Lincoln Eastern Bypass

Environmental Statement

Volume 3 – Technical Appendices

December 2012

Produced by

Lincolnshire COUNTY COUNCIL
HIGHWAYS ALLIANCE

Document Control Sheet

Project Title	Lincoln Eastern Bypass
Report Title	Environmental Statement
	Volume 3 - Technical Appendices
Revision	1
	Document Reference Number: 1030171/R/001
Status	Final
Control Date	December 2012

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
1	Final	M Duffort	30/11/2012	S Newman	30/11/2012	F Symes	04/12/2012

Distribution

Organisation	Contact	Copies
Mouchel	John Pollard	1e

Contents

1 Introduction

1.1 Jacobs Lincoln Eastern Bypass Environment Statement (2009)

Lincolnshire COUNTY COUNCIL

-IN PARTNERSHIP-

JACOBS

Lincolnshire County Council

Lincoln Eastern Bypass Environmental Statement

August 2009

Revision 0

B0231400/OD38
Jacobs 1 City Walk, Leeds, West Yorkshire, LS11 9DX
Tel: 0113 242 6771 Fax: 0113 389 1389

Document control sheet

Client: Lincolnshire County Council
Project: Lincoln Eastern Bypass
Title: Environmental Statement

Job No: B0231400

	Originated by	Checked by	Reviewed by	Approved by
ORIGINAL	NAME Sharon Woodruff	NAME Simon White and Dan Johnston	NAME Simon White	NAME Stephen Taylor
DATE August 2009	SIGNATURE		SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE

CONTENTS

1 INTRODUCTION

1.1 THE PURPOSE OF THIS ENVIRONMENTAL STATEMENT

1.1.1 This Environmental Statement describes the potential environmental effects of the proposed Lincoln Eastern Bypass (LEB). The Environmental Statement is intended to ensure that the environmental effects of the scheme are fully understood and taken into account before Lincolnshire County Council makes a decision on the planning application.

1.2 WHY THE LINCOLN EASTERN BYPASS IS NEEDED

1.2.1 The proposal is for a new road to form the main road link between the A158 Wragby Road Roundabout, to the north east of the city (which links to the northern bypass), and the A15 north-south primary route between Humberside and Peterborough, to the south of the city.

1.2.2 The aim of the scheme is to reduce the severe traffic congestion and delays caused by the passage of the A15 through Lincoln city centre, and the additional pressures of locally generated and attracted traffic.

1.3 OBJECTIVES OF THE LINCOLN EASTERN BYPASS

1.3.1 The proposed LEB has the following objectives:

- To further the growth of Lincoln as a regional centre;
- To open up land to the east of the city for further development;
- To relieve congestion to the east of the city, bringing environmental benefits to areas such as the historic core; and
- To offer opportunities to provide additional facilities to encourage the greater use of public transport, cycling and walking.

1.4 GENERAL DESCRIPTION OF THE SCHEME AND ITS SETTING

1.4.1 The LEB would be a dual carriageway road through an area of predominantly arable land, to the east of the city of Lincoln and the villages of Canwick and Bracebridge Heath, and to the west of the outlying villages of North Greetwell, Cherry Willingham, Washingborough and Branston. The total length of the route would be 7.85km, and is shown on Figure 1.1.

1.4.2 Starting from Wragby Road at the existing A15 roundabout, the road would pass under Hawthorn Road, which would be carried over on a new bridge. A roundabout would be created at the junction of the bypass with Greetwell Road. From there, the bypass would continue south west, crossing over the Lincoln to Market Rasen railway line. It would then cross the River Witham floodplain on an embankment, with a bridge over the North Delph, River Witham, South Delph and Canwick Fen Drain.

1.4.3 To the south of the river, the bypass would cross under the Lincoln to Spalding railway line, after which it would join Washingborough Road at a new roundabout. South of Washingborough Road, the route would run southwards, up Lincoln Edge in cutting, to pass under Heighington Road at the top.

1.4.4 Once at the top of the Lincoln Edge, the bypass would run through agricultural land, approximately mid-way between the villages of Canwick to the west and Branston to the east. A new roundabout would be constructed where the bypass would cross

Lincoln Road. From there, the route would continue in a south-westerly direction to join Sleaford Road at a new roundabout just outside Bracebridge Heath. Bloxholm Lane to the east of the bypass would be diverted to the new roundabout on Sleaford Road. A bridleway bridge would lead from the eastern section of Bloxholm Lane, over the bypass, to join the western section of Bloxholm Lane, which would no longer be a through road for traffic.

