarios)

Of which Traded 2962

Change in carbon dioxide equivalent emissions in opening year (tonnes): 2,965
(between 'with scheme' and 'without scheme' scenarios)

Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): -£128,140
(N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
Traded sector	0	0	0	124
Non-traded sector	0	0	0	5819

Qualitative Comments:

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 GHG, which forms the focus of this appraisal.

For the purposes of the OBC, the Transport User Benefit Appraisal (TUBA) software program was used for each Proposed Scheme Option, accounting for a 60-year appraisal period (2026 – 2085).
The emissions of CO2 increase as a result of the scheme by 2962 tonnes for a projection of 60 years.
The increase in CO2 due to opening the scheme is predicted to be 0 tonnes in the opening year.

Sensitivity Analysis:

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): -£12,131,759

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): -£3,567,020

Data Sources:

Traffic Data and Emissions of CO_2 provided by TUBA (NHRR_Core_VDM_v04_Output)

TAG Landscape Impacts Worksheet

	Step 2	Step 3				Step 4
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Impact**
Pattern	A predominantly low-lying landform, with the exception of the Lincoln Cliff at the eastern extent of the study area. A regular pattern of medium to large fields enclosed by hawthorn hedgerows and ditches dominates the landscape. A network of small, narrow lanes, traverse across the study area, with more dominant arterial road corridors extending from Lincoln in a broadly north to south orientation, at the western and eastern study limits. Sparse settlements primarily on higher ground, around the periphery of the study area, including Waddington and Bracebridge Heath. The River Witham, and River Brant dissects the landscape from north to south, through the middle of the study area. The pattern of the study area is most consistent with sub-area Trent & Witham Vales - Witham & Brant Vales , within the North Kesteven Landscape Character Assessment.	Visually common place features found locally. Similar to floodplain landscapes found at a national level, with the exception of the topography to the east, which, when combined, create a unique character at a Regional Scale.	Common landscape features at a local level.	High importance at a regional scale.	The Proposed Scheme would divide the landscape from north to south, effectively creating a definitive southern boundary to the urban fringe of the main settlement to Lincoln to the north. The Proposed Scheme will sever fields directly below the footprint of the road corridor, creating localised smaller fragmented parcels of land on either side, at odds to the wider character. Views of the Proposed Scheme will be partially screened by the areas topography (Lincoln Cliff). Therefore the substitutability of the pattern of the landscape to change is considered as low. The alignment of the road is at odds to others within the adjoining landscape that travel at right angles to one another.	Reinstatement of field boundaries around severed parcels of land, should be considered as part of the mitigation proposal associated with the Proposed Scheme. In addition to the above, hedgerow screen planting should be carried out on either side of the Proposed Scheme, associated with the permanent highway boundary, reinstating the current form and pattern of the landscape. Where adjacent to near-by visually sensitive receptors, the inclusion of trees within the hedgerows should be considered to provide filtered views of more visually intrusive HGVs. The change to the landscape pattern will be most perceivable from those areas of higher ground including residential properties (visual receptors) located along Station Road and users of Viking Way. The Proposed Scheme is anticipated to have a **Moderate Adverse** impact on the pattern of the landscape.
Tranquillity	At the western and eastern extent of the study area, the tranquillity of the area is compromised by the proximity of the A46 and A15 respectively. To the east, the tranquillity is further compromised due to the proximity of the Proposed Scheme to RAF Waddington. Low flying aircraft were observed at regular intervals flying over head, when carrying out the initial site walkover in November 2018. Within the wider study area, tranquillity is considered to be high, as a result of the lack of significant built form and low lying nature of the landscape, increasing the dominance of the sky within associated views.	The tranquillity of the landscape matters at a local scale.	Due to the proximity of the Proposed Scheme to the existing A46, A15 and RAF Waddington, the tranquillity of the landscape is restricted to those areas located more centrally within the study area.	Of Local importance, due to the proximity of the landscape to the urban fringe of Lincoln and the usage of the area by receptors utilising the numerous PRoWs.	Due to the presence of the existing A46 and A15 within the receiving landscape detracting from the sense of tranquillity at either end of the Proposed Scheme, combined with the loss of tranquillity associated with the proximity of the eastern end of the Proposed Scheme to RAF Waddington the substitutability of the current level of tranquillity of the area is considered to be high.	The Proposed Scheme would compromise the aspects that contribute towards tranquillity, beyond that currently experienced today, by establishing a dual carriageway (a prominent linear feature) through an area currently perceived as being undeveloped, detracting from the sense of isolation and openness. The tranquillity of sub-area Witham & Brant Vales, will be most significantly affected by the Proposed Scheme. The Proposed Scheme is anticipated to have a **Moderate Adverse** impact on the tranquillity of the landscape.
Cultural	There are a number of culturally significant features located within the study area. These include the pattern of compact villages seen today across much of the area, which is thought to have become established from the 10th century, with villages tending to be located on slightly raised land where drainage and agricultural productivity were better. The former sand and gravel pits to the west of the study area, indicating former industrial usage of the area have been restored forming wetland habitats and recreational sites (Whisby Nature Park) within the local area. Distinctive landmark features, include Lincoln Cathedral, which is discernible within views from various locations within the study area, including along Blackmoor Road, at the southern extent of the study area. Windmills are a feature of the area, with most being converted into alternative services, maintaining their prolonged existence within the landscape. The long distance trail, located within the eastern extent of the study area, referred to as the Viking Way, reflects the historic influence of Danelaw in the area. RAF Waddington opened in 1916, primarily as a training base, prior to re opening as a bomber base in March 1937. Today, Waddington is one of the RAFs busiest operational airfields. In addition to its formal military works the airbase has put on air shows for the past 20 yrs. The RAF base is a defining feature of sub-area Central Plateau - Limestone Heath within the North Kesteven Landscape Character Assessment.	The cultural elements of the landscape matter at a Local, Regional and National scale.	The area is of high cultural significance at a regional and local level, given the proximity of the scheme to a number of culturally significant features within the landscape, that shape the character of the area and create a 'sense of place'.	Of Local and Regional importance. RAF Waddington is of National importance, due to the role it continues to play in defending the nation.	The cultural substitutability to change is considered to be low, due to the proximity of the RAF Waddington to the existing A607, A15 and the network of roads that cross the study area.	Mitigation planting will be restricted at the eastern end of the Proposed Scheme, due to the proximity of the Scheme to RAF Waddington, reducing the risk of bird strikes. The Proposed Scheme will directly sever the current alignment of Viking Way, resulting in a PRoW diversion being imposed. The Proposed Scheme is not anticipated to directly effect the pattern of the historical settlements within the area. The Proposed Scheme is anticipated to have a **Moderate Adverse** impact on the cultural value of the landscape.
Landcover	Land use within the study area is a mix of arable, pastoral, residential and commercial. A predominantly rural and sparsely settled area with small villages and dispersed farms linked by quiet lanes, contrasting with the more populated area of Lincoln to the north. The study area is predominantly associated with the River Witham floodplain. Fields are bound by hedgerows, with intermittent trees. Small isolated scattered copses of trees are scattered throughout the study area at irregular intervals. The River Witham, dissects the study area, from north to south, where it forms a confluence with the River Brant. A number of roads traverse through the study area, including the A46 (Roman Road) at the western extent of the study area, and the A15 and A607 to the east. Overhead powerlines interrupt the skyline in the central and western areas of the study area. Along the northern edge of the study area, residential development is more pronounced, with isolated farm steads scattered throughout the study area, with more noticeable smaller settlements of Aubourn and Harmston to the south. At the eastern extent of the study area, associated with the settlement of Waddington is RAF Waddington. At the western extent of the study area, to the west of the A46 former gravel or sand extraction pits have been flooded, creating large scale water bodies and wetland areas, within the landscape (Whisby Nature Park). Within the study area the landcover is a combination of all four sub-areas recorded within the study area, although the study area principally falls within sub-area Witham & Brant Vales.	The combination of the topography of the area, combined with the arrangement of the features within the landscape, results in a landcover that matters at a local and regional scale.	Common place features associated with floodplains at a national level. Remaining landscape features consistent with urban fringe environments found nationally at the edge of large cities. It is the combination of the features that creates sense of place.	Moderately important at a local scale - common within the surrounding landscape.	The landcover of the area is considered to have a moderate substitutability. Once lost, fertile alluvium soil currently used for agriculture can not be easily replaced, reducing the areas substitutability. Landscape features such as woodland copses and hedgerows can be replaced, and will be considered as part of the landscape strategy to accompany the proposal. Similar features to that of the Proposed Scheme are already found to be present within the receiving landscape, increasing the substitutability to change further.	The Proposed Scheme will permanently change the nature of the land use directly beneath the footprint of the road corridor, including the demolition of a number of properties along Station Road. Where possible, existing vegetation lost to the Proposed Scheme in the form of woodland and hedgerows will be replaced. The Proposed Scheme is anticipated to have **Moderate Adverse** impact on landcover.

Summary of character	Predominantly open landscape with long distance views to the west discernible from the area of higher ground to the east of the study area, referred locally as the Lincoln Cliff. The landscape is predominately undeveloped owing to the main land use within the area, being mixed use agriculture. The River Witham cuts through the landscape from north to south. Lincoln Cathedral is discernible throughout the study area, contributing to the study area's sense of place. Similarly RAF Waddington located within the eastern extent of the study area contributes to the areas sense of place, due to the frequency of low flying aircraft evident within views, and the subsequent reduction of tranquillity within the affected area as a result. Within the North Kesteven Landscape Character Assessment, the study area is spilt over three of the four character types, and comprises of four sub-areas. Of these the study area predominantly falls within sub-area Witham & Brant, however sub-area Lincoln Cliff contributes most in this instance to sense of place and local character, due to being visually dominate within views.	The landscape matters at a local and regional scale.	The landscape is considered to be rare at a regional and local level, due to the combination of topography and landcover creating a unique sense of place.	The landscape matters at a local and regional level.	Due to being located within the urban fringe of the city of Lincoln, the sensitivity of the landscape to change will be increased, resulting in the landscape being considered as having a medium substitutability to change. Other dual carriageways are recorded at the western and eastern end of the study area, increasing the landscape's substitutability to change with respect to this particularly type of development. The Proposed Scheme is a narrow linear feature within a wider character area, resulting in a reduced magnitude of change. Long distance views from areas of higher ground will not be significantly affected by the Proposed Scheme, retaining the landscape's sense of openness.	The Proposed Scheme is considered to be at odds with the existing landscape, due to the proposed alignment of the road corridor and the combination of proposed features including embankments, cutting slopes and bridge structures. The Proposed Scheme is anticipated to have a **Moderate Adverse** impact on landscape character. Those visual receptors most likely to be significantly affected by the Proposed Scheme include those residential properties Station Road, Pottergate Close, Appin Way, Sycamore Grove, King Drive and isolated farm steads. The Proposed Scheme is anticipated to have a **Moderate Adverse** to **Large Adverse** impact on visual receptors.
Reference Sources						
MAGIC Maps - https://magic.defra.gov.uk/MagicMap.aspx ; Natural England National Character Area Profile (NCA) No.47 Southern Lincolnshire Edge National Character Area profiles, Natural England (September 2014). Available at: https://www.gov.uk/government/publications/national-character-area-profiles-data-for-local-decision-making/national-character-area-profiles (Sourced November 2018) ; Natural England National Character Area Profile (NCA) No.48 Trent & Belvoir Edge National Character Area profiles, Natural England (September 2014). Available at: https://www.gov.uk/government/publications/national-character-area-profiles-data-for-local-decision-making/national-character-area-profiles (sourced November 2018); North Kesteven Landscape Character Assessment (2007), David Tyldesley and Associates North Kesteven Landscape Character Assessment, David Tyldesley And Associates For North Kesteven District Council (September 2007) Available at: https://www.n-kesteven.gov.uk/residents/planning-and-building/planning/planning-applications/north-kesteven-landscape-character-assessment/ (Sourced November 2018) The Historic Landscape Characterisation Project for Lincolnshire - Historic Landscape Characterisation, North Kesteven District Council website. Available at: https://www.lincolnshire.gov.uk/residents/environment-and-planning/conservation/archaeology/historic-landscape-characterisation/70142.article (Sourced November 2018)					
Step 5 - Summary Assessment Score						
Large Adverse Effect						
Qualitative Comments						
The Proposed Scheme, is at odds with the pattern of similar features within the landscape, creating an arc as opposed to a straight linear feature. It is not considered that the Proposed Scheme will be integrated within the landscape, due to the western end of the road corridor being raised on embankment, through an otherwise predominantly flat landscape. In addition to this, the inclusion of structures in the form of bridges, will further detract from the landscape setting. The Proposed Scheme will permanently alter the pattern of the landscape, in addition to creating a permanent change to the nature of the land use along the road corridor itself. The Proposed Scheme will permanently sever linear features within the landscape of cultural significance resulting in a change to their current alignment. The Proposed Scheme will also sever a number of policy lead designations as identified upon the adopted Central Lincoln Local Plan, including an 'Area of Great Landscape Value' and a 'Green Wedge. To reduce impacts during both construction and operation, mitigation planting should be prepared as part of the Proposed Scheme design, however this may not mitigate fully the visually intrusive nature of the Proposed Scheme, from areas of higher ground, where long distance views are perceivable. A Landscaping Strategy is also being produced to further align landscape into the emerging design of the Proposed Scheme.					

TAG Townscape Impacts Worksheet

	Step 2	Step 3					Step 4
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
Layout	N/A						
Density and mix	N/A						
Scale	N/A						
Appearance	N/A						
Human interaction	N/A						
Cultural	N/A						
Land use	N/A						
Summary of character	N/A						

Reference Sources

N/A

Step 5 - Summary Assessment Score

N/A

Qualitative Comments

The study area is predominantly open countryside, crossing farmland, with only small settlements or the edge of the outlying villages of Lincoln for example North Hykeham, therefore the Townscape appraisal has been scoped out.

TAG Biodiversity Impacts Worksheet

Step 2		Step 3				Step 4	Step 5
Area	**Description of feature/ attribute**	**Scale (at which attribute matters)**	**Importance (of attribute)**	**Trend (in relation to target)**	**Biodiversity and earth heritage value**	**Magnitude of impact**	**Assessment Score**
Bats	Protected Species	National	A large number of bat records were returned from the records centre. The speices and closest records for each include brown long-eared bat approximately 200m from the proposed scheme, soprano pipistrelle approximately 5km from the proposed scheme, common pipistrelle approximately 10m from the proposed scheme, Whiskered/Brandt's bat Myotis mystacinus/brandtii roost approximately 3.2km form the proposed scheme and Daubenton's bat approximately 4km from the proposed scheme. In addition, a large number of records of bats foraging or flying across the area were included within the data. As well as the species listed above, these include Nathusius' pipistrelle and noctule, along with a number of records of unspecified bat species. Potential breeding and hibernation sites in structures and buildings for bats exist at multiple locations within the Survey Area. Mature and semi-mature trees are also present throughout the Survey Area, although no systematic survey of the bat roost potential of trees was undertaken, several trees with features likely to be suitable for roosting bats were noted. Foraging and commuting habitat for bats is present throughout the Survey Area.	All species of bats recorded within the UK are protected from killing, injury and disturbance and their roosts protected from damage or destruction under the Habitats Regulations. Protection is also afforded under the Wildlife and Countryside Act 1981 (as amended) with respect to disturbance of individuals occupying places of rest or shelter and obstruction of access to these. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes. Certain species of bats, including Bechstein's bat, greater and lesser horseshoe bats, noctule, brown long-eared bat and soprano pipistrelle are also listed as Species of Principal Importance (SPI) for the conservation of biodiversity in England in accordance with Section 41 of the NERC Act 2006. Section 40 obliges public bodies (including local planning authorities) to have regard for the conservation of biodiversity (including SPI) when discharging their duties (including determining planning applications).	Medium	Intermediate negative	The scheme may directly affect roosting bats which may be present within industrial buildings and residential buildings. Bats may also be affected if roosting within mature and semi-mature trees which will require removal to accommodate the Proposed Scheme. Indirect effects from the scheme may arise through the destruction of foraging and commuting lines and increased lighting and disturbance along the route of the proposed scheme. Further survey work is required to assess the effects on bats. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Moderate Adverse** impact on bats.
GCN	Protected Species	National	A total of 23 great crested newt records were returned from the data search, including four records within 1km of the proposed scheme. Potential great crested newt breeding habitat is present within the Survey Area, with six ponds shown on OS mapping as being located within 150m of the proposed scheme footprint. Great crested newts are also known to disperse throughout terrestrial habitat up to 250m away from breeding ponds so the proposed scheme land may also support newts from ponds outside the 100m buffer Survey Area. Due to the predominance of arable land within the Survey Area the amount of suitable land into which to disperse after breeding is limited.	Great crested newts are protected from killing, injury and disturbance and their places of rest or shelter (occupied habitat) protected from damage or destruction under the Habitats Regulations. Protection is also afforded under the Wildlife and Countryside Act 1981 (as amended) with respect to disturbance of individuals occupying places of rest or shelter and obstruction of access to these. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes. Great crested newts and common toad Bufo bufo are also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.	Medium	Intermediate negative	Great crested newts may occupy breeding ponds up to 250m away from the footprint of the proposed scheme and use intervening terrestrial habitat. Despite the dominance of low quality arable habitat throughout the Study Area great crested newts may occur in the vicinity of the Proposed Scheme. Therefore further survey work is recommended. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on GCN.
Otter	Protected Species	National	There are 45 records of otter Lutra lutra within the Study Area. These include two records from the within the footprint of the proposed scheme. Within the Survey Area there is very little of otter breeding habitat present. Resting sites are likely to be present along the River Witham and otters are known to commute and feed along the section of the river within the Survey Area. This was confirmed by the presence of fresh otter spraint which was found during the Phase 1 Habitat survey.	The European otter is protected from killing, injury and disturbance and its place of rest or shelter (holt) is protected from damage or destruction under the Habitats Regulations. Protection is also afforded under the Wildlife and Countryside Act 1981 (as amended) with respect to disturbance of individuals occupying places of rest or shelter and obstruction of access to these. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes. Otters are also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.	Medium	Intermediate negative	Evidence of otter presence was found along the western bank of the River Witham with fresh otter spraint being present on a concrete platform near the Flood Control Building. Although presence has already been established, further survey work, is necessary to avoid the destruction or damage of any resting places which may be affected by the crossing of the River Witham by the Proposed Scheme. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on Otters.
Badger	Protected Species	National	There are 33 records of badger within the Study Area. 15 of these records are of badger setts, the closest of which is located approximately 750m from the centre of the proposed scheme. During the Phase 1 Habitat survey no signs of badger presence, including setts, latrines, snuffle holes, tracks, footprints or hairs, were found. The Phase 1 Habitat survey, however, was restricted to PRoWs and therefore large areas of land were not accessed. Within this land there are numerous potential badger breeding sites. Suitable foraging habitat is also present throughout the survey area within woodland, improved grassland, amenity grassland, poor semi-improved grassland and arable fields.	The Protection of Badgers Act 1992 makes it illegal to wilfully kill, injure or take any badger, or attempt to do so. It also makes it an offence to intentionally or recklessly damage, destroy or obstruct access to any part of a badger sett. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes.	Medium	Intermediate negative	Although signs of badger activity were not found during the Phase 1 Habitat survey, suitable breeding and foraging habitat is present within the Study Area. Further survey work is required to establish whether badgers are present within the Study Area and may therefore be affected by the Proposed Scheme. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on badgers.