1.4.5 Works to side roads would involve the creation of bridges over the bypass for Hawthorn Road and Heighington Road, as well as bridges for non-motorised users at Greetwell Road and Bloxholm Lane. Greetwell Road would be realigned and improved to tie it in to the new roundabout at the bypass. An underpass is proposed for non-motorised users to cross the bypass at Lincoln Road.

1.4.6 A footpath and cycleway would be provided along the length of the route, running to the west of the main carriageway. A ramp would be provided to take non-motorised users off the bypass in the River Witham floodplain, linking to the Sustrans cycleway alongside the River Witham to Lincoln.

1.5 LEGAL BASIS OF THE ENVIRONMENTAL STATEMENT

1.5.1 The size of the project and the potential significance of its environmental effects mean that an Environmental Impact Assessment (EIA) is required, under the *Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999* (Statutory Instrument 293), as amended by the Town and Country Planning (Environmental Impact Assessment) (Amendment) (England) Regulations 2008. These Regulations implement the European Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, as amended by Council Directive 97/11/EC.

1.5.2 The EIA for the LEB has been carried out in accordance with the guidance set out in the *Design Manual for Roads and Bridges* (DMRB). DMRB sets out general principles for EIA on highway schemes.

1.5.3 EIA is a staged process. This Environmental Report presents the findings of the Stage 3 assessment. Stage 1 and Stage 2 assessments have already been completed for this scheme. At Stage 1, comparisons were made between the predicted environmental impacts of a range of possible route corridors, and at Stage 2, comparisons were made between the predicted environmental impacts of three possible route options. Following the completion of the Stage 2 assessment and a period of public consultation, a preferred option has been selected and taken forward to Detailed Design. This Stage 3 assessment is a full EIA of the preferred option.

1.5.4 DMRB specifies a list of specialist topics to be considered in any highways-related EIA, with guidance on the methods and approaches to be used for each topic. Most of the other topics also use other, discipline-specific guidance published by other government departments, public bodies and professional institutions. The topics considered are:

- Air Quality;
- Noise and Vibration;
- Cultural Heritage;
- Landscape and Visual Impacts;
- Ecology and Nature Conservation;
- Road Drainage and the Water Environment;
- Soils and Geology;

- Land Use;
- Pedestrians, Equestrians, Cyclists and Community Effects;
- Vehicle Travellers; and
- Disruption due to Construction.

1.5.5 Where appropriate, the potential environmental effects of both the construction and operation of the proposed scheme have been assessed.

1.5.6 Further information on the approach and methods used in the EIA is given in Chapter 4 of this Environmental Statement.

1.6 THE EXISTING ENVIRONMENT

1.6.1 Air Quality in some parts of Lincoln is poor, and so an Air Quality Management Area (AQMA) has been designated for a number of streets in Lincoln. Traffic congestion along these streets contributes to the poor local air quality. Air Quality in the area of the proposed bypass is well within acceptable limits.

1.6.2 Traffic noise is associated with existing vehicular routes through Lincoln. Noise levels are currently relatively low in the area to the east of Lincoln.

1.6.3 The River Witham Valley bottom was a major focus of prehistoric and later ritual activity. Archaeological remains in the valley bottom have been shown to be particularly well preserved.

1.6.4 Lincoln was one of the key towns of Roman Britain. Sites of Roman date within the study area include several settlements, possible Roman ironstone mines, artefact scatters and individual findspots.

1.6.5 To the east of the proposed bypass, parts of the shrunken medieval and later settlement of Greetwell survive as earthworks and are preserved as a Scheduled Ancient Monument.

1.6.6 The land along the northern and southern sections of the proposed bypass is raised on plateau areas. The land drops down in the centre to the Witham Valley, which flows west to east through the Lincoln Gap. The steep slope of the Lincoln Edge forms the southern side of the valley.

1.6.7 Five sites within the study area have been designated by the local authorities as Sites of Nature Conservation Interest (SNCIs) or Local Wildlife Sites (LWSs). These are:

- Greetwell Wood SNCI;
- Canwick Hall Wood SNCI;
- Washingborough Junction SNCI;
- Witham Corridor LSW; and
- Greetwell Junction Railway Embankment LWS.

1.6.8 The study area includes a range of habitats, as follows:

- Hedgerows;
- Arable land;
- Amenity grassland;
- Improved grassland;
- Neutral grassland – semi improved;

- Marshy grassland;
- Tall ruderal;
- Broadleaved semi-natural woodland;
- Broadleaved plantation;
- Mixed plantation;
- Dense scrub;
- Buildings;
- Bare ground; and
- Water.