Water vole	Protected Species	National	There are 115 records of water vole Arvicola amphibius within the Study Area. Nine of these records are located within the footprint of the proposed scheme. Water vole breeding and foraging habitat is mostly located within the western section of the Survey Area where the greatest number of field drains occur. No signs of water vole, including burrow holes, droppings/latrines, feeding remains or runways were found during the Phase 1 Habitat survey, however due to the timing of the survey and access restrictions the possibility of water vole presence within the Survey Area cannot be discounted.	The water vole is protected from killing and injury and its place of rest or shelter (burrow) is protected from damage, destruction or obstruction under the Wildlife and Countryside Act 1981 (as amended). Additional protection from disturbance is extended to individuals occupying places of rest or shelter. Activities that would otherwise constitute an offence under this legislation may be licensed natural England for certain purposes. The water vole is also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.	Medium	Intermediate negative	No signs of water vole were found during the Phase 1 Habitat survey but the survey was undertaken at a sub-optimal time of year for detecting water vole presence. Many of the field drains had also been recently cleaned out which would destroy most signs of water vole occupation. It is therefore recommended that further survey work is undertaken. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on water vole.
Birds - wintering	Protected Species	National	A large number of bird records were returned from the records centre, including the following Schedule 1 species recorded within the footprint of the proposed scheme.	Under the Wildlife and Countryside Act 1981 (as amended) the majority of wild birds are protected from killing and injury (with certain exceptions), and their nests and eggs protected from taking, damage and destruction whilst in use. Additional protection is extended to species listed under Schedule 1 of the Act, meaning it is also an offence to disturb these species at or near an active nest, or whilst they have dependent young.	Medium	Intermediate negative	More long-term effects may arise from the operation of the road including increased disturbance and risk of mortality through road traffic collisions. This is particularly likely for raptors, notably barn owls which are known to roost adjacent to the footprint of the proposed scheme near the River Witham. Habitat loss may also affect foraging wintering birds which may use fields, hedgerows and trees throughout the Survey Area. Wintering bird surveys should be undertaken to identify which species and numbers of birds are using land within the Survey Area during the winter months and within which areas wintering birds are concentrated. Wintering bird surveys occur from October to February (inclusive). If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on wintering birds.
Birds - breeding	Protected Species	National	A large number of bird records were returned from the records centre, including the following Schedule 1 species recorded within the footprint of the proposed scheme. Breeding and foraging habitat for birds occurs throughout the Survey Area. During the Phase 1 Habitat survey a barn owl nesting box was found to be located to the west of the River Witham.	Under the Wildlife and Countryside Act 1981 (as amended) the majority of wild birds are protected from killing and injury (with certain exceptions), and their nests and eggs protected from taking, damage and destruction whilst in use. Additional protection is extended to species listed under Schedule 1 of the Act, meaning it is also an offence to disturb these species at or near an active nest, or whilst they have dependent young.	Medium	Intermediate negative	Habitat for nesting birds exists throughout the length of the proposed scheme, with the potential for large scale habitat loss due to clearance of vegetation to accommodate the road. Vegetation clearance may have a direct effect on breeding birds and measures should be put in place to avoid damage to nests, eggs and young birds. In order to assess the effects of the proposed scheme on breeding birds, further surveys are recommended. Breeding bird surveys should be undertaken to identify which species and numbers of birds are holding territories and breeding within the Survey Area. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on breeding birds.
Reptiles	Protected Species	National	The data returned from the desk study included records of common lizard, grass snake and slow-worm from within 5km of the proposed scheme. Two records of grass snake are located within the footprint of the proposed scheme. The majority of habitat within the Survey Area is sub-optimal for reptiles, being comprised mainly of arable fields. More suitable areas of habitat do exist in close proximity to the Survey Area.	Native widespread reptile species (common or viviparous lizard, adder, grass snake and slow worm) are partially protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). This includes protection from killing and injury. All reptile species are also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.	Medium	Minor Negative	The majority of habitat throughout the Study Area is unsuitable for reptiles, comprising large areas of arable land. More suitable areas of reptile habitat are detailed and are recommended for further survey work. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Slight adverse** impact on reptiles.
Plants	Protected Species	National	Intact hedges are present along many of the field boundaries, particularly towards the western end of the Survey Area where they often run alongside drainage ditches. Although all hedges within the Survey Area have all been classed as species-poor this may not actually be the case as most of the hedges had been recently flailed, making it very difficult to assess the number of species present within individual hedges. It appeared that the most frequent species comprising the hedgerows was hawthorn, with other species including blackthorn, dog rose, wild privet Ligustrum vulgare, ash, hazel and field maple.	Important hedgerows defined by the Hedgerow Regulations 1997 are a material consideration in Planning Applications and developments.	Medium	Intermediate negative	Further survey work is recommended to identify if there are sections of species-rich hedgerow present along field boundaries. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Moderate Adverse** impact on plants.
Plants	Non-native invasive species	National	Records of non-native invasive plant species are present within the Study Area. None of records are located within the footprint of the proposed scheme. One WCA Schedule 9 invasive plant species was found during the Phase 1 Habitat survey, however due to access restrictions, there may potentially be other WCA Schedule 9 species present at other locations within the Survey Area.	Under the Wildlife and Countryside Act 1981 (as amended) , schedule 9, it is illegal to allow the persistence of, or allow the spread of, invasive non native plant species into the wild	Medium	Intermediate negative	Further Schedule 9 species may be present throughout the Study Area within land parcels which were not visited due to access restrictions. Further survey work is therefore recommended. If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on non-native invasive species.
Whisby Nature Park Local Nature Reserve (LNR)	The site consists of flooded gravel pits surrounded by grassland, marsh, scrub and willow carr. Elements of the original landscape, from before quarrying also remain, with fragments of heathland, old hedgerows and a small oak woodland.	National	The site consists of flooded gravel pits surrounded by grassland, marsh, scrub and willow carr. Elements of the original landscape, from before quarrying also remain, with fragments of heathland, old hedgerows and a small oak woodland.	Managed by the Lincolnshire Wildlife Trust, the site forms a mosaic of habitats. Fragments of heathland remain and since quarrying stopped in the 1930s, over 500 plant species including mosses, orchids and lichens occur alongside water and wetlands that are predominantly man-made.	High	Neutral	The Proposed Scheme holds very little habitats of value that can be found on the LNR. Moreover, the LNR is located circa 1.4km away and therefore no anticipated constraints to the Proposed Scheme are noted. The Proposed Scheme is anticipated to have a **Neutral** impact on this site.

Waddington Grassland (Viking Way) Local Wildlife Site	Consisting of calcareous pasture slopes. Habitats present include grazed grassland, marshy areas, scrub and ponds. One field supports ancient grassland.	County	Important for grassland	The site lies within the proposed works and has the potential to be directly impacted.	Medium	Intermediate negative	Future grassland will be required for the scheme as a compensatory measure to ensure no net loss due to the proximity of the site to the scheme. The Proposed Scheme is anticipated to have a **Moderate adverse** impact on this site.
River Witham, Bracebridge to South Hykeham Local Wildlife Site	Limestone escarpment where the dominant land use is grazing pasture farmland. Fields are bordered by hedgerows and trees.	County	Limestone escarpment and grazing pasture	The site lies within the proposed works and has the potential to be directly impacted.	Medium	Minor Negative	No habitat exist that are not present in the scheme other than Limestone Escarpment. The Proposed Scheme is anticipated to have a **Slight adverse** impact on this site.
Bloxholm Lane Local Wildlife Site	3.6 ha of woodland containing mature trees with a shrub layer and patches of rich ground flora.	County	Woodland	The site lies within 200m of the proposed works and is unlikely to be directly affected.	Medium	Minor Negative	The Proposed Scheme is anticipated to have a **Slight adverse** impact on this site
South Hykeham Meadows 1 Site of Conservation Interest	Species-rich unimproved grassland.	County	Important for grassland	The site lies within 250m of the proposed works and is unlikely to be directly affected.	Medium	Neutral	The Proposed Scheme is anticipated to have a **Neutral** impact on this site
South Hykeham Meadows 2	Three main habitat types consisting of improved pasture, a small orchard and a fragment of ancient meadow. Hedgerows border the site and a dry ditch runs along the western boundary.	County	Grassland, meadow and orchard	The site lies within 250m of the proposed works and is unlikely to be directly affected.	Medium	Neutral	**Neutral**
Brant Washlands Local Wildlife Site	Shallow embankments built across the river valley, with control sluices in the rivers. The habitat is a floodplain.	County	Floodplain	The site lies within 300m of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Waddington Brick Pit Local Geological Site	Habitat comprises broad-leaved woodland habitat around a flooded, disused pit. Woodland around the edges of pit is predominantly silver birch, ash and alder.	County	Woodland	The site lies within 300m of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Low	Neutral	**Neutral**
North Hykeham Gravel Pit Local Wildlife Site	Large lake formed from gravel workings. Containing three small wooden islands. The lake supports limited flora but the steep banks are covered in scrub. Original oak woodland located on the northern edge of lake and birch woodland on the southern edge.	County	Gravel quarry lakes	The site lies within 500m of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Ski World, Whisby Pits Complex Local Wildlife Site	Three flooded gravel pits dominated by Canadian pondweed and blanketweed. Surrounded by acid grassland and improved grassland. Seasonally wet areas.	County	Grassland and gravel pits	The site lies within 500m of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
North Hykeham Hayfield Local Wildlife Site	Semi-natural neutral grassland at least 0.1 ha in extent. High quality hay meadow bordered by scrub. The adjoining southern boundary is seasonally flooded.	County	Grassland and hay meadow	The site lies within 700m of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
North Hykeham Meadows Local Wildlife Site	None given	County	Unknown but likely hay meadows	The site lies within 800m of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Whisby Nature Park Local Wildlife Trust Reserve	Comprises of flooded gravel pits, olds sand spoil heaps with slack areas, open water habitats that are bordered by reedbed, grazing marsh and scrub.	County	Former industrial site with gravel pits and open water	The site lies within 1.2km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Low	Neutral	**Neutral**
Teal's Lake, Whisby Pits Complex Local Wildlife Site	Grassland, scrub, open water.	County	Mosaic	The site lies within 1.2km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Whisby Nature Park, Whisby Pits Complex Local Wildlife Site	Small, medium and large flooded gravel pits. One significant flowing stream. Some pits support wet willow scrub. Dense willow and birch scrub occurs on spoils between pits which develops into canopy scrub resembling woodland.	County	Former industrial site with gravel pits and open water including wet patches of woodland	The site lies within 1.3km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Hykeham Railway Line, Whisby Nature Park Local Wildlife Site	Predominant vegetation is semi-improved neutral grassland dominated by false oat-grass. Scattered scrub occurs along both sides of railway.	County	Grassland	The site lies within 1.6km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Mr Nevile's Pits East, Whisby Pits Complex Local Wildlife Site	Grassland, scrub, open water.	County	Mosaic	The site lies within 1.7km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**

River Witham, Aubourn to Beckingham Local Wildlife Site	None given	County	Unknown	The site lies within 1.8km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Mr Nevile's Pits, West, Whisby Pits Complex Local Wildlife Site	A flooded sand and gravel pit bordered by willow woodland. Lake edges are covered by dense woodland and deep wet carr. Pike Drain supports a diverse range of flowering plants.	County	Woodland and flooded gravel pits	The site lies within 1.9km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**
Witham Corridor, south of Bracebridge	None given	County	Unknown	The site lies within 1.9km of the proposed works therefore no anticipated constraints to the Proposed Scheme are noted.	Medium	Neutral	**Neutral**

Reference Sources

WSP (2018). Lincolnshire County Council. Lincoln Southern Bypass Preliminary Ecological Appraisal, Phase 1 survey data; Lincolnshire Environmental Records Centre (LERN) and open source data (MAGIC). Protected species data; North Kesteven District Local Wildlife Sites Review (2009). Local Wildlife Review: North Kesteven Surveys (2010), Lincolnshire County Council Lincoln Southern Bypass: Environmental report (2005). Lincoln Policy Area Strategic Flood Risk Assessment Volume one (2010). North Kesteven District Council. The Natural Environment of the Parish of Thorpe on the Hill.

Summary Assessment Score

Moderate Adverse

Qualitative Comments

Excluding hardstanding the Survey Area consists of 82.3% arable land, 7.3% improved grassland and 6.3% poor semi-improved grassland. Arable land is generally of low ecological value with little potential for supporting protected species although the field boundaries are often formed of hedgerows, tree lines and field drains, with greater protected species potential.

The tree and hedge lines are likely to support breeding birds and may potentially provide roosting sites for bats, with opportunities for badger sett construction along their base. Field drains provide potential habitat for water voles, whilst otter spraint was found adjacent to the River Witham. Evidence of roosting barn owls was also found near the river.

Other protected species that may be present within the Survey Area include common reptiles and great crested newt, although suitable habitat for both of these is very restricted within the Survey Area.

As the alignment passes through habitat that could support national and European species, then these species could be affected (including the presence of any built structures on site) therefore a moderate adverse impact is anticipated. However once the assessment of these species has been completed in the form of further survey including any potential mitigating activities, then the overall scheme should not exceed a slight adverse effect.

TAG Historic Environment Impacts Worksheet

Step 2		Step 3			Step 4
Feature	**Description**	**Scale it matters**	**Significance**	**Rarity**	**Impact**
Form	There are no designated heritage assets located within the scheme. There are four non-designated heritage assets located within the scheme. These comprise medieval ridge and furrow (HER 62576), the site of an Avro Manchester Bomber aircraft crash in World War II (HER 65789), a sherd of Romano-British Pottery (HER 61267) and a Roman site (HER 61259). There are 17 Listed Buildings within 1km Study Area. No World Heritage Sites, Scheduled Monuments, Registered Parks and Gardens or Battlefields were identified within 1km study area. The Listed Buildings comprise of one Grade II* Listed Buildings and 16 Grade II. The nearest listed building is 90m from the proposed scheme, this is Grade II Gates and Walls to the Manor House (NHLE 1360604). Four others lie within 500m of the scheme include Grade II* Church of St Michael (NHLE 1061957), Grade II Farm buildings at the Manor House (NHLE 1061753), Church Farmhouse (NHLE 1164588), The Manor House (NHLE 1305031).	The protection and enhancement of heritage assets is of national concern as set out in the National Planning Policy Framework, this aims to conserve heritage assets in a manner appropriate to their significance.	The Grade II* Listed Building is of national significance, while the Grade II Listed Buildings and conservation areas are of regional significance. The non-designated heritage assets are significant at a regional and local level.	The designated heritage assets are nationally common features. All aspects of the heritage resource within the study area are not rare within a national and local context	There will be no direct impacts on any designated heritage assets as none lie within the footprint of the Scheme. There is potential for a change in the setting of the designated heritage due to the impact of new road which will cause a visual change and may cause a degradation in tranquillity. Visual change will be from new structures and movement across the landscape which is not currently present; the change in tranquillity is likely due to traffic noise. The Proposed Scheme will introduce a new road into a predominantly agricultural landscape, and would result in a **minor adverse impact** on the form and character of the landscape. The potential for buried remains on the site is high due to the location of the non-designated heritage assets in particular the Roman site. Therefore the effect of the scheme is **moderate to major adverse.**
Survival	The built heritage assets are believed to be completed and in regular use, although there use may not be for the purpose they were built. The survival of below-ground heritage assets is unknown but in areas with no development thought to be good.	The protection and enhancement of heritage assets is of national concern as set out in the National Planning Policy Framework, which sets out to conserve heritage assets in a manner appropriate to their significance. The survival of heritage assets is a contributing factor to their significance. The survival of designated assets matters on a national level, those in poor condition could have suffered significant levels of loss.	The survival of the built heritage assets contributes to their architectural and historical significance. The survival of any below-ground heritage assets is likely good and therefore will contribute to the significance	The rate of survival for the designated assets is fairly common nationally.	The scheme is unlikely to impact on the survival of the built heritage assets and therefore the effect is predicted to be **neutral.** The scheme is likely to impact on any below-ground heritage assets (known and unknown) and therefore the impact will be **moderate to major adverse.**
Condition	The condition of the Listed Buildings is thought to be good. The condition of any unknown below-ground heritage assets is currently unquantifiable but in areas of no development they are expected to be good.	The condition of the heritage assets contributes to regional value of the area. It also contributes to the national importance.	The condition of the built heritage assets contributes to their architectural and historical significance. The condition of the below-ground heritage assets (known and unknown) is unknown and therefore unquantifiable. In areas of undisturbed ground there is potential for the condition of below-ground heritages to be good.	The condition of the designated assets is believed to be fairly typical of those nationally. The condition of the potential below ground assets is unknown and therefore their rarity is unquantifiable.	The scheme will have a **neutral** effect on the condition of the built heritage assets. The scheme is likely to impact on any below-ground assets. Impacts on any known or unknown below-ground heritage assets would be a **major adverse**.
Complexity	There is thought to be little complexity, or groups, within the below-ground heritage assets. The heritage assets associated with The Manor House (HER 1061753, 1205031, 1360604) can be thought of as a group due to their proximity. The complexity of the below-ground remains is unknown at this stage but any findspots and remains associated with the Roman Site (HER 61259) are likely to be a group.	The protection and enhancement of heritage assets is of national concern as set out in the National Planning Policy Framework, which sets out to conserve heritage assets in a manner appropriate to their significance. The complexity of assets, including individually complex assets or groups of assets contributes to their significance.	The majority of the built heritage assets are not complex but represent a variety of forms and purposes that defines the area and region. The significance of the complexity of any below-ground archaeological assets cannot be assessed at this stage.	The level of complexity of the designated assets is common nationally. Complexity of the unknown below-ground archaeological assets is unknown.	The scheme will have a **neutral** effect on the complexity of the built heritage assets. The scheme is likely to impact on any below-ground assets. Impacts on any known or unknown below-ground heritage assets would be a **major adverse**.