1.6.9 The River Witham and the South Delph are both classed as main rivers by the Environment Agency. Both flow west to east through the Witham Valley. The North Delph and Canwick Fen Drain are non-main rivers which also flow west to east through the valley.

1.6.10 The study area is underlain by Jurassic rock comprising, from north to south, Lias Clay, Northampton Sands and Ironstone, and Lincolnshire Limestone. The River Witham has cut through the Lincolnshire Limestone formation to form the Lincoln Gap.

1.6.11 The Lincolnshire Limestone is a major aquifer, meaning that it is regionally important and supports large drinking water supplies, whilst the Northampton Sand and Ironstone and the alluvium are classified as minor aquifers, and so are of local importance.

1.6.12 Greetwell Quarry has been designated as a Site of Special Scientific Interest (SSSI) for its geological interest as an outcrop of Lincolnshire Limestone.

1.6.13 The study area includes residential properties and community facilities in the villages of North Greetwell, Canwick, Washingborough, Heighington, Branston and Bracebridge Heath and on the eastern edge of Lincoln, in addition to a number of individual farm units.

1.6.14 Most of the land in the area of the proposed bypass is agricultural land, with the majority of it being classed under the Agricultural Land Classification (ALC) as grades 2 and 3a, defined as ‘best and most versatile land’.

1.6.15 A number of public rights of way are found within the study area, including public footpaths, bridleways, cycle routes and greenway routes. The most popular non-motorised user route between the City of Lincoln and settlements to the east of the city is the Sustrans route along the River Witham.

2 DETAILED DESCRIPTION OF THE SCHEME

2.1 ROUTE

2.1.1 The proposed LEB would provide a 7.85km dual carriageway, linking the existing northern relief road at the junction of the A15 and A158 Wragby Road in the north to the A15 Sleaford Road in the south. Improvements would also be made to the existing Greetwell Road between the proposed Greetwell Road roundabout and its junction with Outer Circle Road.

2.1.2 A separate 3.0m wide combined cycle and pedestrian right of way would be provided along the full length of the scheme which would link up with existing public rights of way. There would be additional provisions for equestrians in the form of a widened verge. A number of further non-motorised user facilities are proposed and detailed below.

2.1.3 The road has been designed to allow for a 70mph speed limit.

2.1.4 A new four arm roundabout is to be constructed to replace the existing roundabout at the A158 Wragby Road / A15 junction. From here the bypass would be at existing ground level adjacent to the roundabout before falling into a cutting below the existing level of Hawthorn Road. Hawthorn Road would be raised on embankments to cross the bypass on an overbridge. No junction would be formed at this location.

2.1.5 The LEB would then pass southward; mainly in cutting and adjacent to the edge of Greetwell Quarry before being carried on embankment over the eastern corner of the limestone quarry cavity and on towards its junction with Greetwell Road. Within this section the minor road, Greetwell Fields, is to be stopped up with alternative provision made for access.

2.1.6 At Greetwell Road, a four arm roundabout is proposed. A pedestrian / cycle bridge would be provided over the bypass, to the north of the roundabout.

2.1.7 Between the bypass and Outer Circle Road junction, Greetwell Road would be realigned to remove the dip and bend that the existing road follows.

2.1.8 From the junction with Greetwell Road the proposed bypass would continue south passing over an embankment and a new structure over the Lincoln to Market Rasen Railway. The LEB then turns south-westerly and falls gently into the Witham Valley on an embankment towards the River Witham and the adjacent watercourses.

2.1.9 A five span viaduct is proposed to carry the LEB over the River Witham and the adjacent watercourses. A pedestrian / cycle bridge is proposed to link the pedestrian and cycle facility adjacent to the LEB to the Sustrans cycle route which runs along side the river.

2.1.10 The LEB would then pass under the Lincoln to Spalding Railway, and immediately to the south, would connect to the B1190 Washingborough Road via a new four arm roundabout. From here the bypass would travel in a south-easterly direction while climbing in a deep cutting and passing under Heighington Road. Heighington Road would be carried over the bypass along its existing alignment on a new bridge. No junction would be provided with the LEB at this location. The LEB turns to travel south west to form a new four arm roundabout at its junction with the B1188 Lincoln Road.

2.1.11 A pedestrian / cycle underpass is proposed to cross the bypass just north of the roundabout junction with the B1188 Lincoln Road.