Context	The context of the built heritage assets is likely to be associated with need from local populations and the agricultural trade. The context of the below-ground heritage assets is unable to be assessed at this stage.	The context and setting of most cultural heritage assets is a material consideration at local and national policy level.	The context of the built heritage assets is unknown at this time but for agricultural building surrounded by undeveloped land is likely to be of moderate contribution. The context of below-ground heritage assets is unknown at this stage.	The context of the designated assets is common nationally. The rarity of the context of unknown below-ground archaeological assets is unquantifiable at this stage.	The scheme may impact upon the context of built heritage assets. The scheme may impact upon below-ground heritage assets but it is **unknown** how this will impact the context at this stage.
Period	The built heritage assets are of Late and Post-Medieval date. The date of the known below-ground heritage assets is thought to be from the Prehistoric period onwards.	Period does not necessarily determine the importance of the historic resource although, it can affect it. Policies within the Local and Regional Plans make reference to the safeguarding and enhancement of cultural heritage assets. The protection of designated assets and areas regardless of their period is of national concern as set out in the National Planning Policy Framework.	The date of the of heritage assets is significant as it is important for understanding the area.	The dates of the built heritage assets are very common. The dates of the Prehistoric below-ground heritage assets are more uncommon.	The scheme will have a **neutral** effect on the period of the built heritage assets. The scheme is likely to impact on any below-ground assets.

Reference Sources

TAG Unit A Chapters 5 and 8;
Lincoln Historic Environment Record (HER);
MAGIC Maps; and
Ordnance Survey Maps.

Step 5 - Summary Assessment Score

Moderate adverse

Qualitative Comments

The Proposed Scheme would have minor adverse impacts upon designated heritage assets due to the impact being indirect, on setting, and moderate to major adverse impacts on non-designated heritage assets due to the impact being direct and there being a high potential for survival. The overall assessment score is determined as moderate adverse. The assessment score is therefore based on the assumption that adequate and appropriate mitigation of adverse impacts on the potential heritage resource is achievable, without the benefit of any detailed survey work/intrusive evaluation to more accurately assess the potential for buried archaeological remains and the value of the built heritage resource.

TAG Water Environment Impacts Worksheet

Description of study area/ summary of potential impacts	Key environmental resource	Features	Quality	Scale	Rarity	Substitutability	Importance	Magnitude	Significance
Potential floodplain loss and increased flood risk Pollution to surface waters during construction Pollution to surface waters from routine runoff Pollution to surface waters from accidental spillage Alteration to watercourse flow characteristics that may affect channel, erosive or deposition processes	River Witham	Water supply	High – large main river; moderate ecological status and good chemical status; no known statutory or non-statutory designations; may be used for agricultural or commercial water supply although currently unknown	Regional	Medium	Medium	High	Negligible	Insignificant
		Biodiversity	High - no known statutory or non-statutory designations but likely to support aquatic species such as otter	Regional	Medium	Medium	High	Minor	Low Significance
		Transport and dilution of waste	High – receives discharge from adjacent agricultural land and likely to receive discharge from urban runoff	Regional	Medium	Medium	High	Negligible	Insignificant
		Recreation	Medium – supports no known water based recreational activities although adjacent to public footpath in rural area	Regional	Low	Low	Medium	Negligible	Insignificant
		Value to economy	Medium – value to economy currently uncertain although large main river that may be used for agricultural or commercial water supply	Regional	Medium	Low	Low	Negligible	Insignificant
		Conveyance of flow	High – large watercourse important for flood flow conveyance	Regional	Medium	Medium	High	Moderate	Significant
		Flood storage	Very High – large watercourse important for flood storage	Regional	Medium	Very High	High	Moderate	Significant
	River Brant	Water supply	Medium – main river; moderate ecological status and good chemical status; no known statutory or non-statutory designations	Regional	Medium	Medium	High	Negligible	Insignificant
		Biodiversity	High - no known statutory or non-statutory designations but likely to support aquatic species such as otter	Regional	Medium	Medium	High	Negligible	Insignificant
		Transport and dilution of waste	High – receives discharge from adjacent agricultural land and may to receive discharge from urban runoff	Regional	Medium	Low	Medium	Negligible	Insignificant
		Recreation	Medium – supports no known water based recreational activities although close to public footpath in rural area	Regional	Low	Low	Low	Negligible	Insignificant
		Value to economy	Medium – value to economy currently uncertain although may be used for agricultural water supply	Regional	Medium	Medium	Low	Negligible	Insignificant
		Conveyance of flow	High – important for flood flow conveyance	Regional	Medium	Medium	High	Negligible	Insignificant
		Flood storage	High - important for flood storage	Regional	Medium	Medium	High	Negligible	Insignificant
	Ordinary watercourses and land drains	Water supply	Low – small water features that are unlikely to be used for water supply	Local	Low	Low	Low	Negligible	Insignificant
		Biodiversity	Medium - no known statutory or non-statutory designations; may have local value but are deep and steep sides and also likely to be ephemeral	Local	Low	Low	Low	Minor	Insignificant
		Recreation	Low - supports no known water based recreational activities and unlikely to have recreational value	Local	Low	Low	Low	Negligible	Insignificant

		Conveyance of flow	Medium – Form an important network of drains for drainage of adjacent agricultural land although importance for flow conveyance for flood management uncertain	Local	Low	Low	Medium	Moderate	Low significance
		Flood storage	Medium – May provide some flood storage value although likely to be limited	Local	Low	Low	Medium	Moderate	Low significance
Pollution to groundwater during construction Pollution to groundwater from routine runoff Pollution to groundwater from accidental spillage Heavy metal contamination and presence of PAHs. Changes to groundwater hydrodynamics Changes to baseflow to surface water bodies Changes to groundwater distribution and flow from earthworks	Groundwater	Bedrock Aquifer - Principal Aquifer	The eastern area of the Proposed Scheme lies above the Upper Lincolnshire Limestone & Lower Lincolnshire Limestone which are defined by the EA as a Principal aquifer. The limestone aquifer provides potable water as public water supply. Note this should be confirmed after consultation with the EA. Any contamination to this aquifer will be difficult to remediate and may have a significant effect on water quality. Aquifer not assumed to be in hydraulic connectivity with the overlying superficial aquifer due to the presence of a intervening clay aquitard (BGS Borehole SK96SE16). The aquifer is located within a Major Aquifer High Groundwater Vulnerability Zone.	Regional	Medium	Limited	Very High	Moderate Adverse	Highly Significant
		Bedrock Aquifer - Secondary 'B' Aquifer	The central and western area of the Proposed Scheme alignment is founded in the Charmouth Mudstone Formation & Scunthorpe Mudstone Formation. These units are designated by the EA as 'Secondary 'B' Aquifers". The Secondary 'B' Aquifers may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.	Regional	Low	Limited	Medium	Slight Adverse	Slightly Significant
		Superficial Aquifer - Secondary 'A' Aquifer (Alluvium & Balderton Sand & Gravel Formation)	Superficial Alluvium and the Balderton Sand & Gravel units are sporadically located across the study area. The EA define these units as Secondary 'A' Aquifers.	Local	Medium	Feasible	Medium	Moderate Adverse	Moderately Significant
		WFD & Future Groundwater Use	Witham (confluence of Brant to confluence of Catchwater Drain) - Ecologically Moderate, Chemically Good	Regional	Medium	Limited	High	Moderate Adverse	Highly Significant
			Witham (confluence Cringle Brook to confluence Brant) - Ecologically Moderate, Chemically Good						
			Lower Brant - Ecologically Moderate, Chemically Good						
			Witham Lias U - Quantitatively Good, Chemically Good						
			Witham Limestone Unit A - Quantitatively poor, Chemically Poor						
		Public Water Supply	Public Water Supply Current drainage strategy indicates that highway drainage is proposed to be discharged into the Source Protection Zone II following suitable treatment.	Local	High	Limited	Very High	Moderate Adverse	Highly Significant
		Private Water Supplies	Currently unknown. Data request to the Environment Agency (EA) required.	N/A	N/A	N/A	N/A	N/A	N/A
		Licenced Abstractions	Currently unknown. Data request to the Environment Agency (EA) required.	N/A	N/A	N/A	N/A	N/A	N/A
			Current bridge design unknown. Piling and foundation design, operation and construction impacts. Density, depths	Local	Low	Limited	Medium	Moderate Adverse	Moderately Significant

from earthworks Groundwater mounding and groundwater flow obstruction Pressurised groundwater, reduction in water table Reduced groundwater recharge from decreased infiltration		Proposed Structures - Bridges, underground storage, Road & Drainage/Balancing Ponds	and orientation of the subsurface structure will determine the magnitude of potential impacts. Washout and erosion is a potential issue during the operation of the cut. Dewatering groundwater may create dissolution and voids in the limestone deposits. It will introduce impermeable areas and generate more surface runoff. Therefore there could be a mild local decrease in the water table as a consequence of the reduction of the direct groundwater recharge area. The potential impact of a decrease in the amount of infiltration, due to the presence of impermeable areas, is considered to be low. Therefore, it is unlikely that the local groundwater abstractions would be significantly affected. The proposed underground storage within the limestone bedrock is likely to encounter groundwater seepage, groundwater heave and groundwater mounding due to the introduction of an impermeable barrier to groundwater flow. Additional risks include construction phase contamination of the principal aquifer. The performance of drainage/balancing ponds may be inhibited by potential high groundwater levels.						

		Baseflow to surface water bodies & Surface Water Bodies	The Proposed Scheme will require bridges to be built which have the potential to obstruct groundwater in the superficial and bedrock aquifers. Ground investigation works will help determine the nature of the deposits and therefore the likely impacts. Design of the proposed road is not known during the time of this assessment i.e. embankment option, cuttings or reprofiling. Potential dewatering methods required during construction. The combination of these impacts may reduce the amount of base flows supplied to surface water bodies. The overall impact will depend on the hydraulic state of the surface water bodies and whether they are a gaining or losing system i.e. base flow provided by groundwater (likely) or if the river loses base flow to groundwater.	Local	Medium	Limited	High	Moderate adverse	Significant
		Conveyance of flood flows	There is potential that groundwater levels in the area may be close to the ground level. Proposed structures and road cutting (if any) for the development of the scheme may likely require dewatering and groundwater management. This is likely during the constructional phases of the scheme, particularly during periods of heavy rainfall and the winter period.	Local	Medium	Limited	High	Moderate Adverse	Significant

Reference Sources

1) DEFRA – MagicMap Webtool – Source Protection Zones (SPZ), Groundwater Vulnerability, Aquifer Designation and Water Framework Directive (2009) – River Basin Management Plans
2) British Geological Survey (BGS) – Geology of Britain - Geoindex Webtool
3) TAG Unit A3 Environmental Impact Appraisal, December 2015, Department for Transport
4) Scheme Redline Boundary

Summary Assessment Score

Moderate Adverse

Qualitative Comments

It is likely that the risks to the quality of the water environment can largely be mitigated during construction through the implementation of a construction environmental management plan (CEMP). However, the Proposed Scheme will require a new bridge across the River Witham and will cross numerous drains within the Witham floodplain. The construction of the Proposed Scheme may also require temporary dewatering or groundwater control for the excavation of drainage ponds and storage tanks. The risks to water quality during construction will therefore be difficult to mitigate entirely. Effects to surface water quality will be temporary and are unlikely to pose long term impact. Effects to groundwater quality could pose long term impact and are slight to moderate adverse at this stage.

During the operation of the Proposed Scheme the risks to water quality in the River Witham, other drains and groundwater that may receive the discharge of runoff from the Proposed Scheme will be mitigated by a surface water drainage system that will include appropriate pollution control measures and, if required, attenuation.

Surface water will be discharged to adjacent land drains that discharge to the River Witham, the residual impact to surface water quality is likely to be negligible. There may be discharge of surface water runoff to groundwater within the Source Protection Zone II (based on the current drainage design), the runoff will be treated prior to discharge however a residual impact is likely to be moderate adverse at this stage.

The proposed crossing of the River Witham is considered to be minor adverse at this stage. It will comprise a bridge that will maintain the existing alignment and bed of the River Witham and have minimal effect to flow dynamics within the river, although a new bridge pier within the channel may be required. The design of proposed crossings of drains is unknown and will be informed by consideration of hydraulic capacity requirements and ecological requirements and the post mitigation impact is minor adverse at this stage.

The magnitude of the impact of the Proposed Scheme of flood risk will be heavily dependent on the characteristics of flooding in the area, the operation of the Lincolns Washlands FAS, the flood outlines from the defended scenario with updated climate change allowance and the detailed design of the Proposed Scheme. Hydraulic analysis of the operational scenario will be required and, potentially, of the temporary (construction) scenarios. Discussions with the EA are ongoing regarding the potential effects of the Proposed Scheme, the required scope of more detailed analysis and likely mitigation requirements. At this stage of the assessment the Proposed Scheme is considered to have a moderate adverse effect to flood flow conveyance and loss of flood storage.

Following consultation with the EA, further assessment will be required of potential breach scenarios of the reservoir embankment and the river banks in close proximity of the Proposed Scheme. The risk of a river bank breach just upstream of the Proposed Scheme is relatively high and will required further assessment, potentially informed by hydraulic modelling. Costs associated with providing structural reinforcements to the river bank in the area of structural weakness could be high.

There may be an impact on groundwater flow due to subsurface structures, such as founding structures for the embankment. There may additionally be a reduction in baseflow due to reduced infiltration from the introduction of impermeable road surfaces. These may result in a permanent impact on catchment hydrogeology caused by the introduction of a barrier to subsurface flow and changes to local groundwater dynamics.

Groundwater management is likely to be required during both the construction and operation phases of the Proposed Scheme.