2.1.12 The route would then continue south-westwards towards the A15 Sleaford Road. A new three arm roundabout would be formed at the junction with the A15 Sleaford Road, south of Bracebridge Heath. Bloxholm Lane to the east of the bypass would be diverted to join Sleaford Road at the roundabout. A bridleway bridge would cross over the bypass to link both sections of Bloxholm Lane.

2.2 JUNCTIONS

2.2.1 The LEB running from the A158 Wragby Road to the A15 Sleaford Road would contain five junctions, these are:

- A158 Wragby Road roundabout;
- Greetwell Road roundabout;
- B1190 Washingborough Road roundabout;
- B1188 Lincoln Road roundabout;
- A15 Sleaford Road roundabout.

2.2.2 The A158 Wragby Road roundabout would be a four arm roundabout with an inscribed circle diameter (ICD) of 100m.

2.2.3 Greetwell Road roundabout would be a four arm roundabout with the LEB running north to south and Greetwell Road running east to west through the junction. It would have an ICD of 80m.

2.2.4 The B1190 Washingborough Road roundabout would be a four arm roundabout with an inscribed circle diameter of 95m.

2.2.5 The B1188 Lincoln Road Roundabout would be a four arm roundabout with an inscribed circle diameter of 85m.

2.2.6 The A15 Sleaford Road Roundabout would be a three arm roundabout with an inscribed circle diameter of 85m.

2.3 STRUCTURES

2.3.1 The construction of the LEB would include 10 structures between the A158 Wragby Road junction and the A15 Sleaford Road junction.

2.3.2 The structures would include:

- Three overbridges;
- Two underbridges;
- Three pedestrian / cycleway bridges;
- One pedestrian / cycleway underpass; and
- One retaining wall.

Hawthorn Road Overbridge

2.3.3 The proposed Hawthorn Road overbridge is a two-span continuous concrete bridge carrying the unclassified Hawthorn Road over the proposed LEB. The bridge superstructure comprises precast concrete beams acting compositely with an in situ reinforced concrete slab. The bridge deck would be made integral with the reinforced concrete intermediate pier and abutments. Reinforced soil wingwalls parallel to the road above would be provided.

Greetwell Road Pedestrian / Cycle Bridge

2.3.4 The proposed Greetwell Road pedestrian / cycle bridge is a single span steel bridge carrying a combined footway and cycleway over the proposed LEB. The superstructure would comprise two steel trusses with no plan bracing connecting the top of each truss. The steel trusses would be supported on two reinforced concrete abutments.

Lincoln to Market Rasen Railway Underbridge (bypass over)

2.3.5 The proposed Lincoln to Market Rasen Railway underbridge is a single span steel composite bridge to carry the proposed LEB over the Lincoln to Market Rasen railway line and an accommodation access track. The bridge superstructure would comprise unpainted weathering steel plate girders to act compositely with an in situ reinforced concrete deck slab. The substructure would comprise reinforced concrete abutments.

Pylon Retaining Wall

2.3.6 The proposed solution for this retaining wall is a steepened reinforced soil slope.

River Witham Viaduct

2.3.7 The proposed River Witham viaduct is a five-span continuous underbridge carrying the LEB over the River Witham, south and north Delphs, a Sustrans cycleway, an access track and part of the flood plain. The bridge superstructure would comprise unpainted weathering steel plate girders acting compositely with an in situ reinforced concrete deck slab. The substructure would comprise reinforced concrete circular columns for the intermediate supports and reinforced concrete abutments. Reinforced concrete wingwalls parallel to the main carriageway of the bypass would be provided.

Sustrans (South Delph) Pedestrian / Cycle Bridge

2.3.8 The proposed Sustrans footbridge would be a single span steel bridge to carry the diverted Sustrans cycleway over the South Delph. The superstructure would comprise two steel trusses supported on two small reinforced concrete abutments.

Lincoln to Spalding Railway Overbridge (bypass under)

2.3.9 The proposed Lincoln to Spalding Railway overbridge would be two span reinforced concrete structures carrying the Lincoln to Spalding Railway line over the proposed LEB. The bridge would comprise a twin cell box type reinforced concrete structure with reinforced concrete wingwalls. It is envisaged that the twin cell box structure would be constructed adjacent to the railway embankment on a pre-constructed thrust base to enable the bridge to be slid into its final position during a railway possession.

Heighington Road Overbridge

2.3.10 The proposed Heighington Road overbridge is a two-span continuous concrete bridge carrying Heighington Road over the proposed LEB. The bridge superstructure would comprise precast concrete beams composite with an in situ reinforced concrete slab. The bridge deck would be made integral with the reinforced concrete intermediate pier and abutments. Reinforced soil wingwalls parallel to the road above would be provided.

B1188 Lincoln Road Pedestrian Underpass

2.3.11 The proposed Lincoln Road underpass is a reinforced concrete box structure with splayed reinforced soil wingwalls carrying the proposed LEB over a combined footway and cycleway.

Bloxholm Lane Pedestrian / Cycle Bridge

2.3.12 The proposed Bloxholm Lane footbridge would be a single span steel bridge carrying a combined footway and cycleway over the proposed LEB. The superstructure comprises two steel trusses. The steel trusses are supported on two reinforced concrete abutments.

2.4 LIGHTING

2.4.1 In accordance with TD 16/07, Geometric Design of Roundabouts, of DMRB Volume 6, all roundabouts would be lit. A Departure from Standard to TD 34/07, Design of Road Lighting for the Strategic Motorway and All Purpose Trunks Road Network, of DMRB Volume 8, has been approved by the Highway Authority. This departure relaxes the street lighting provision on the approach to the roundabout junctions along the bypass such that 322.5m would be lit (215m (stopping sight distance) x 1.5, rather than 295m (SSD) x 1.5).

2.4.2 With regards to infill lighting, TD 34/07 states that if the gap between lit carriageway is less than 4 x SSD then lighting shall be provided. As a result, the section between Greetwell Road and the A1190 Washingborough Road would be lit.

2.5 DRAINAGE

2.5.1 LEB intercepts several natural catchments along its route. Intercepting drainage would be provided in the form of ditches to limit the frequency and severity of flooding incidents caused by run-off from beyond the highways boundary.

2.5.2 The intercepting drainage would generally follow the topography of the existing ground at the toe of the embankment or top of the cutting slope and would be kept separate from highway drainage. The intercepting drainage would convey the natural catchment run-off to the appropriate watercourse, with natural drainage patterns maintained as far as possible. It is considered that pollution control and attenuation measures are not required.

2.5.3 There are six watercourses that are to be culverted as part of the LEB scheme. These include Reepham Beck, Wragby Road Ditch South, Greetwell Fields Drain, Greetwell Beck, a tributary of Branston Brook and Canwick Fen Drain. Additional culverts would be provided to allow continuity of intercepting drainage.

2.5.4 Due to the sensitivity of watercourses within the study area, allowable discharges from the highways drainage network would be limited to existing greenfield run-off rates.

2.5.5 The highways drainage philosophy for LEB includes:

- The speedy removal of surface water from the carriageway to provide safety and minimum nuisance through positive drainage;
- Use of a sealed drainage system which allows for the containment of accidental spillage;
- Treatment of the highways drainage water prior to discharge to surface water wherever necessary; and

- Attenuation prior to outfall to surface water to limit the discharge to equivalent green field run-off rates as described in Section 3.2.

2.5.6 All highway drainage would discharge to surface water via attenuation ponds. These ponds would be lined with impermeable liners. Discharge to groundwater was considered for the southern section of the scheme but was rejected on the basis of high groundwater levels proved by ground investigation.

2.5.7 A two cell arrangement is to be provided at all attenuation pond locations. Both cells would be lined and Cell 1 would include an isolation facility to contain the ''first flush'' in case of accidental spillage. Cell 1 and Cell 2 would act as sediment ponds

2.5.8 Cell 1 has been designed to have a minimum 24-hour retention period. This is to maximise the removal of suspended solids.

2.5.9 Particular attention has been given to the discharge to the tributary of Branston Brook which is smaller than the other watercourses and has licensed surface water abstractions downstream of the discharge point. At this outfall, Cell 1 has been designed as a surface flow wetland in accordance with HA 103/06 and with appropriate planting for contaminant removal.

2.6 PERMANENT LANDTAKE

2.6.1 The area within the proposed highway boundary would be 67 hectares.

2.7 DIVERSION OF STATUTORY SERVICES

2.7.1 A number of public utilities exist within the route study area and some may be affected. It should be noted, as highlighted in the returns from utility providers, the information is indicative only and their accuracy should not be relied upon.

2.7.2 The extent of any diversions has yet to be confirmed between the Local Authority, the contractor and the public utility companies.

E-On (Electricity)

2.7.3 Overhead electrical services of up to 132KV cross the routes at a number of locations.

2.7.4 Underground 33kV cables are present traversing the proposed alignment between Hawthorn Road and Greetwell Road. These then cross Greetwell Road to the west of the proposed junction with the scheme before crossing under the Lincoln to Market Rasen Railway and veering towards the city.