Appendix B

APPRAISAL SUMMARY TABLE

Appraisal Summary Table

Date produced:	

Contact:	
Name	
Organisation	
Role	Promoter/Official

Name of scheme:	
Description of scheme:	

Impacts		Summary of key impacts	Assessment			
			Quantitative	Qualitative	Monetary £(NPV)	Distributional 7 pt scale/ vulnerable grp
Economy	Business users & transport providers		Value of journey time changes(£) Net journey time changes (£) 0 to 2min | 2 to 5min | > 5min			
	Reliability impact on Business users					
	Regeneration					
	Wider Impacts					
Environment	Noise	Receptors located in proximity to the scheme and existing routes feeding into the scheme are predicted to experience a significant increase in noise levels, however, overall the effects once operational are considered beneficial. Opening Year Daytime noise level of 66 dB LAeq, 16h or higher - Do Minimum (DM) 822 properties, Do Something (DS) 796 Design Year Daytime noise level of 66 dB LAeq, 16h or higher - 710 properties DM, 603 properties DS No properties subject to road traffic noise levels in excess of 80 dBLAeq, 16h	Households experiencing increased daytime noise in opening year: 970 Households experiencing reduced daytime noise in opening year: 712 Households experiencing increased daytime noise in design year: 748 Households experiencing reduced daytime noise in design year: 3158	N/A	£5,212,053 *Based on least beneficial change	Quintiles: 0-20%: Large Beneficial; 20-40%: Slight Beneficial; 40-60%: Moderate Beneficial; 60-80%: Large Beneficial; 80-100%: Slight Beneficial Education Facilities: Negliogible to Minor Beneficial (one receptor Major Adverse) Elderly Facilities: Negligible to Minor Beneficial
	Air Quality	Scheme is not situated within an AQMA, however, several road links including A15 and B1262 feed in to the city centre AQMA.. All roadside NO2 Concentrations predicted for the opening year (2026) and operating year (2041) of the Proposed Scheme are below the annual mean NO2 EU limit value for Defra PCM model road links overlain by the Proposed Scheme. Links indicating the potential for exceedances no longer present in the opening year and operating year scenarios. In the majority of cases where significant changes in air quality were predicted these were improvements. Significant deteriorations in air quality were predicted on the A15 St Catherines junction in the city centre, and at the A46 Hykeham Roundabout.	Overall deterioration in property weighted air quality despite a greater number of properties experiencing an improvement compared to those experiencing no change or a deterioration in concentrations of air pollutants.	N/A	NPV change in NOx emissions -£349,092 NPV change in PM_{10} emissions -£8,803,339 Total NPV change -£9,152,430	Improvements in NO_2 concentrations concentrated in the lower two deprivation quintiles. Negative impacts predicted in the third quintile are likely to have a disproportionately negative effect on the positive impacts in the lowest two quintiles.
	Greenhouse gases	Predicted increase of GHG emission from road-based fuel consumption attributed to a predicted increase in fuel consumption as the Proposed Scheme will attract / generate additional traffic flow and links the Lincoln Eastern and Western Bypasses.	Change in non traded carbon over 60y (CO_2e): 181,041 Change in traded carbon over 60y (CO_2e): 2,962	N/A	Dis-benefit: - £7,849,390	
	Landscape	Permanent change to the pattern of the landscape. Road alignment at odds to the pattern of the existing road layout within the surrounding area creating a perceivable change to landscape character. Directly sever Area of Great Landscape Value, Green Wedge and linear features of cultural significance within the landscape including Viking Way. Change to the nature of the existing view through the introduction of scheme. Demolition of a number of residential properties along Station Road. Construction will result in significant impacts on the visual amenity, from areas of higher ground where long distance views over the floodplain are discernible.	N/A	Large Adverse	N/A	
	Townscape	N/A	N/A	N/A	N/A	
	Historic Environment	Potential for direct impacts upon below-ground heritage remains (known and unknown) within the scheme footprint. Four known below-ground heritage assets within the scheme area. Potential for indirect impacts to the settings of 17 Listed Buildings within 1 km of the scheme. Direct impact on the historic landscape, through visual intrusion and an alteration of the landscape use.	N/A	Moderate Adverse	N/A	
	Biodiversity	Potential to impact bat roosts, damage or removal to habitats currently contributing to foraging and commuting, and disturbance from lighting. Potential to impact Great Crested Newt, Otters, badgers, water voles and reptiles due to the loss of suitable habitat for these species associated with land take Potential to impact birds due to removal of suitable nesting, over wintering and foraging habitat. Potential to impact plants by spread of Schedule 9 species and removal of species-rich hedgerow.	N/A	Moderate Adverse	N/A	
	Water Environment	Potential for road runoff to impact surface and groundwater quality. Potential to impact the hydromorphological and ecological quality of the watercourses and drains. Potential to impact the flood conveyance routes and floodplain storage due to the embankments of the Proposed Scheme. Potential to impact catchment hydrogeology and groundwater flow due subsurface structures associated with the embankment.	N/A	Moderate Adverse	N/A	
Social	Commuting and Other users		Value of journey time changes(£) Net journey time changes (£) 0 to 2min | 2 to 5min | > 5min			

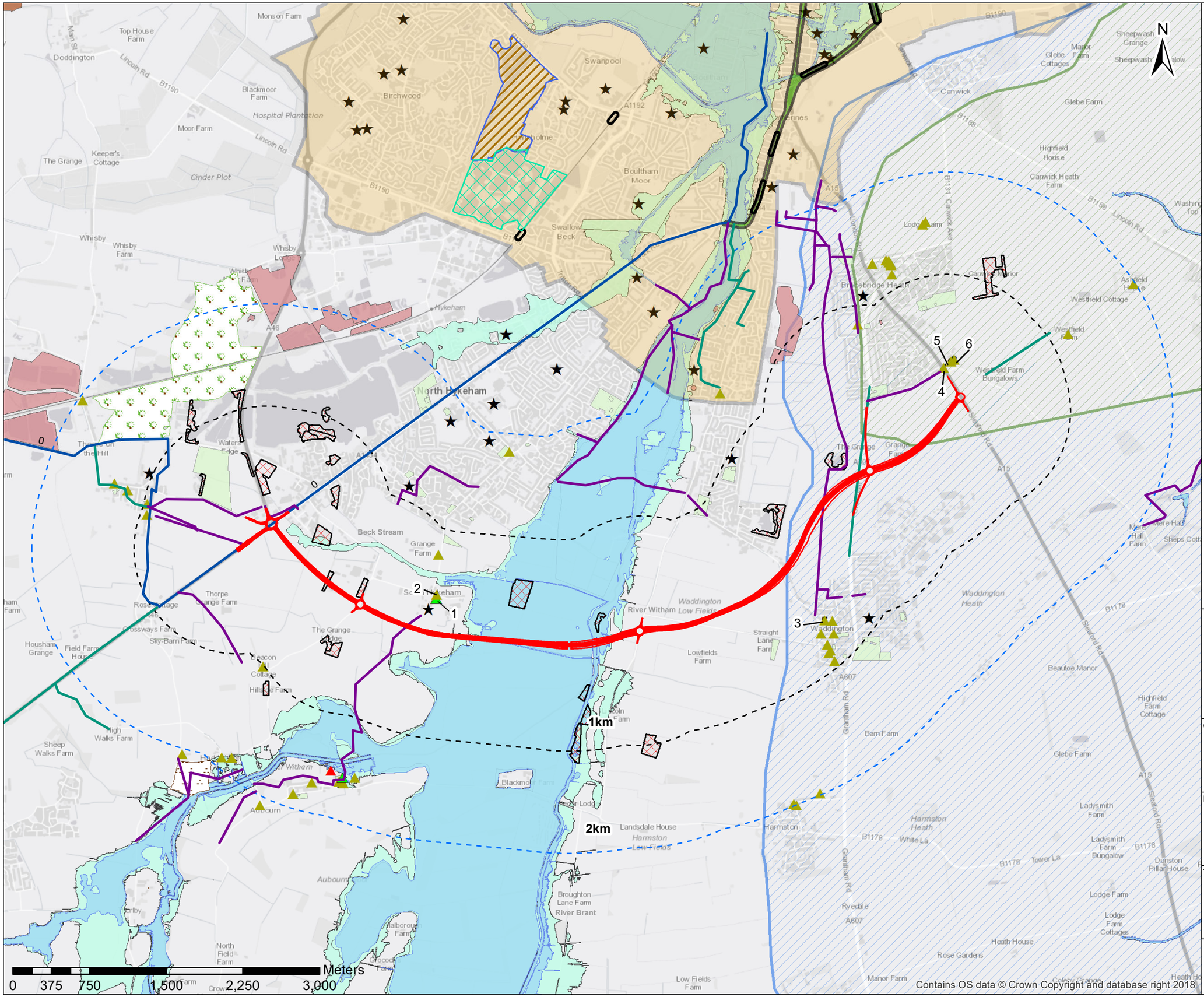
Scenario	Properties: Improvement	Properties: No Change	Properties: Deterioration	Score	Emissions (tonnes)
NO_2 2026	16345	86	2977	-454.87	-
PM_{10} 2026	15430	0	3978	3130.11	-
NO_2 2041	12979	39	6390	1221.83	-
PM_{10} 2041	13044	0	6164	3550.42	-
NOX 2026	-	-	-	-	+14.09
NOX 2041	-	-	-	-	+12.08

Scenario	Distributional impact of income deprivation: 0-20%	20-40%	40-60%	60-80%	80-100%	Are the impacts distributed evenly?
2026 NO2	✓✓✓	✓✓✓	✓✓	✓	✓	No
2026 PM10	✓✓✓	✓✓✓	×××	✓✓	✓✓	No
2041 NO2	✓✓✓	✓✓✓	O	✓	✓✓	No
2041 PM10	✓✓✓	✓	×××	✓✓	✓✓✓	No

	Reliability impact on Commuting and Other users					
	Physical activity					
	Journey quality					
	Accidents					
	Security					
	Access to services					
	Affordability					
	Severance					
	Option and non-use values					
Public Account	Cost to Broad Transport Budget					
	Indirect Tax Revenues					

Appendix C

SUPPORTING FIGURES



Key

- North Hykeham Relief Road
- 2km Buffer
- 1km Buffer
- Public Right of Way Footpaths
- Sustrans Regional Cycle Route
- Sustrans Local Cycle Route
- DEFRA Noise Action Planning Important Area (NIA)
- Scheduled Monument

Listed Buildings

Grade

I II* II

1 CHURCH FARMHOUSE
2 CHURCH OF ST MICHAEL
3 FARM BUILDINGS AT THE MANOR HOUSE
4 GATES AND WALLS AT THE MANOR HOUSE
5 MANOR HOUSE
6 THE MANOR HOUSE

- Sites of Special Scientific Interest
- Local Nature Reserve
- National Forest Inventory, Decidious Woodland
- Ancient Woodland Inventory
- OS Green Space Site (OS Open Data)
- Lincoln NO2 AQMA
- Lincoln PM10 AQMA
- Historic Landfill Sites
- Schools

Source Protection Zones

- Zone II - Outer Protection Zone
- Zone III - Total Catchment
- Floodzone 3
- Floodzone 2

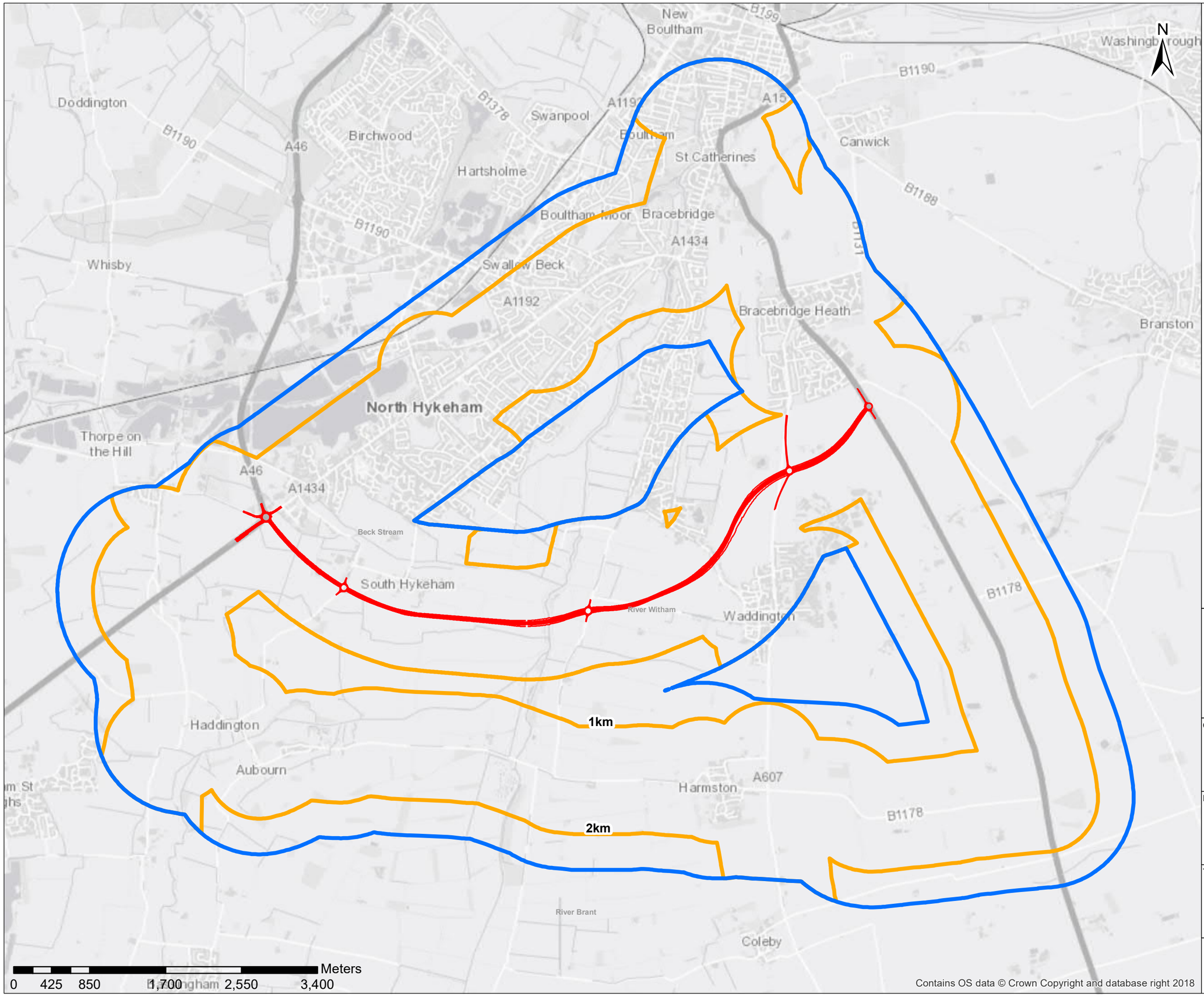
wsp

Client: Lincolnshire COUNTY COUNCIL — Working for a better future

Project: **LINCOLN SOUTHERN BYPASS**

Title: **FIGURE 1 ENVIRONMENTAL CONSTRAINTS**

Drawing Number:	Figure 1	Drawn:	LH
Date:	06/11/2018	Checked:	CM
Scale:	1:35,000	Approved:	JB



Key

- 1km Study Area
- 600m Calculation Area
- North Hykeham Relief Road

wsp

Client: Lincolnshire County Council — Working for a better future

Project: **LINCOLN SOUTHERN BYPASS**

Title: **FIGURE A2 ENVIRONMENTAL CONSTRAINTS**

Drawing Number:	Figure 1	Drawn:	LH
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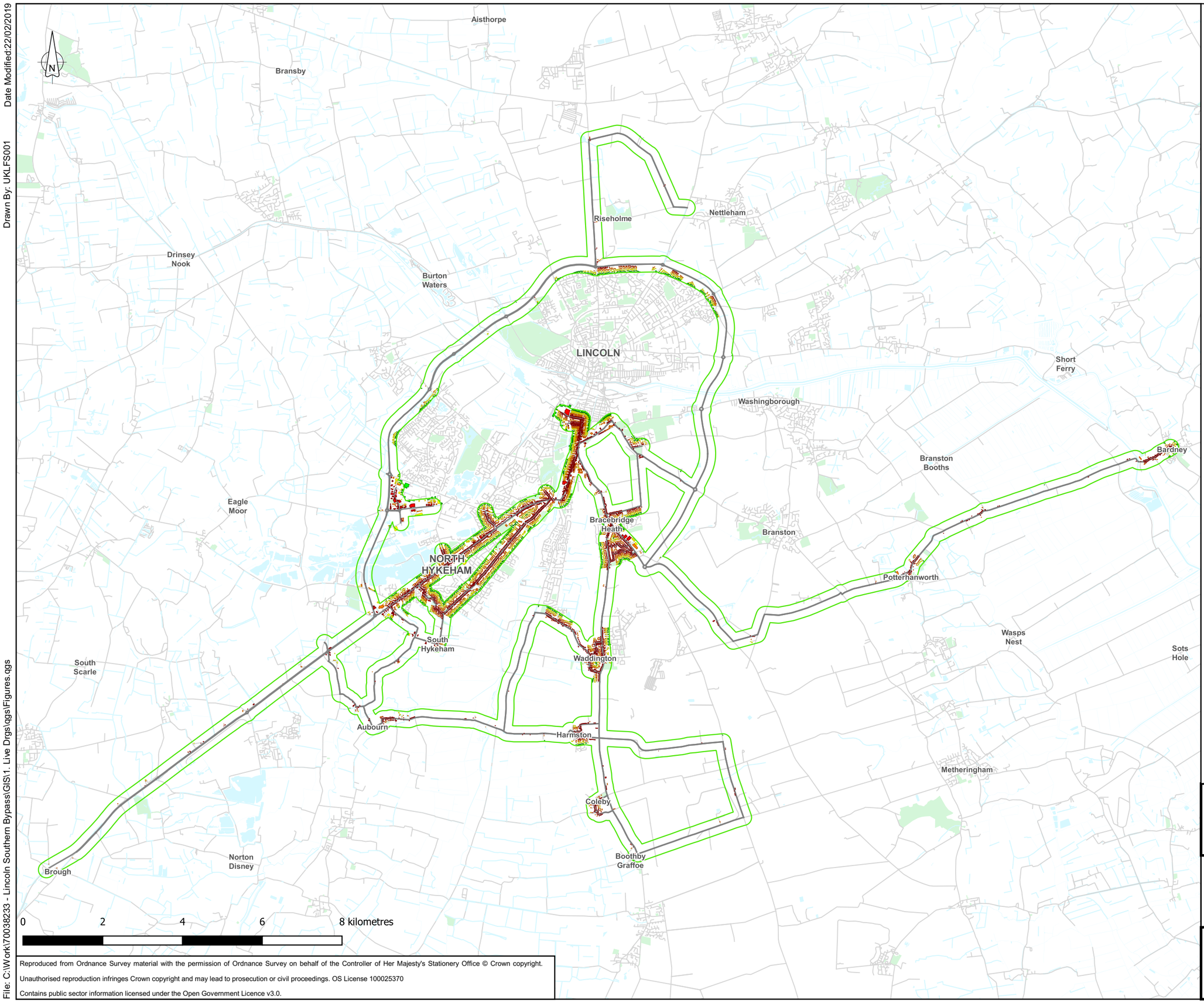
Scale:	1:40,000	Approved:	JB

Date Modified:22/02/2019

Drawn By: UKLFS001



Legend

- DoMinimumRoads
- Do-Minimum 200m Study Area

Banded Do-Minimum Receptors

- 0-50m
- 50-100m
- 100-150m
- 150-200m

TITLE:

LINCOLN SOUTHERN BYPASS

FIGURE No:

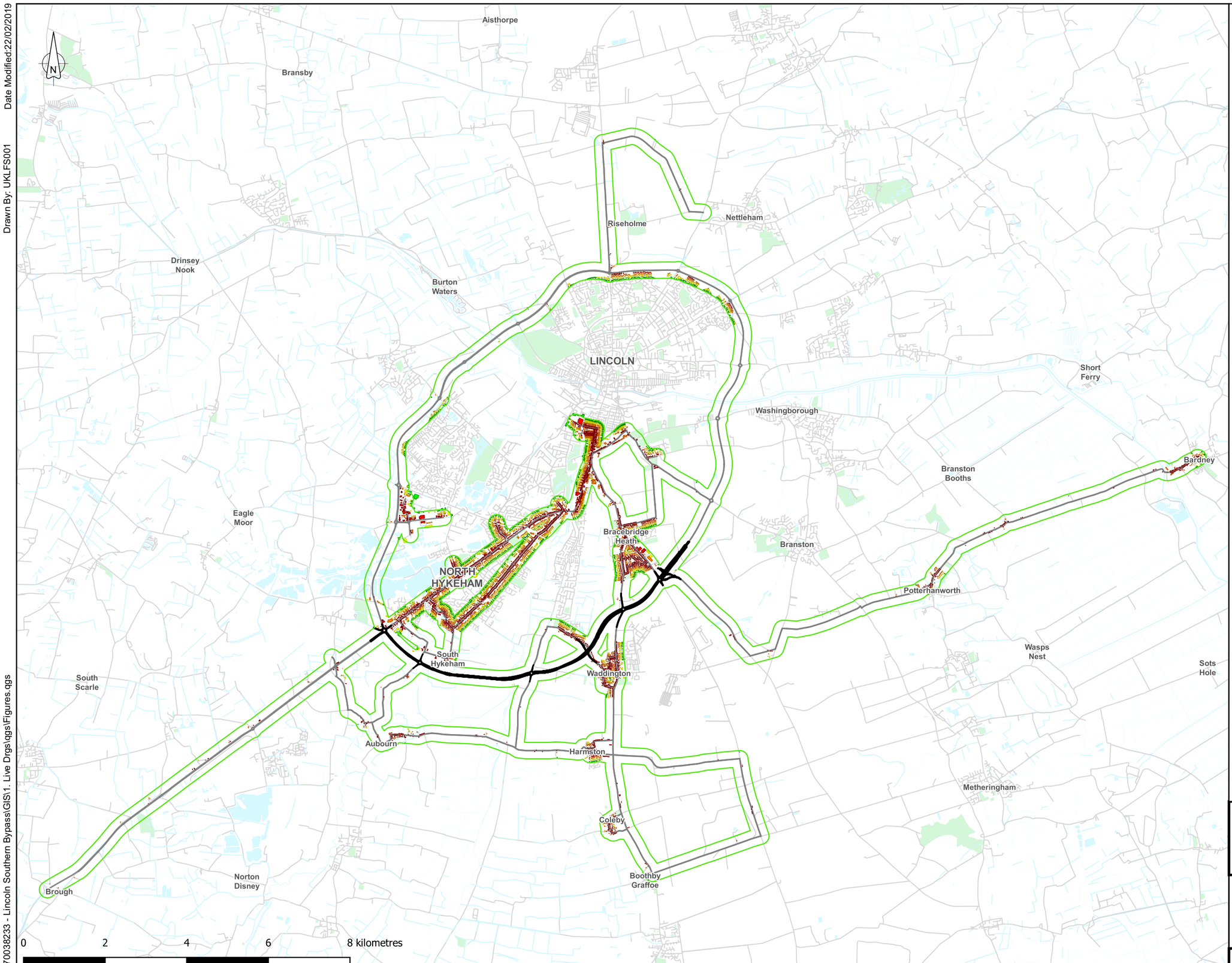
FIGURE 5-6

File: C:\Work\70038233 - Lincoln Southern Bypass\GIS\1. Live Drgs\qgs\Figures.qgs

Date Modified:22/02/2019

Drawn By: UKLFS001

File: C:\Work\70038233 - Lincoln Southern Bypass\GIS\1. Live Drgs\qgs\Figures.qgs



Legend

- Proposed Scheme
- DoSomethingRoads
- Do-Something 200m Study Area

Banded Do-Something Receptors

- 0-50m
- 50-100m
- 100-150m
- 150-200m

wsp

TITLE:

LINCOLN SOUTHERN BYPASS

FIGURE No:

FIGURE 5-7

Appendix D

PRELIMINARY ECOLOGICAL APPRAISAL (PEA) 2018

Lincolnshire County Council

LINCOLN SOUTHERN BYPASS

Preliminary Ecological Appraisal

OUR REF
FEBRUARY 2018

CONFIDENTIAL

Lincolnshire County **Council**

LINCOLN SOUTHERN BYPASS

Preliminary Ecological Appraisal

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70038233
OUR REF. NO. OUR REF

DATE: FEBRUARY 2018

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	Table text	Table text	Table text	Table text
Date	28/02/18	Table text	Table text	
Prepared by	Paul Hanson	Table text	Table text	
Signature				
Checked by	Becky Bailey	Table text	Table text	Table text
Signature				
Authorised by	Andy Bascombe	Table text	Table text	Table text
Signature				
Project number	70038233	Table text	Table text	Table text
Report number	Table text			
File reference	Table text	Table text	Table text	Table text

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TABLES

FIGURES

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EXECUTIVE SUMMARY

The Lincoln Southern Bypass is intended to link the completed Lincoln Eastern Bypass (at A15 Sleaford Road) with the existing A46 Western Relief Road (at its junction with the A1434 Newark Road), creating a complete ring road around the city of Lincoln. Public consultation has been undertaken as part of the selection of the Preferred Route, which was chosen from a choice of three options. The proposed scheme passes immediately to the south of South Hykeham before crossing the River Witham at SK 952 641. It then continues north of Waddington and finally joins the A15 to the south-east of Bracebridge Heath. The overall length of the proposed scheme is approximately 8.5km.

This report provides baseline ecological information about the proposed scheme and a surrounding Study Area with particular reference to whether legally protected and/or notable sites, species or habitats are present or likely to be present. This information has been gathered through an ecological desk study and a habitat survey. In combination these different sources of information allow an assessment to be made of the potential for the Survey Site to support protected or notable species, informed by the occurrence of such species within the vicinity of the proposed scheme and by the suitability of surrounding habitats.

The main limitation to the survey was that a large proportion of the Survey Area could not be accessed due to permission not being available at the time of the survey. Access was only available along Public Rights of Way. The majority of land along the proposed scheme, however, could be observed from PRoWs due to the mostly flat and open nature of the terrain. Aerial imagery was also used to identify habitats which were not observable from public land. The survey was also undertaken at a sub-optimal time of year for a Phase 1 Habitat survey. It is considered, however, that sufficient information was gathered to enable an assessment of the habitat types present, in line with standard Phase 1 Habitat categories and the potential for these to support protected or notable species. It is, therefore, considered that the Phase 1 Habitat types were accurately identified.

The Survey Area was found to consist predominantly of large expanses of arable land, of low ecological value, bounded by ditches and hedgerows, with lines of trees along some sections of hedgerow. The hedgerows and ditches mostly appear heavily managed, with hedgerows being recently flailed and many of the ditches having been recently cleared. Several small areas of woodland are present but none of the woodland is designated as Ancient Woodland Inventory. There are also no statutory designated sites within the Study Area, with the nearest such site being located 1.4km north of the western end of the scheme. There are 19 non-statutory designations within the Study Area, with 2 of these, Waddington Grassland (Viking Way) and River Witham, Bracebridge to South Hykeham, located within the footprint of the proposed scheme. The land to the west is very flat but there is some more hilly terrain towards the eastern end of the Survey Area, just to the west of Waddington. The River Witham flows south to north across the central section of the proposed scheme and there are numerous ponds located within 250m of the proposed scheme.

Suitable habitat is present within the Survey Area for the following protected species/faunal groups; bats, badger, otter, water vole, birds, reptiles and great crested newt. Their presence could provide ecological constraints to the proposed scheme but in order to assess the nature of the ecological constraints further survey work for the aforementioned species/faunal groups is necessary and will have to be programmed into the scheme design and schedule at the earliest possible stage. This is because there are seasonal constraints to many ecological surveys and missing the survey window may delay and increase the cost of the project.

All accessible land and waterbodies should also be searched for Wildlife & Countryside Act 1981 (as amended) Schedule 9 plants prior to vegetation clearance to avoid the risk of spreading these non-native invasive plant species.

Contact name Paul Hanson

Contact details 07810 287857 | Paul.Hanson

1 INTRODUCTION

1.1 BACKGROUND

PROJECT BACKGROUND

1.1.1. Lincolnshire County Council commissioned WSP to complete a Preliminary Ecological Appraisal (PEA) along Route 2c of the proposed Lincoln Southern Bypass in January 2018.

1.1.2. Subject to funding, the Lincoln Southern Bypass would form part of the Lincolnshire Coastal Highway. It would link the completed Lincoln Eastern Bypass (at A15 Sleaford Road) with the existing A46 Western Relief Road (at its junction with the A1434 Newark Road), creating a complete ring road around Lincoln.

1.1.3. Two public consultations have been carried out on this project to seek views on the selection of the Preferred Route from three options, Route 2a, Route 2b and Route 2c. In April 2006, Route 2c was selected, and following further route development and a second public consultation in October 2006 the County Council's Executive Committee made the decision to endorse the Emerging Preferred Route, Route 2c, as its Preferred Route for Lincoln Southern Bypass as shown in Figure 1. This will hereafter be referred to as the 'proposed scheme'.

ECOLOGICAL BACKGROUND

1.1.4. The 'Survey Area' as hereafter referred to in this report, is located to the south of the city of Lincoln. The proposed scheme is centred on Ordnance Survey (OS) grid reference SK 956 642, with its western end joining the A46/A434 junction at OS grid reference SK 920 652. The eastern end of the Survey Area terminates at SK 988 664 on the A15 Sleaford Road. The Survey Area consists of the footprint of the proposed Route 2c scheme, with a 150m buffer either side of the road and associated earthworks and junctions. The preferred route is shown in Figure 1.

1.1.5. The proposed scheme passes immediately to the south of South Hykeham before crossing the River Witham at SK 952 641. It then continues north of Waddington and finally joins the A15 to the south-east of Bracebridge Heath. The overall length of the proposed scheme is approximately 8.5km.

1.1.6. The Survey Area lies within two Natural England Natural Character Areas (NCAs):

- Land to the west of the proposed scheme is within NCA 48; Trent and Belvoir Vales. The Trent and Belvoir Vales National Character Area (NCA) is characterised by undulating, strongly rural and predominantly arable farmland, centred on the River Trent. A low-lying rural landscape with relatively little woodland cover, the NCA offers long, open views. Newark-on-Trent lies at the centre with Grantham, Nottingham, Lincoln and Gainsborough on the peripheries. The southern and eastern edges of the Vales are defined by the adjoining escarpments of the Lincolnshire Edge and the Leicestershire and Nottinghamshire Wolds NCA. To the west, the escarpment of a broad ridge of rolling landscape defines the boundary with the neighbouring Sherwood and Humberhead Levels NCAs. The area's generally fertile soils and good quality agricultural land have supported a diversity of farming over a long period but, because of this, little semi-natural habitat remains. The powerful River Trent and its flood plain provide a strong feature running through the landscape. It is a major corridor for wildlife moving through the area and supporting a variety of wetland habitats and provides flood storage as well as large amounts of cooling water for local power stations.
- Land from immediately to the west of Waddington, to the eastern end of the development is all contained within NCA 47; Southern Lincolnshire Edge. The Southern Lincolnshire Edge is an area of clear character defined by the dramatic limestone cliff to the west and the dip slope that drops gently away to the edge of the fens in the east. It shares the cliff and the dip slope, and many landscape characteristics, with the Northern Lincolnshire Edge and Coversands NCA to the north. It is an open landscape with far-reaching views over the Trent and Belvoir Vales and up to Lincoln Cathedral. On the free draining higher ground, land cover is primarily arable, in large geometric fields divided by limestone walls, with few trees or woodland. On the wetter, heavier clay soils to the east and south-west, pasture is more prevalent; hedgerows are the predominant boundary and the landscape has a more intimate, enclosed feel, with more trees, woodland and parkland.

1.1.7. Land use along the route of the proposed scheme is dominated by large expanses of arable fields, with only small localised areas of improved grassland which appear to be predominantly used for grazing horses. Areas

of poor semi-improved grassland and woodland exist mainly where the topography of the ground makes arable farming impractical or where small remnants of land occur between large expanses of arable fields. To the south of the eastern end of the proposed scheme there is a large airfield (RAF Waddington).

1.2 SCOPE OF REPORT

1.2.1. Lincolnshire County Council commissioned WSP to complete a Preliminary Ecological Appraisal (PEA) along Route 2c of the proposed Lincoln Southern Bypass Road in January 2018. The objectives of the study were as follows:

- to provide baseline ecological information about the proposed scheme and a surrounding study area with particular reference to whether legally protected and/or notable sites, species or habitats are present or likely to be present;
- to provide recommendations to enable compliance with relevant nature conservation legislation and planning policy; and
- if necessary, to identify the need for avoidance, mitigation, compensation or enhancement measures and/or further ecological surveys.

1.3 RELEVANT LEGISLATION AND POLICY

1.3.1. This appraisal has been compiled with reference to the following relevant nature conservation legislation, planning policy and the UK Biodiversity Framework from which the protection of sites, habitats and species is derived in England. The context and applicability of each item is explained as appropriate in the relevant sections of the report and additional details are presented in Appendix A.

- The Conservation of Habitats and Species Regulations 2017 as amended (Habitats Regulations);
- The Wildlife and Countryside Act 1981 (as amended) (WCA);
- Countryside Rights of Way Act 2000;
- The Natural Environment and Rural Communities (NERC) Act 2006;
- The Protection of Badgers Act 1992;
- The Hedgerow Regulations 1997;
- The Wild Mammals (Protection) Act 1996;
- The UK Post-2010 Biodiversity Framework (2011-2020) (JNCC and DEFRA, 2012);
- Biodiversity 2020: A strategy for England's wildlife and ecosystem services (DEFRA, 2011);
- UK Biodiversity Action Plan (UKBAP)[1];
- The National Planning Policy Framework (NPPF) 2012 (DCLG, 2012);
- Technical Advice Note 5; Nature Conservation and Planning 2009; and
- Environment Act 1995.

[1] The UK BAP has now been replaced by the UK Post-2010 Biodiversity Framework, however, it contains useful information on how to characterise important species assemblages and habitats which is still relevant.

2 METHODS

2.1 OVERVIEW

2.1.1. This appraisal has been prepared with reference to current good practice guidance published by the Chartered Institute for Ecology and Environmental Management (CIEEM, 2013 and 2015), and Joint Nature Conservation Committee (JNCC, 2010); and guidance contained in the British Standard - Code of Practice for Biodiversity and Development BS42020:2013 (British Standards Institute (2013).

2.1.2. This PEA is based on the following data sources:

- an ecological desk study;
- a habitat survey;
- a protected/notable species assessment; and
- great crested newt habitat suitability surveys of accessible ponds.

2.2 DESK STUDY

2.2.1. The desk study was undertaken in February 2018 to review existing ecological baseline information available in the public domain and to obtain information held by relevant third parties. For the purpose of the desk study exercise, records were collated within various survey distances around the Survey Area. This approach is consistent with current good practice guidance published by the CIEEM, 2013 and 2015. To provide the baseline data for the ecological desk study, the following information was requested from Lincolnshire Environmental Records Centre:

- records of legally protected and notable species within 5 km of the Survey Area; and
- records of non-statutory sites designated for nature conservation value within 2km of the Survey Area.

2.2.2. Freely downloadable datasets (available from Natural England) were consulted for information regarding the presence of statutory designated habitats[2] within 2km of the Survey Area. This search was extended to 10km for Natura 2000 sites (Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) of European importance and internationally designated Ramsar sites.

2.2.3. Freely downloadable datasets (available from Natural England) were consulted for information regarding Habitats of Principal Importance (HPI)[3] within 1km and woodland listed on the Ancient Woodland Inventory[4].

2.2.4. In addition, open source 1:25,000 Ordnance Survey mapping was used to identify any mapped water bodies and watercourses within 500m of the Survey Area.

2.2.5. The findings of the desk study have been incorporated within Section 4 and Appendix B of this report, and are shown on Figure 2.

2.2.6. The ecological desk study was completed by a senior ecologist who is a full member of CIEEM, and has completed numerous ecological desk studies within recent years.

2.3 HABITAT SURVEY

2.3.1. A Phase 1 Habitat survey of the Survey Area was carried out on the 3rd and 4th January 2018 in variable weather conditions including moderate rain and periods of bright sunshine, with moderate wind on the first day and calmer conditions on the second day. The survey covered the entire length of the proposed scheme. Access to private land was not granted for the survey so all observations were made from Public Rights of Way (PRoW), Where the nearest publicly accessible land was a considerable distance from the footprint of the proposed scheme, binoculars were used to help observe habitat features. In addition to land beneath the

[2] Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR) and Local Nature Reserves (LNR).

[3] Mapped locations of HPI are usually not available, but HPI aligns in the most part with UKBAP habitats. Inventories of UKBAP habitat have been prepared by a variety of organisations and at a national (Natural England priority habitat inventory) and local scale (e.g. by local records centres). In some instances these are primarily based on aerial photograph analysis rather than field survey.

[4] The ancient woodland inventory in England lists areas over two hectares in size which have been continuously wooded since at least 1600.

footprint of the proposed road, associated embankments and junctions, an approximate distance of 100-150m either side of the proposed scheme was also surveyed. The Phase 1 Habitat survey was completed by a full member of CIEEM, with extensive experience within the last six years of completing PEAs of a variety of greenfield and brownfield sites.