2.7.5 132kV overhead lines traverse the route between Hawthorn Road and Greetwell Road. These then cross the south eastern corner of Greetwell Quarry where a pylon is situated upon a spur of non-excavated rock within the quarry, before crossing Greetwell Road West and the Lincoln to Market Rasen Railway before then turning towards the city.

2.7.6 To minimise the diversionary works required it is proposed to construct a retaining wall adjacent to the pylon at chainage 2075 to limit the footprint of the adjacent embankment.

2.7.7 Overhead 33kv cables cross over the existing Washingborough road at the proposed new Washingborough Road roundabout junction.

2.7.8 Another overhead cable crosses the proposed bypass three times between Washingborough Road and Bloxholm Lane.

Anglian Water

2.7.9 Three water mains have been identified as crossing the study area. The first is a 125mm main runs easterly along the alignment of Washingborough Road. The second is a 9 inch main runs north easterly from Bracebridge Heath towards Washingborough. The third is a 300mm ductile iron main runs east across the A15 Sleaford Road south of Bracebridge Heath.

2.7.10 Two foul drains have been identified as crossing the routes. The first is a 150mm drain north of Hawthorn Road which runs from The Chase housing development north easterly towards Wragby Road. The second is south of Washingborough Road, where two 12 inch pipes run east from the sewerage works towards Washingborough. It is envisaged that diversion works are likely at all of these locations.

British Telecom (Openreach)

2.7.11 Underground plant owned by British Telecom (BT) is present along: Wragby Road, under the existing junction with the A15; Greetwell Road; B1190 Washingborough Road; B1188 Lincoln Road; Bloxholm Lane and A15 Sleaford Road. BT have stated that some diversions may be required as part of the scheme.

Transco (Gas)

2.7.12 Underground plant, owned by Transco is present along: Wragby Road and the existing junction with the A15; Hawthorn Road and Bloxholm Lane.

2.7.13 Transco have stated that diversion or protection works may be required at all of the above locations.

2.8 CONSTRUCTION

2.8.1 The construction period for the bypass is anticipated to be approximately 36 months commencing in 2013 for a completion within 2016. There are, however, some advance works that may be carried out before the start of the main construction period such as diversion of existing services, site clearance, habitat creation works and archaeological mitigation works.

2.8.2 The site clearance and habitat creation works would be carried out to avoid the bird nesting and mammal breeding season.

2.8.3 Construction traffic would be restricted to use only A Class Roads to enter and leave Lincoln i.e. the A1434, A158, A57, A46 and the A15. Within the area adjacent to the construction site, permitted access routes would be determined through discussion with the contractor and the Highway Authority to minimise disruption and maximise safety to both the general public and construction work force.

2.8.4 In addition temporary access routes would be required to gain access to the site between the Lincoln to Market Rasen Railway and Lincoln to Spalding Railway lines for construction works prior to the construction of the two new railway bridges. Again, discussion between the contractor and the Highway Authority would take place to minimise disruption to both general public and ecological habitat.

2.8.5 As these routes would cross private land, licences would be required. These temporary access routes would be restricted in use to the following:

- Regular daily use would be limited to cars and light vans only; and
- Access for larger vehicles and plant would only be permitted by agreement with the Highway Authority and after consultation with affected residents, landowners and businesses.

2.8.6 To allow the movement of materials gained from the cutting to the south of Washingborough Road to the site of the embankment between the River Witham and the Lincoln to Market Rasen Railway Line it would be necessary to construct a temporary structure over the River Witham. Licences would be required for the land needed for the erection of this temporary bridge to the side of the proposed route.

2.8.7 To enable construction of the bridges at Hawthorn Road and Heighington Road, and the improvements to Greetwell Road, temporary road closures would be sought from the Highway Authority to enable more efficient and safer construction methods.

2.9 WASTE AND RESOURCES

2.9.1 A site waste management plan (SWMP) would be developed in advance of the construction phase to ensure that building materials would be used efficiently, re-use and recycling would be maximised, and waste disposal would be in accordance with legal requirements.

2.9.2 Rock excavated to create the cuttings would be re-used in the construction of the scheme. No excess rock would remain, and therefore there would be no need for off-site disposal.

3 CONSIDERATION OF ALTERNATIVES

3.1 ROUTE CORRIDORS CONSIDERED AT STAGE 1

3.1.1 During the Stage 1 assessment, carried out in 2007, five potentially feasible corridors were assessed. To the north of Washingborough Road, the corridors were constrained by Greetwell Quarry, Greetwell Hall, Scheduled Ancient Monuments and the Conservation Area of Washingborough. Hence the corridors in this area all followed the same line. To the south of Washingborough Road, the five corridors diverged.

3.1.2 The corridors were identified as follows:

- Blue Corridor – 7.4km long, terminating north of Waddington Airfield;
- Orange Corridor – 7.8km long, terminating north of Waddington Airfield;
- Green Corridor – 9.2km long, terminating south of Waddington Airfield;
- Brown A Corridor – 7.4km long, terminating north of Waddington Airfield; and
- Brown B Corridor – 9.5km long, terminating south of Waddington Airfield.

3.1.3 The Stage 1 assessment found that all five corridors would have similar environmental impacts, although the impacts of the Blue and Brown A Corridors would be slightly less adverse than the impacts of the other corridors. These corridors were used as the basis for the route options considered at Stage 2.

3.1.4 The results of the Stage 1 assessment were presented in the *Lincoln Eastern Bypass Stage 1 Assessment Report* (Jacobs and Lincolnshire County Council, February 2008).

3.1.5 Table 3.1 is taken from the Stage 1 Assessment Report, and provides an overview of the impacts of the five corridors.

Table 3.1: Summary of Environmental Impacts identified at Stage 1

Impact Area	Effects	Units	Blue Corridor	Orange Corridor	Green Corridor	Brown A Corridor	Brown B Corridor
Air Quality	Sensitive properties	Number	None	None	None	None	None
	Total properties	Number	7	c.32	c.30	5	5
	Change in air quality within AQMAs	-	Positive	Positive	Positive	Positive	Positive
	In terms of air quality, the two brown corridors would be the preferred options						
Cultural Heritage	Legally Designated Sites	Number	2	3	3	2	2
	Non-Legally Designated Sites	Number	67	65	57	58	61
	Total	Number	69	68	60	60	63
	At this stage, there is no preferred corridor based on cultural heritage						
Disruption due to Construction	Residential properties affected	Number of properties within corridor	7	c.32	c.30	5	5
	Public rights of way affected	Numbers and types	See section on Pedestrians, Cyclists, Equestrians and Community Effects				
	Existing roads affected by the corridors	Number	9	9	11	9	10
	At this stage, the Brown A corridor is the preferred option in terms of disruption due to construction						
Ecology and Nature Conservation	Designated sites	Number	2	2	2	2	2
	At this stage, there is no preferred corridor in terms of ecology						
Landscape and Visual Effects	Landscape Impact	Summary	Minimal cuttings and embankments required. Minimal intrusion into wider countryside.	Disruption of a relatively tranquil and remote area around Ashfield.	Long route, hence increased landscape impacts. Disruption to local road and track network	Isolates small areas of farmland	Isolates small areas of farmland. Long route, hence increased landscape impacts.

Impact Area	Effects	Units	Blue Corridor	Orange Corridor	Green Corridor	Brown A Corridor	Brown B Corridor
	Visual impact	Significance	Slight adverse over the blue section, with moderate adverse over the purple section	Moderate Adverse	Severe Adverse (with moderate adverse along purple section)	Moderate Adverse	Moderate Adverse
	At this stage, the Blue corridor is the preferred option in terms of landscape and visual amenity						
Land Use	Properties affected	Number	7	c.32	c.30	5	5
	Listed buildings	Number	3	2	4	2	2
	Agricultural land affected	Land classification	2	2	2 and 3	2	2 and 3
	At this stage, there is no preferred corridor in terms of land use						
Traffic Noise and Vibration	Noise reduction	Locations	Existing A15 and other routes within Lincoln	Existing A15 and other routes within Lincoln	Existing A15 and other routes within Lincoln	Existing A15 and other routes within Lincoln	Existing A15 and other routes within Lincoln
	Noise increase within corridor	Number of properties within corridor	7	c.32	c.30	5	5
	Noise increase on roads leading to and from the corridor	Number of access roads	5	5	5	5	5
	At this stage, the Brown A and B corridors are preferred, based upon traffic noise and vibration						
Pedestrians, Cyclists, Equestrians and Community Effects	Public rights of way affected	Public rights of way within corridor	6 footpaths 2 bridleways 1 equestrian route 3 cycle routes 3 quiet lanes	5 footpaths 2 bridleways 1 equestrian route 3 cycle routes 3 quiet lanes	6 footpaths 3 bridleways 1 equestrian route 3 cycle routes 3 quiet lanes	5 footpaths 2 bridleways 1 equestrian route 3 cycle routes 3 quiet lanes	5 footpaths 3 bridleways 1 equestrian route 3 cycle routes 3 quiet lanes
	At this stage, there is only a slight difference between the options						

3.2 ROUTE OPTIONS CONSIDERED AT STAGE 2

3.2.1 Three potential routes were identified based on the Blue and Brown A Corridors identified during Stage 1, and were subject to a comparative assessment at Stage 2.