2.3.2. Habitats were described and mapped following the standard Phase 1 Habitat survey methodology (JNCC, 2010). Phase 1 Habitat survey is a standard technique for classifying and mapping British habitats. The dominant plant species are recorded and habitats are classified according to their vegetation types. Where appropriate consideration was given to whether habitats qualify, or could qualify, as a Habitat of Principal Importance following habitat descriptions published by the Joint Nature Conservation Committee (JNCC, 2008).

2.3.3. Habitats were marked on a paper base map and were subsequently digitised using a Geographical Information System (GIS). The smallest area to be mapped was 0.25 ha (roughly 50m x 50m), which was selected as a suitable scale to sample the range of different vegetation types present.

2.3.4. Target notes were made to provide information on specific features of ecological interest (e.g. otter *Lutra lutra* spraint or habitat features too small to be mapped). These are included in Appendix D.

2.3.5. Any invasive plant species listed on Schedule 9 of the WCA 1981 (as amended) which were evident during the Phase 1 Habitat survey were also target noted. Detailed mapping of such species; or a full survey of the Survey Area for all invasive plant species is beyond the scope of this commission.

2.3.6. Data collected as part of this Phase 1 Habitat survey is suitable for use in retrospective biodiversity unit calculations, if required.

2.4 PROTECTED SPECIES ASSESSMENT

2.4.1. The suitability for the Survey Area to support legally protected and notable species was assessed using the desk study results and combined with field observations during the habitat survey. The assessment of habitat suitability for protected and notable species was based on professional experience and judgement. This was supplemented by standard sources of guidance on habitat suitability assessment for key faunal groups including: bats (Collins, 2016 and Mitchell-Jones, 2004); badger (Harris et al, 1991 and Roper, 2010); otter (Chanin, 2003); water vole (Dean et al, 2016); reptiles (Froglife, 1999 and Gent and Gibson, 2003) and great crested newt (Gent and Gibson, 2003 and English Nature, 2001).

2.5 NOTES AND LIMITATIONS

2.5.1. A comprehensive description of the Survey Area has been provided; however, the following limitations apply to this assessment:

- Ecological survey data is typically valid for two years unless otherwise specified, for example if conditions are likely to change more quickly due to ecological processes or anticipated changes in management'.
- Records held by local biological record centres and local recording groups are generally collected on a voluntary basis; therefore, the absence of records does not demonstrate the absence of species, it may simply indicate a gap in recording coverage.
- The survey was not completed during the optimal survey season for Phase 1 Habitat survey, generally accepted to be from April-September (inclusive). Botanical surveys are seasonally limited, and throughout the spring and summer period certain species will be more or less evident at different times (i.e. depending on the flowering season). However, it is considered that sufficient information was gathered to enable an assessment of the habitat types present, in line with standard Phase 1 Habitat categories and the potential for these to support protected or notable species. The majority of land within the Survey Area comprised arable fields which can be assessed as such at any time of year.
- A large proportion of the Survey Area could not be accessed due to permission not being available at the time of the survey. Access was only available for PRoWs. The majority of land along the proposed scheme, however, could be observed from PRoWs due to the mostly flat and open nature of the terrain. Aerial imagery was used also used to identify which habitats were not observable from public land. It is, therefore, considered that the Phase 1 Habitat types were accurately identified.
- The Phase 1 Habitat survey was carried out over a period of two days, as such only a selection of all species that occur within the Survey Area will have been recorded. However, through use of desk study information to supplement site survey data, it is considered that an accurate assessment of the potential for the Site to support protected species or those of conservation concern was possible.

- The extended Phase 1 Habitat map (Figure 1) has been reproduced from field notes and plans. Whilst this provides a sufficient level of detail to fulfil the requirements of a PEA, the map is not intended to provide exact locations of key habitats.

3 RESULTS

3.1 DESIGNATED SITES

STATUTORY SITES

3.1.1. The desk study identified one statutory nature conservation site within 2km of the proposed scheme. There were found to be no designated sites of European or International importance within 10km of the proposed scheme. A description of the national site is detailed in Table 1 below.

Table 1 - Statutory Designated Sites of National Importance

Site Name	Designation	Size (ha)	Approximate Distance and orientation from Site	Description
Whisby Nature Park	LNR	108	1.4km north of the western end of the proposed scheme	The site consists of flooded gravel pits surrounded by grassland, marsh, scrub and willow carr. Elements of the original landscape, from before quarrying also remain, with fragments of heathland, old hedgerows and a small oak woodland.

NON-STATUTORY SITES

3.1.2. A total of fifteen Local Wildlife Sites (LWS), one Local Geological Site (LGS), two Sites of Nature Conservation Interest (SNCIs) and one Lincolnshire Wildlife Trust (LWT) reserve are located within 2km of the centre of the proposed scheme. These are listed in Table 2 below.

Table 2 - Non-statutory Designated Sites

Site Name	Designation	Approximate distance from Site proposed scheme (km)
Waddington Grassland (Viking Way)	LWS	0.0
River Witham, Bracebridge to South Hykeham	LWS	0.0
Bloxholm Lane	LWS	0.11
South Hykeham Meadows 1	SNCI	0.27
South Hykeham Meadows 2	SNCI	0.28
Brant Washlands	LWS	0.29
Waddington Brick Pit	LGS	0.3
North Hykeham Gravel Pit	LWS	0.74
Ski World, Whisby Pits Complex	LWS	0.76
North Hykeham Hayfield	LWS	0.79
North Hykeham Meadows	LWS	0.85
Whisby Nature Park	LWT Reserve	1.26
Teal's Lake, Whisby Pits Complex	LWS	1.29
Whisby Nature Park, Whisby Pits Complex	LWS	1.32
Hykeham Railway Line, Whisby Nature Park	LWS	1.61

Mr Nevile's Pits East, Whisby Pits Complex	LWS	1.73
River Witham, Aubourn to Beckingham	LWS	1.85
Mr Nevile's Pits, West, Whisby Pits Complex	LWS	1.92
Witham Corridor, South of Bracebridge	LWS	1.92

OTHER HABITATS OF CONSERVATION IMPORTANCE

3.1.3. There are no areas of AWI woodland within 1km of the Survey Area. There are, however, several areas of potential HPI habitat within 1km of the Survey Area including rivers, ponds, hedgerows and arable field margins, as shown on the Phase 1 Habitat map in Figure 1.

3.2 HABITAT SURVEY

OVERVIEW

3.2.1. The Survey Area consists predominantly of large expanses of arable land, bounded by ditches and hedgerows, with lines of trees along some sections of hedgerow. The hedgerows and ditches mostly appear heavily managed, with hedgerows being recently flailed and many of the ditches having been recently cleared, with the banks being cleaned back to bare soil in many cases. Several small areas of woodland are present but none of the woodland is designated as ancient. The land to the west is very flat but there is some more hilly terrain towards the eastern end of the Survey Area, just to the west of Waddington. The River Witham flows south to north across the central section of the proposed scheme and there are numerous ponds located within 250m of the proposed scheme.

3.2.2. The following account summarises the findings of the Phase 1 Habitat survey. Twelve Phase 1 Habitat types were identified in the Survey Area. They are mapped on Figure 1 and are listed in Table 3 along with areas in hectares (or length for linear features). A description of the dominant and notable species and the composition and management of each habitat is provided below. Target notes are provided in Appendix C and photographs in Appendix D. Alpha-numeric codes used in this section cross-refer to the JNCC Phase 1 Habitat survey classification (JNCC, 2010). The order of the habitat descriptions below reflects their ordering in the Phase 1 Habitat survey manual and does not reflect habitat importance.

Table 3 - Phase 1 Habitat Areas

Phase 1 Habitat	Area (ha)	Length (m)	% of Site Area
Broadleaved Woodland-Semi-natural – A1.1.1	4.1		1.2
Broadleaved Woodland-Plantation – A1.1.2	3.1		0.9
Scattered Scrub – A2.2	<3		<1
Broadleaved Parkland / Scattered Trees – A3.1	<3		<1
Improved Grassland – B4	24.5		7.3
Poor Semi-improved Grassland – B6	21		6.3
Open Water-Standing Water – G1	0.7		0.2
Open Water-Running Water – G2		6484	n/a

Cultivated / Disturbed Land-Arable – J1.1	274.9		82.3
Cultivated / Disturbed Land-Amenity Grassland – J1.2	57.6		1.7
Boundaries-Intact Hedge-Species-poor – J2.1.2		8043	n/a
Boundaries-Hedge and Trees-Species-poor – J2.3.2		9633	n/a
TOTAL			100

BROADLEAVED WOODLAND-SEMI NATURAL – A1.1.1

3.2.3. There are several areas of broadleaved semi-natural woodland within the Survey Area. The largest such areas are at Danker Wood (Photograph 1), near the western end of the proposed scheme and at Target Notes 11 and 12 near the eastern end of the proposed scheme. There are also two very small patches of broadleaved semi-natural woodland, just to the east of the River Witham.

3.2.4. The woodland at Danker Wood and at Target Note 11 is of a similar species composition with the most frequent canopy tree species being ash *Fraxinus excelsior*, hawthorn *Crataegus monogyna*, pedunculate oak *Quercus robur* and field maple *Acer campestre* with occasional silver birch *Betula pendula*, grey willow *Salix cinerea*, alder *Alnus glutinosa* and goat willow *Salix caprea*. The woodland at Target Note 12, however, is dominated by silver birch, which surrounds two ponds at a disused quarry site. Although the majority of the woodland at Target Note 11 appears to be semi-natural self-sown silver birch there is a small section, along the eastern edge of the former quarry which consists of a small stand of Scots pine *Pinus sylvestris*, presumably of plantation origin.

3.2.5. There appears to be minimal management of these woodlands, with very dense understorey layers of self-seeded trees and shrubs including frequent patches of bramble *Rubus fruticosus* agg. The only WCA Schedule 9 invasive plant species to be found during the survey was New Zealand Pigmyweed *Crassula helmsii* which was growing submerged in the large pond at Target Note 12 (Photograph 2). As this species can grow submerged or as a terrestrial form it is assumed that it is also present on land within the woodland at Target Note 12. Due to access restrictions the woodlands were only observed from near the edges with PRoWs so it may be possible that other patches of WCA Schedule 9 species occur within the woodlands.

BROADLEAVED WOODLAND-PLANTATION – A1.1.2

3.2.6. The main patches of broadleaved plantation woodland within the Survey Area are adjacent to an industrial estate to the west of the junction of South Hykeham Road, Boundary Road and Long Lane near the western end of the proposed scheme. The plantation consists of two rectangular blocks of trees along the eastern and western edges of the estate. Species present include pedunculate oak, ash, field maple, hawthorn, hazel *Corylus avellana,* blackthorn *Prunus spinosa* and silver birch.

3.2.7. A small triangular block of plantation woodland also occurs next to the River Witham at Target Note 6 (Photograph 3). This stand consists almost entirely of field maple. No WCA Schedule 9 invasive plant species were observed within the plantation woodland areas but full access was not available during the survey so their presence cannot be ruled out.

SCATTERED SCRUB – A2.2

3.2.8. Scattered scrub is present throughout the length of the Survey Area but is mostly in patches which are too small to map at the scale of the proposed scheme. The largest single patch occurs within an area of poor semi-improved grassland at Target Note 3, near the western end of the Survey Area. Species present within the grassland include hawthorn, bramble, gorse *Ulex europaeus*, broom *Cytisus scoparius*, dog rose *Rosa canina*, grey willow and blackthorn. No WCA Schedule 9 species were found to be present.

BROADLEAVED PARKLAND / SCATTERED TREES – A3.1

3.2.9. Scattered trees occur over amenity grassland at Waddington Grange Farm. They could not be identified to species as observations were possible only from the nearest PRoW at Grantham Road A607.

IMPROVED GRASSLAND – B4

3.2.10. Improved grassland occurs as small isolated patches amongst the far more extensive arable habitat. The majority of the improved grassland present appears to be used for grazing horses, with the largest amount being along the eastern side of Wath Lane track to the south of South Hykeham. The fields here are divided into small paddocks with wooden horse shelters present along Wath Lane (Photograph 4). Smaller improved grassland fields are present either side of Station Road, to the west of Waddington and to the north of the disused quarry at Target Note 12.

POOR SEMI-IMPROVED GRASSLAND – B6

3.2.11. Poor semi-improved grassland has been used during this survey to classify rough, ungrazed grasslands that appear to be subject to less intensive management than the enclosed, grazed improved grasslands which are present. A rectangular area of poor semi-improved grassland, with scattered scrub, is located just to the south-east of Hykeham Roundabout (Target Note 3, Photograph 5) with a narrow strip of this habitat type occurring along an embankment running parallel with a drain running into the River Witham (Target Note 5, Photograph 6). A small wedge of poor semi-improved grassland is indicated at Target Note 10 (Photograph 7), immediately to the west of an un-named track running north from Somerton Gate Lane towards Station Road. Other more extensive areas of poor semi-improved grassland occur on steeply sloping ground to the west of Viking Way, a public footpath which runs parallel with Grantham Road A607.

3.2.12. All areas of poor semi-improved grassland appeared to have a similar species composition with coarse tussocky grasses such as Cock's-foot *Dactylis glomerata* and false oat-grass *Arrhenatherum elatius* dominant. The most frequent herbaceous species evident from the dead remains of last year's plants included creeping thistle *Cirsium arvense*, broad-leaved dock *Rumex obtusifolius*, ragwort *Senecio jacobaea* and common nettle *Urtica dioica*.

OPEN WATER-STANDING WATER – G1

3.2.13. There are multiple ponds located within 250m of the proposed scheme which may provide suitable habitat for great crested newts. As access was only available along PRoWs, however, the majority of these ponds were not visited. Figure 1 shows the location of ponds within a 150m buffer either side of the proposed scheme. Ponds at Target Notes 1, 2 and 12 were visited and a great crested newt Habitat Suitability Index (GCN HSI) assessment was undertaken for each waterbody. The results of the HSI assessments are shown in Section 3.4.26 below but a brief description of each pond assessed is given below:

- Target Note 1 (Pond A) (Photograph 8) is located just to the east of the Game Keeper pub, to the north-east of Hykeham Roundabout. It appears to be a balancing pond and has a drain connected to either end of the pond. There appeared to be standing water in the centre of the pond, which is densely vegetated with bulrush *Typha latifolia*, with lesser amounts of common reed *Phragmites australis* and great willowherb *Epilobium hirsutum* and some grey willow scrub. The surrounding habitat consists of a road, car parks, amenity grassland and the pub to the west. To the east of the pond there are car parks and a garden centre.
- Target Note 2 (Pond B) (Photograph 9) is located to the south-east of Hykeham Roundabout, within an area of poor semi-improved grassland and scrub, surrounded by a tall hedge with trees. The pond is heavily shaded by trees including crack willow *Salix fragilis* and hawthorn. The pond sides are gently sloping and the pond contains large amounts of leaf litter. The land surrounding the semi-improved grassland consists of arable land to the south and west with leisure and retail units to the east and Newark Road to the north.
- Target Note 12 (Ponds C1 and C2) is the disused quarry site which consists of two ponds surrounded by predominantly silver birch woodland. The smaller pond to the south (Pond C1) is shown in Photograph 10 with the larger pond to the north (Pond C2) shown in Photograph 11 The WCA Schedule 9 plant species New Zealand pigmyweed was found growing submerged within Pond C2. The disused quarry site is surrounded by arable land to the south and east, with improved grassland to the north and west.

OPEN WATER-RUNNING WATER – G2

3.2.14. Running water within the survey area consists of numerous field drains and the River Witham:

- Field drains are mostly confined to the flatter western half of the Survey Area, with the land becoming hillier from just to the west of Waddington. The field drains are variable in depth and width but they all generally appear to be well maintained. The majority of the drains observed during the survey had been recently cleaned out with the banksides being cleared of vegetation and re-profiled (Photograph 12).

- The River Witham intersects the proposed scheme approximately half way along the route. At the point where the river is crossed, just to the north of the flood defence control building and field maple plantation at target Note 6, it is approximately 15m wide, with embankments either side (Photograph 13). Marginal vegetation at the time of the survey, consisted mostly of reed canary-grass *Phalaris arundinacea*. There are two field drains running parallel either side of the river behind the embankments (Target Note 7; Photograph 14).

CULTIVATED / DISTURBED LAND-ARABLE – J1.1

3.2.15. Arable land is the most widespread habitat type within the Survey Area, with it comprising 82.3% of the total land within a 100m buffer around the proposed scheme route. During the site visit arable fields were recorded at different stages of cultivation, with the following all being classified as arable habitat:

- freshly ploughed bare soil;
- recently harvested fields with stubble or other crop remains;
- horticultural land;
- recently seeded crop fields; and
- recently reseeded grasslands.

CULTIVATED / DISTURBED LAND-AMENITY GRASSLAND – J1.2

3.2.16. Amenity grassland is present within the Survey Area mostly as ornamental lawns associated with private houses, farms and commercial premises. The largest single parcel of amenity grassland is a private airstrip located near the junction of Boundary Lane and Long Lane, towards the western end of the Survey Area. Amenity grassland is generally intensively managed and regularly mown, leading to a low species-diversity. Perennial rye-grass *Lolium perenne* is often dominant, usually with lesser amounts of red fescue *Festuca rubra* and bent grass *Agrostis* species and cultivars. Due to frequent mowing herbaceous species are often restricted to low growing or rosette forming species such as daisy *Bellis perennis*, white clover *Trifolium repens* and common cat's-ear *Hypochaeris radicata*, which are able to avoid the mower blades.

BOUNDARIES-INTACT HEDGE-SPECIES-POOR – J2.1.2

3.2.17. Intact hedges are present along many of the field boundaries, particularly towards the western end of the Survey Area where they often run alongside drainage ditches. Although all hedges within the Survey Area have all been classed as species-poor this may not actually be the case as most of the hedges had been recently flailed (Photograph 12), making it very difficult to assess the number of species present within individual hedges. It appeared that the most frequent species comprising the hedgerows was hawthorn, with other species including blackthorn, dog rose, wild privet *Ligustrum vulgare*, ash, hazel and field maple. Survey at a more appropriate time of year is recommended to get a better assessment of how species-rich the hedges are within the Survey Area.

BOUNDARIES-HEDGE AND TREES-SPECIES-POOR – J2.3.2

3.2.18. The same comments as above apply to the survey of lines of hedges and trees, with regard to the timing of the survey. During the survey, however, it could be seen that there are some large mature and semi-mature trees within hedge lines which lie beneath the footprint of the proposed scheme. Examples of this occur at Target Note 4 where the road footprint intersects a line of large oak trees along Wath Lane (Photograph 15) and along Somerton Gate Lane where the proposed scheme intersects a line of semi-mature ash trees (Photograph 16). There will also be other locations, within land which was not accessed during the survey, where mature or semi-mature trees will be lost, the most frequent of which are ash and pedunculate oak.

3.3 PROTECTED AND NOTABLE SPECIES ASSESSMENT

3.3.1. The potential for the Survey Area to support legally protected species and notable species has been assessed using the results of the desk study and observations made during the site survey of habitats within and immediately surrounding the Survey Area. A summary of desk study information is included within Appendix B. Desk study records have only been considered below if they are recent (from the last 10 years) and/or if they relate to species that may be supported by habitats at the Survey Area. Habitats present within the Survey Area are suitable for the following species; further consideration is given below to the likelihood for these species to be present within the Survey Area:

- Bats
- Badger
- Otter

- Water Vole
- Birds
- Reptiles
- Amphibians

3.3.2. The Survey Area does not provide suitable habitat for other protected or notable species and other species, beyond those listed above, will not be considered further in this PEA.

BATS

3.3.3. A large number of bat records were returned from the records centre. These include:

- Eight records of brown long-eared bat *Plecotus auritus* roosts, the closest of which was recorded in 2010 and is located approximately 200m from the centre of the proposed scheme;
- One record of a soprano pipistrelle *Pipistrellus pygmaeus* roost, recorded in 2016 and located approximately 5km from the centre of the proposed scheme
- Eight records of common pipistrelle *Pipistrellus pipistrellus* roosts, the closest of which was recorded in 2011 and is located approximately 10m from the proposed scheme;
- One record of a Whiskered/Brandt's bat *Myotis mystacinus/brandtii* roost, recorded in 2011 and located approximately 3.2km form the centre of the proposed scheme and;
- One record of a Daubenton's bat *Myotis daubentonii* roost, recorded in 2013 and located approximately 4km from the centre of the proposed scheme.

3.3.4. In addition, a large number of records of bats foraging or flying across the area were included within the data. As well as the species listed above, these include Nathusius' pipistrelle *Pipistrellus nathusii* and noctule *Nyctalus noctula*, along with a number of records of unspecified bat species.

3.3.5. Potential breeding and hibernation sites for bats exist at multiple locations within the Survey Area. Buildings are present beneath the footprint of the proposed scheme at:

- an industrial estate to the west of the junction of South Hykeham Road, Boundary Road and Long Lane near the western end of the proposed scheme; and
- along Station Road, to the west of Waddington, the proposed scheme passes right through a row of large detached houses.

3.3.6. Mature and semi-mature trees are also present throughout the Survey Area, occurring as lines of trees along field boundaries, small woodland blocks or as groups of trees surrounding ponds. Although no systematic survey of the bat roost potential of trees was undertaken during this survey, several trees with features likely to be suitable for roosting bats were noted. An example is shown in Photograph 17, of a large mature crack willow next to the pond at Target Note 2, with large splits along a broken bough.

3.3.7. Foraging and commuting habitat for bats is present throughout the Survey Area including the following features:

- hedgerows with or without adjacent field drains;
- lines of trees and hedges with or without adjacent field drains;
- blocks of woodland;
- ponds; and
- the River Witham.

BADGER

3.3.8. There are 33 records of badger within the Study Area. 15 of these records are of badger setts, the closest of which is located approximately 750m from the centre of the proposed scheme.

3.3.9. During the Phase 1 Habitat survey no signs of badger presence, including setts, latrines, snuffle holes, tracks, footprints or hairs, were found. The Phase 1 Habitat survey, however, was restricted to PRoWs and therefore large areas of land were not accessed. Within this land there are numerous potential badger breeding sites including:

- blocks of woodland;
- hedgerows and lines of trees along field margins;
- beneath patches of dense scrub; and
- within embankments along the River Witham.

3.3.10. Suitable foraging habitat is also present throughout the survey area within woodland, improved grassland, amenity grassland, poor semi-improved grassland and arable fields.

OTTER

3.3.11. There are 45 records of otter *Lutra lutra* within the Study Area. These include two records from the within the footprint of the proposed scheme. Further information on the type of record, such as whether it relates to a sighting, field evidence, or a holt or couch, is not available.

3.3.12. Breeding habitat for otters includes extensive reed beds, lakes and ponds, deciduous woodland, young conifer plantations, extensive areas of scrub and features such as large areas of blockstone or boulders and buildings/structures immediately adjacent to watercourses. Given the size of the Survey Area there is very little of these types of habitat present. Breeding dens are rarely besides flowing main rivers due to the danger of flooding. Resting sites, including couches (uncovered resting areas), however, are often located next to a watercourse. Couches may be located under exposed tree roots or undercut riverbanks, in pollarded trees, drains or dense vegetation such as bramble, reed and nettle patches and are the most frequently used and encountered type of otter resting site.

3.3.13. Resting sites are likely to be present along the River Witham and otters are known to commute and feed along the section of the river within the Survey Area. This was confirmed by the presence of fresh otter spraint which was found during the Phase 1 Habitat survey. The spraint was on a concrete mooring platform, at the bottom of a flight of steps, just to the east of the Witham Washlands Flood Control Building on the west bank of the river (Photograph 18). This location is indicated on Figure 1 as Target Note 8.

WATER VOLE

3.3.14. There are 115 records of water vole *Arvicola amphibius* within the Study Area. Nine of these records are located within the footprint of the proposed scheme.

3.3.15. Water vole breeding and foraging habitat is mostly located within the western section of the Survey Area where the greatest number of field drains occur. No signs of water vole, including burrow holes, droppings/latrines, feeding remains or runways were found during the Phase 1 Habitat survey.

3.3.16. Water voles, however, usually hold territories from late February through until October. The timing of the survey therefore was sub-optimal to detect signs of the species. The possibility of water vole presence within the Survey Area cannot be discounted, particularly with the number of drainage ditches which could not be accessed at the time of the survey. Although the River Witham is considerably wider and deeper than is usually favoured by water voles their presence within the river is also possible as is presence around the margins of ponds.

BIRDS

3.3.17. A large number of bird records were returned from the records centre, including the following Schedule 1 species recorded within the footprint of the proposed scheme: kingfisher *Alcedo atthis* scaup *Aythya marila*, Lapland bunting *Calcarius lapponicus*, black tern *Chlidonia niger*, marsh harrier *Circus aeruginosus*, hen harrier *Circus cyaneus*, whooper swan *Cygnus cygnus*, merlin *Falco columbarius*, peregrine *Falco peregrinus*, hobby *Falco Subbuteo*, great northern diver *Gavia immer*, little gull *Hydrocoloeus minutus*, Mediterranean gull *Larus melanocephalus*, common crossbill *Loxia curvirostra*, common scoter *Melanitta nigra*, red kite *Milvus milvus*, whimbrel *Numenius phaeopus*, osprey *Pandion haliaetus*, black redstart *Phoenicurus ochruros*, snow bunting *Plectrophenax nivalis*, Slavonian grebe *Podiceps auritis*, greenshank *Tringa nebularia*, green sandpiper *Tringa ochropus*, redwing *Turdus iliacus* and barn owl *Tyto alba.*

3.3.18. Breeding and foraging habitat for birds occurs throughout the Survey Area. Potential breeding and foraging areas exist within woodland and along hedgerows and tree lines, within poor semi-improved grassland and around arable and improved grassland field margins. There are also breeding and foraging opportunities for wetland species along the banks of the River Witham and within larger ponds and field drains.

3.3.19. During the Phase 1 Habitat survey a barn owl nesting box was found to be located to the west of the River Witham along a fence line (Photograph 19). The box was situated on a wooden pole and bore an identity number and contact details for The Wildlife Conservation Partnership. Fresh owl pellets were found beneath the box, indicating recent usage (Photograph 20).

REPTILES

3.3.20. The data returned from the desk study included records of common lizard *Zootoca vivipara*, grass snake *Natrix helvatica helvetica* and slow-worm *Anguis fragilis* from within 5km of the proposed scheme. Two records of grass snake are located within the footprint of the proposed scheme.

The majority of habitat within the Survey Area is sub-optimal for reptiles, being comprised mainly of arable fields. More suitable areas of habitat do exist, however, at the following locations:

- within a small poor semi-improved grassland field with scattered scrub, just to the south-east of Hykeham Roundabout (Target Note 3);
- along a narrow strip of poor semi-improved grassland occurring along an embankment running parallel with a drain running into the River Witham (Target Note 5);
- a small wedge of poor semi-improved grassland at Target Note 10, immediately to the west of an un-named track running north from Somerton Gate Lane towards Station Road;
- within poor semi-improved grassland occurring on steeply sloping ground to the west of Viking Way, a public footpath which runs parallel with Grantham Road A607; and
- along embankments running either side of the River Witham. The habitat along the river may be particularly attractive to grass snakes which frequently use rivers and drainage ditches as foraging areas and commuting corridors.

AMPHIBIANS

3.3.21. A total of 23 great crested newt records were returned from the data search, including four records within 1km of the proposed scheme. The data also included records of common frog *Rana temporaria*, common toad *Bufo bufo*, palmate newt *Lissotriton helveticus* and smooth newt *Lissotriton vulgaris*.

3.3.22. Potential great crested newt breeding habitat is present within the Survey Area, with six ponds shown on OS mapping as being located within 150m of the proposed scheme footprint. Due to access restrictions only four of these ponds were visited during the Phase 1 Habitat survey (Ponds A, B, C1 and C2, as described in Paragraph 3.3.14 above). These four ponds were all subject to HSI assessment, with the results given below in Table 4.

3.3.23. Great crested newts are also known to disperse throughout terrestrial habitat up to 250m away from breeding ponds so the proposed scheme land may also support newts from ponds outside the 100m buffer Survey Area. Dispersal of great crested newts into habitats surrounding the breeding ponds is influenced by the quality of the surrounding habitat, with woodland, scrub and rough grassland being favoured over more managed habitats such as amenity grassland and arable land. Due to the predominance of arable land within the Survey Area the amount of suitable land into which to disperse after breeding is limited.

Table 4 – Great Crested Newt Pond HSI Scores

	POND A		POND B		POND C1		POND C2	
Category	Field Score	SI	Field Score	SI	Field Score	SI	Field Score	SI
Location	A (optimal)	1	A (optimal)	1	A (optimal)	1	A (optimal)	1
Pond Area	400	0.8	650	1	800	0.98	5700	0.23
Pond Drying	Sometimes	0.5	Rarely	1	Sometimes	0.5	Never	0.9
Water Quality	Moderate	0.67	Moderate	0.67	Moderate	0.67	Moderate	0.67
Shade	5%	1	80%	0.6	80%	0.6	5%	1
Fowl	Absent	1	Absent	1	Minor	0.67	Minor	0.67
Fish	Possible	0.67	Possible	0.67	Minor	0.33	Major	0.01
Ponds	3	0.65	0	0.01	3	0.65	3	0.65
Terrestrial Habitat	None	0.01	Moderate	0.67	Moderate	0.67	Moderate	0.67

Macrophytes	100%	0.8	10%	0.4	5%	0.33	10%	0.4
Overall HSI		**0.50**		**0.49**		**0.60**		**0.42**

3.3.24. A categorical scale (shown below) has been developed by which HSI scores are used to define pond suitability for great crested newts.

Table 5 – Categorisation of HSI Scores

HSI	Pond Suitability
<0.5	Poor
0.5-0.59	Below Average
0.6-0.69	Average
0.7-0.79	Good
>0.8	Excellent

3.3.25. Pond A is categorised as having Below Average suitability for great crested newts, Pond B is Poor, Pond C1 is Average and Pond C2 is Poor.

NON-NATIVE INVASIVE PLANT SPECIES

3.3.26. Records of the following non-native invasive plant species listed on Schedule 9 of the Wildlife and Countryside Act are present within the Study Area: wall cotoneaster *Cotoneaster horizontallis*, Himalayan cotoneaster *Cotoneaster simonsii*, New Zealand pigmyweed *Crassula helmsii*, Canadian waterweed *Elodea canadensis*, Nutall's waterweed *Elodea nuttalli*, Japanese knotweed *Fallopia japonica*, giant hogweed *Herecleum mantegazzianum*, Himalayan balsam *Impatiens glandulifera*, curly waterweed *Lagarosiphon major*, yellow archangel *Lamiium galeobdolon subsp. argentatum*, parrot's-feather *Myriophyllum aquaticum*, rhododendron *Rhododendron ponticum* and Japanese rose *Rosa rugosa*. None of records are located within the footprint of the proposed scheme.

3.3.27. One WCA Schedule 9 invasive plant species was found during the Phase 1 Habitat survey. New Zealand pigmyweed was growing submerged within Pond C2 at Target Note 12. Due to access restrictions, however, large areas of land were not visited during the survey and therefore there may potentially be other WCA Schedule 9 species present at other locations within the Survey Area.

4 DISCUSSION AND RECOMMENDATIONS

4.1.1. This section considers the potential for effects on designated sites, legally protected species, notable species and notable habitats as a consequence of the proposed scheme. Where further surveys or detailed assessment of potential effects are required in order to design suitable mitigation this is identified.

4.2 STATUTORY DESIGNATED SITES

4.2.1. There were found to be no designated sites of European or International importance within 10km of the proposed scheme. The desk study identified one statutory nature conservation site of National importance within 2km of the Survey Area; Whisby Nature Park LNR, which is located 1.4km north of the western end of the proposed scheme.

4.2.2. No negative impacts are envisaged on Whisby Nature Park LNR as this site is considered sufficiently distant from the proposed scheme as to remain unaffected by the proposals.

4.3 NON-STATUTORY DESIGNATED SITES

4.3.1. Non-statutory sites within Lincoln are protected through Policy LP21: Biodiversity and Geodiversity of the Central Lincolnshire Local Plan (adopted April 2017). Within this policy it is stated that: 'all development should protect, manage and enhance the network of habitats, species and sites of international, national and local importance (statutory and non-statutory), including sites that meet the criteria for selection as a Local Site'.

4.3.2. There are two non-statutory designations located within the footprint of the proposed scheme. These are Waddington Grassland (Viking Way) LWS and River Whitham, Bracebridge to South Hykeham LWS. A third LWS, Bloxholm Lane, is located approximately 100m from the footprint of the proposed scheme. Construction of the proposed scheme may result in direct loss of land from these sites and/or habitat degradation through indirect impacts of construction, such as increased sediment in run-off and increases in noise and lighting. Further surveys and/or mitigation may be required in order to quantify and reduce impacts on these sites.

4.3.3. No negative impacts are envisaged on all other non-statutory designated sites identified in this PEA as these sites are considered sufficiently distant from the proposed scheme as to remain unaffected by the proposals.

4.4 HABITATS

4.4.1. Although there are no protected habitats or AWI woodland present within the Survey Area there are habitats present which may qualify as HPI, including rivers, ponds, hedgerows and arable field margins. No assessment has yet been carried out to see if these habitats meet the criteria to be classified as HPI in accordance with Section 41 of the NERC Act 2006. Under Section 40 of this legislation, every public body (including planning authorities) must, ' in exercising its functions, have regard so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity'.

4.4.2. A small area of broadleaved semi-natural woodland will be lost behind houses along Station Road, to the west of Waddington, with two small sections of broadleaved plantation woodland to be lost adjacent to an industrial estate to the west of the junction of South Hykeham Road, Boundary Road and Long Lane near the western end of the proposed scheme.

4.4.3. Improved grassland, which is of low nature conservation interest will be lost:

- to the east of Wath Lane, just south of the village of South Hykeham; and
- east and west of Station Road, to the west of Waddington.

4.4.4. Poor semi-improved grassland, with a higher nature conservation value will be lost:

- to the south-east of Hykeham Roundabout, at the western end of the proposed scheme where a small amount of scattered scrub will also be lost;
- along an embankment running parallel to a drain entering the River Witham through its western bank; and
- along steeply sloping ground to the west of Viking Way, a public footpath which runs parallel with Grantham Road A607.

4.4.5. Open standing water (Pond A) will be lost to the south-east of Hykeham Roundabout, at the western end of the proposed scheme.

4.4.6. Multiple stretches of open running water will be lost where the road footprint intersects field drains. Some of these drains may potentially support plant communities of nature conservation interest or provide water vole habitat. The River Witham will be crossed by the proposed scheme. Although the course of the river will not be altered, significant modification of the banks around the crossing point is likely to take place.

4.4.7. The majority of habitat that will be lost throughout the length of the proposed scheme is arable land which is largely of low nature conservation interest.

4.4.8. Multiple lengths of intact hedgerow will be lost where the road footprint crosses them. The value of these sections of hedgerow is not currently known as most sections had been recently flailed at the time of the Phase 1 Habitat survey with further survey work, at an appropriate time of year, required to ascertain the species-richness of the hedges.

4.4.9. Multiple lengths of hedge and trees will be lost where the road footprint crosses them. Mature and semi-mature trees have been recorded at several crossing points during the survey and further loss of mature trees may also be confirmed once full access to the land is provided.

4.5 PROTECTED AND NOTABLE SPECIES

4.5.1. The results of the desk study, Phase 1 Habitat Survey and protected species assessment highlighted the potential presence of several protected species or species of conservation concern within the Survey Area, or within the immediate surroundings of the Survey Area. These include bats, badger, otter, water vole, birds, reptiles and amphibians. The legal protection afforded to these species is outlined below and, where appropriate, the requirement for further survey and/ or mitigation measures is identified

BATS

4.5.2. All species of bats recorded within the UK are protected from killing, injury and disturbance[5] and their roosts protected from damage or destruction under the Habitats Regulations. Protection is also afforded under the Wildlife and Countryside Act 1981 (as amended) with respect to disturbance of individuals occupying places of rest or shelter and obstruction of access to these. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes.

4.5.3. Certain species of bats, including the Bechstein's bat, greater and lesser horseshoe bats, noctule, brown long eared bat and soprano pipistrelle bat are also listed as Species of Principal Importance (SPI) for the conservation of biodiversity in England in accordance with Section 41 of the NERC 2006. Section 40 obliges public bodies (including local planning authorities) to have regard for the conservation of biodiversity (including SPI) when discharging their duties (including determining planning applications).

4.5.4. The scheme may directly affect roosting bats which may be present within industrial buildings and residential buildings as detailed in Section 3.4.7 above. Bats may also be affected if roosting within mature and semi-mature trees which will require removal to accommodate the scheme.

4.5.5. Indirect effects from the scheme may arise through the destruction of foraging and commuting lines and increased lighting and disturbance along the route of the proposed scheme.

4.5.6. Further survey work is required to assess the effects on bats as described in Table 6 below.

BADGER

4.5.7. The Protection of Badgers Act 1992 makes it illegal to wilfully kill, injure or take any badger, or attempt to do so. It also makes it an offence to intentionally or recklessly damage, destroy or obstruct access to any part of a badger sett. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes.

4.5.8. Although signs of badger activity were not found during the Phase 1 Habitat survey, suitable breeding and foraging habitat is present within the Survey Area, as described in Sections 3.4.12 and 3.4.13 above. Further

[5] Disturbance is defined within the Habitats Regulations as that which is likely to impair a species ability to survive, breed or reproduce, hibernate or migrate or to significantly affect the local distribution or abundance of the species.

survey work, as detailed in Table 6 below, is required to establish whether badgers are present within the Survey Area and may therefore be affected by the proposed scheme.

OTTER

4.5.9. The European otter is protected from killing, injury and disturbance[6] and its place of rest or shelter (holt) is protected from damage or destruction under the Habitats Regulations. Protection is also afforded under the Wildlife and Countryside Act 1981 (as amended) with respect to disturbance of individuals occupying places of rest or shelter and obstruction of access to these. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes.

4.5.10. Otters are also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.

4.5.11. Evidence of otter presence was found along the western bank of the River Witham with fresh otter spraint being present on a concrete platform near the Flood Control Building. Although presence has already been established, further survey work, as detailed below in Table 6, is necessary to avoid the destruction or damage of any resting places which may be affected by the crossing of the River Witham by the proposed scheme.

WATER VOLE

4.5.12. The water vole is protected from killing and injury and its place of rest or shelter (burrow) is protected from damage, destruction or obstruction under the Wildlife and Countryside Act 1981 (as amended). Additional protection from disturbance is extended to individuals occupying places of rest or shelter. Activities that would otherwise constitute an offence under this legislation may be licensed natural England for certain purposes.

4.5.13. The water voles is also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.

4.5.14. No signs of water vole were found during the Phase 1 Habitat survey but the survey was undertaken at a sub-optimal time of year for detecting water vole presence. Many of the field drains had also been recently cleaned out which would destroy most signs of water vole occupation. It is therefore recommended that further survey work, as detailed in table 6 below, is undertaken.

BIRDS

4.5.15. Under the amendments to the Habitat Regulations (16th August 2012) Reg 9A(2) & (3) state that local authorities 'must take such steps in the exercise of their functions as they consider appropriate to contribute to…the preservation, maintenance and re-establishment of a sufficient diversity and area of habitat for wild birds in the UK including by means of the upkeep, management and creation of such habitat…'. The legislation continues to state that economic and recreation requirements must be taken into consideration in considering which measures are appropriate.

4.5.16. Under the Wildlife and Countryside Act 1981 (as amended) the majority of wild birds are protected from killing and injury (with certain exceptions), and their nests and eggs protected from taking, damage and destruction whilst in use. Additional protection is extended to species listed under Schedule 1 of the Act, meaning it is also an offence to disturb these species at or near an active nest, or whilst they have dependent young.

4.5.17. Habitat for nesting birds exists throughout the length of the proposed scheme, with the potential for large scale habitat loss due to clearance of vegetation to accommodate the road. Vegetation clearance may have a direct effect on breeding birds and measures should be put in place to avoid damage to nests, eggs and young birds.

4.5.18. More long-term effects may arise from the operation of the road including increased disturbance and increased numbers of birds being killed through road traffic collisions. This is particularly true for raptors, including barn owls which are known to roost adjacent to the footprint of the proposed scheme near the River Witham.

[6] Disturbance is defined within the Habitats Regulations as that which is likely to impair a species ability to survive, breed or reproduce, hibernate or migrate or to significantly affect the local distribution or abundance of the species.

4.5.19. Habitat loss may also affect foraging wintering birds which may use fields, hedgerows and trees throughout the Survey Area. In order to assess the effects of the proposed scheme on breeding and wintering birds, further surveys, as detailed in Table 6 below, are recommended.

REPTILES

4.5.20. Native widespread reptile species (common or viviparous lizard, adder, grass snake and slow worm) are partially protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). This includes protection from killing and injury.

4.5.21. All reptile species are also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.

4.5.22. The majority of habitat throughout the Survey Area is unsuitable for reptiles, comprising large areas of arable land. More suitable areas of reptile habitat are detailed in Section 3.4.23 and are recommended for further survey work as detailed in Table 6 below.

AMPHIBIANS

4.5.23. Great crested newts are protected from killing, injury and disturbance[7] and their places of rest or shelter (occupied habitat) protected from damage or destruction under the Habitats Regulations. Protection is also afforded under the Wildlife and Countryside Act 1981 (as amended) with respect to disturbance of individuals occupying places of rest or shelter and obstruction of access to these. Activities that would otherwise constitute an offence under this legislation may be licensed by Natural England for certain purposes.

4.5.24. Great crested newts and common toad *Bufo bufo* are also listed as SPI in accordance with Section 41 of the NERC Act 2006. Public bodies have an obligation under Section 40 to have regard for these species when carrying out their functions.

4.5.25. Great crested newts which occupy breeding ponds up to 250m away from the footprint of the proposed scheme may use intervening terrestrial habitat. Despite the dominance of low quality arable habitat throughout the Survey Area great crested newts may occur in the vicinity of the proposed scheme. Therefore further survey work is recommended as described in table 6 below.

PLANTS

4.5.26. Invasive WCA Schedule 9 plants are present within Pond C2 at Target Note 12, where New Zealand pigmyweed was found growing submerged in the pond. Further Schedule 9 species may be present throughout the Survey Area within land parcels which were not visited due to access restrictions. Further survey work is therefore recommended as described in Table 6 below.

4.5.27. Further survey work is also recommended to identify if there are sections of species-rich hedgerow present along field boundaries

FURTHER SURVEY REQUIREMENTS

4.5.28. Potential ecological constraints for which further surveys are required to ensure legal and planning policy compliance are listed in Table 6 below.

[7] Disturbance is defined within the Habitats Regulations as that which is likely to impair a species ability to survive, breed or reproduce, hibernate or migrate or to significantly affect the local distribution or abundance of the species.

Table 6 - Key Ecological Constraints and Further Survey Requirements

Ecological Receptor	Potential Constraints	Further Survey Requirements	Seasonal Constraints
Bats	Demolition of industrial and residential buildings and the felling of trees within woodland blocks or along field boundaries may result in the damage/ destruction of a bat roost. The construction and operation of the proposed scheme may destroy habitats that currently contribute to foraging areas and commuting lines within the Survey Area. Increased light levels and disturbance from the road will also have a detrimental effect on bats within the area.	Further assessment of trees / buildings to determine presence, potential presence or likely absence of roosting bats. Features with potential to support roosting bats should be subject to an aerial inspection by a licensed bat ecologist. If the climbing surveys cannot confirm likely absence of roosting bats, dusk emergence and dawn re-entry surveys will be required. Walked transects (activity surveys) should be undertaken to assess the level of usage of the landscape by bats. This will also provide information on which species of bats are present. Further survey work should be in accordance with *Bat Surveys for Professional Ecologists, Good Practice Guidelines (3rd Edition)* Collins, J. (ed.). (2016).	External inspections can be undertaken at any time of year but are most conclusive in the autumn and winter months where no leaf cover exists. Dusk emergence/ dawn re-entry surveys must be undertaken between May and September and are optimal between May and August. Activity surveys can be undertaken between April and October (inclusive), but are also weather dependant.
Badger	The construction of the proposed scheme may necessitate the destruction of a badger sett or setts.	Areas of suitable habitat within the Survey Area, including field boundaries, woodland and scrub, should be searched for signs of badger occupation.	Badger surveys can be undertaken all year round, although vegetation cover and weather can be limiting factors.
Otter	Construction operations may result in destruction or damage of otter resting	Land along the banks of the River Witham, adjacent to the crossing point of the	Otter surveys can be undertaken all year round, although vegetation cover and weather can be limiting factors.

	places along the River Witham. The construction and operation of the proposed scheme may result in increased otter road casualties.	proposed scheme should be searched for signs of otters and potential resting places.	
Water Vole	Water vole burrows may be damaged or destroyed and water voles killed or injured where the proposed scheme intersects field drains.	Drains should be searched a suitable distance either side of where the proposed scheme crosses field drains to search for signs of water vole occupancy.	Surveys should take place between February and October (inclusive). Two survey visits should be undertaken in most cases; one between mid-April to June (inclusive) and one July to September (inclusive) separated by two months.
Birds	Breeding Birds may be nesting within vegetation which will be removed to accommodate the proposed scheme. This may potentially lead to the damage or destruction of nests, eggs or young birds. Foraging birds will suffer a loss of habitat area within which to feed. Raptors, including barn owl, may be subject to higher mortality rates due to increased risk of road vehicle traffic collisions.	Breeding bird surveys should be undertaken to identify which species and numbers of birds are holding territories and breeding within the Survey Area. Wintering bird surveys should be undertaken to identify which species and numbers of birds are using land within the Survey Area during the winter months and within which areas wintering birds are concentrated.	Breeding bird surveys generally take place from March to August (inclusive). Wintering bird surveys occur from October to February (inclusive).

Reptiles	Reptiles present within suitable areas of habitat, as listed in Section 3.4.23 may be killed or injured if groundworks within these areas are to take place during the reptile hibernation period (October to March inclusive).	Reptile survey of suitable habitat to determine presence / likely absence; using artificial refugia.	Typically seven survey visits will be required from March to September (inclusive). July and August may be sup-optimal due to higher ambient temperatures reducing basking activity.
Amphibians	Risk of killing or injuring great crested newts which are using terrestrial habitat within the Survey Area	Initial scoping of ponds using HSI assessment methodology. Presence/likely absence surveys of ponds using bottle trapping, torching, netting and hand searching or eDNA testing of water	HSI assessments can generally be undertaken at any time of year. Presence/likely absence surveys and eDNA testing from mid-April until June (inclusive).
Plants	Risk of causing Schedule 9 plants to spread in the wild, in contravention of the WCA 1981 (as amended). Removal of sections of species-rich hedgerow.	All accessible land and waterbodies should be searched for Schedule 9 plant species prior to vegetation clearance to avoid the risk of spreading these non-native invasive plant species. Hedgerows which are beneath the footprint of the proposed scheme should be surveyed to count the number of native woody species within measured sections of hedge to provide an assessment of species-richness.	Botanical surveys should generally take place between March and September.

4.6 PRELIMINARY AVOIDANCE, MITIGATION AND COMPENSATION MEASURES

4.6.1. To enable compliance with relevant legislation and planning policy, as described above within Section 4.2, 4.3, 4.4 and 4.5 the following avoidance, mitigation and compensation measures should be designed in to the proposed scheme. These will be refined following completion of further survey recommended in Table 6 above.

- Woody vegetation clearance should be undertaken outside the bird breeding season (March to August inclusive) to avoid the risk of damaging or destroying nests, eggs or young birds. If clearance is to take place during the breeding season all woody vegetation should be checked prior to removal. If active nests are found removal should be discontinued, and an exclusion zone put in place until the young birds have fledged.
- If W&C Act 1981 (as amended) invasive plant species are found during vegetation clearance, work around the Schedule 9 species should be discontinued, an appropriate exclusion zone put in place (up to 7m for Japanese knotweed *Fallopia japonica*) and advice sought from a qualified ecologist.
- When undertaking vegetation clearance excessive amounts of woody vegetation should not be removed. Only the minimum amount of trees and scrub should be removed to enable the accommodation of the proposed scheme.

ENVIRONMENTAL BEST PRACTICE

4.6.2. In addition, general environmental protection measures must be implemented during the construction phase of the proposed scheme. Such measures include best environmental practice guidance outlined by the Construction Industry Research and Information Association guidance (CIRIA, 2015). The Environment Agency's Pollution Prevention Advice and Guidance (Environment Agency, 2014) is also applicable here, however the documents are now withdraw from use, but are available for reference on the government website[8]. The following minimum standards should be adhered to prevent ecological impacts beyond the Site boundary:

- Measures should be taken to prevent dust and other emissions from construction affecting land beyond the Site.
- Chemicals and fuels should be stored in secure containers located away from watercourses or water bodies. Spill kits should be available.
- Excavations should be covered or securely fenced (with no potential access points beneath fencing) when the Site is closed (e.g. overnight) to prevent entrapment of animals.
- Retained trees should be protected in accordance with BS5837: *Trees in relation to design, demolition and construction*;
- Noise and vibration should be controlled and kept to the minimum necessary.
- Lighting used for construction should be switched off when not in use and positioned so as not to spill on to adjacent land or retained vegetation within the Site.

4.7 ECOLOGICAL ENHANCEMENT OPPORTUNITIES

4.7.1. The National Planning Policy Framework (NPPF) (2012) states that at an overview level the 'planning system should contribute to and enhance the national and local environment by… minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures'.

4.7.2. At a local level, Policy LP21: Biodiversity and Geodiversity of the Central Lincolnshire Local Plan states that 'Development proposals should create new habitats, and links between habitats, in line with Biodiversity Opportunity Mapping evidence to maintain a network of wildlife sites and corridors to minimise habitat fragmentation and provide opportunities for species to respond and adapt to climate change. Development

[8] http://webarchive.nationalarchives.gov.uk/20140328090931tf_/http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx

should seek to preserve, restore and re-create priority habitats, ecological networks and the protection and recovery of priority species set out in the Lincolnshire Biodiversity Action Plan and Geodiversity Action Plan.

4.7.3. Where development is within a Nature Improvement Area (NIA), it should contribute to the aim and aspirations of the NIA. Development proposals should ensure opportunities are taken to retain, protect and enhance biodiversity and geodiversity features proportionate to their scale, through site layout, design of new buildings and proposals for existing buildings'.

5 CONCLUSIONS

5.1.1. Excluding hardstanding the Survey Area consists of 82.3% arable land, 7.3% improved grassland and 6.3% poor semi-improved grassland. Arable land is generally of low ecological value with little potential for supporting protected species although the field boundaries are often formed of hedgerows, tree lines and field drains, with greater protected species potential.

5.1.2. The tree and hedge lines are likely to support breeding birds and may potentially provide roosting sites for bats, with opportunities for badger sett construction along their base. Field drains provide potential habitat for water voles, whilst otter spraint was found adjacent to the River Witham. Evidence of roosting barn owls was also found near the river.

5.1.3. Other protected species that may be present within the Survey Area include common reptiles and great crested newt, although suitable habitat for both of these is very restricted within the Survey Area. Further survey work for bats, badger, otter, water vole, birds, reptiles and amphibians is recommended, as described in Table 6.

5.1.4. At this early stage in the design process avoidance and mitigation measures are mainly generic in nature, with no agreed enhancement measures but with any measures agreed in the future having to be in accordance with NPPF, 2012 and Policy LP21: Biodiversity and Geodiversity of the Central Lincolnshire Local Plan.

6 REFERENCES

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7 FIGURES

Figure 1- Phase 1 Habitat Mapping

N

LEGEND:

150m buffer

Phase 1 habitat classifications

A1.1.1 - Broadleaved woodland - semi-natural

A1.1.2 - Broadleaved woodland - plantation

B4 - Improved grassland

B6 - Poor semi-improved grassland

G1 - Standing water

J1.1 - Cultivated/disturbed land - arable

J1.2 - Cultivated/disturbed land - amenity grassland

G2 - Running water

J2.1.2 - Intact hedge - species-poor

J2.3.2 - Hedge with trees - species-poor

J2.4 - Fence

A2.2 - Scrub - scattered

A3.1 - Broadleaved Parkland/scattered trees

Target Note

100 0 100 200 300 m

STATUS:

FOR INFORMATION ONLY

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CLIENT:

LINCOLNSHIRE COUNTY COUNCIL

PROJECT:

LINCOLN SOUTHERN BYPASS

TITLE:

Phase 1 habitat map

SCALE @A3:	CHECKED:	APPROVED:
1:8,000	PH	BB
QGIS FILE:	DRAWN:	DATE:
	15/01/18	06/04/18
PROJECT No:	DRAWING No:	REV:
70038233	Page 1 of 4	0.1