3.2.2 The three routes were known as X, Y and Z. The northern sections of all three routes, between Wragby Road and Washingborough Road, were identical. Further south, the routes varied in alignment, although all three routes joined the A15 at the same proposed junction, to the north of Waddington Airfield.

3.2.3 Route X was the most westerly route, Route Z was the most easterly route, and Route Y was between them. All routes were to the east of the villages of Canwick and Bracebridge Heath and to the west of Branston. The three routes are shown on Figure 3.1.

3.2.4 The Stage 2 Environmental Assessment found that, as the three routes were in close proximity to each other and were of similar lengths, they would have similar beneficial and adverse environmental impacts. Route Z would be marginally preferred in terms of soils and geology, air quality and water quality, while Route X would be marginally preferred in terms of landtake, landscape and visual amenity.

3.2.5 The results of the Stage 2 Environmental Assessment were presented in the *Lincoln Eastern Bypass Stage 2 Environmental Assessment Report* (Jacobs and Lincolnshire County Council, January 2008)

3.2.6 Table 3.2 summarises the environmental effects of the route options assessed at Stage 2.

3.2.7 At the end of the Stage 2 Assessment, the findings were used for a public consultation exercise, leading to the identification of the preferred route option to be the subject of a full Environmental Impact Assessment (EIA) at Stage 3.

Table 3.2: Summary of Environmental Effects from Stage 2

	Measure	Route Option X	Route Option Y	Route Option Z
Air Quality	Properties with an improvement in air quality	3079	2800	3079
	Properties with no change	198	562	323
	Properties with a deterioration in air quality	1034	947	902
	Air Quality assessment score	-517.00	-496.14	-537.74
	Rank	**3**	**2**	**1**
Noise and Vibration	Properties within 100m of route	34	32	31
	Rank	**3**	**2**	**1**
Cultural Heritage	Known cultural heritage sites affected	88	87	80
	Risk of unknown archaeological sites being discovered	Least risk	-	Greatest risk
	Rank	No preferred option based on cultural heritage at this stage		
Landscape and Visual Impacts	Effects arising from northern section	Major effects would arise, particularly in the Witham Valley. The route options are identical along this section.		
	Effect on southern slope	Cutting is at an angle to the slope and may be screened	Cutting is at an angle to the slope and may be screened	Cutting is direct and difficult to screen. Impact on open countryside to west of Branston.
	Rank	**1**	**2**	**3**
Ecology and Nature Conservation	**Rank**	No preferred option based on ecology at this stage, as the effects are broadly similar between options, and all effects are of moderate significance. This is unlikely to change following additional survey and assessment.		
Road Drainage and the Water Environment	Impacts on surface water	Low significance	Low significance	Low significance
	Impacts on flood risk	No change	No change	No change
	Rank (with mitigation in place)	**2**	**3**	**1**

	Measure	Route Option X	Route Option Y	Route Option Z
Soils and Geology	Significant constraints	Greetwell Quarry Geological SSSI, Lincoln Edge escarpment, and superficial deposits associated with surface watercourses.	Greetwell Quarry Geological SSSI, Lincoln Edge escarpment, and superficial deposits associated with surface watercourses.	Greetwell Quarry Geological SSSI, Lincoln Edge escarpment, and superficial deposits associated with surface watercourses.
	Rank	**2**	**2**	**1**
Land Use	Impact on private property, land used by the community and development land	Neutral	Neutral	Neutral
	Landtake	38.4 hectares	40.4 hectares	39.5 hectares
	Rank	**1**	**3**	**2**
Pedestrians, Equestrians, Cyclists and Community Effects	Severance	No significant severance caused. Reduced severance in city centre, new crossing of River Witham and links to rights of way	No significant severance caused. Reduced severance in city centre, new crossing of River Witham and links to rights of way	No significant severance caused. Reduced severance in city centre, new crossing of River Witham and links to rights of way
	Rank	**1**	**2**	**2**
Vehicle Travellers	**Rank**	**1**	**2**	**2**
Disruption due to Construction	Number of residential properties within 100m	34	32	31
	Rank	**3**	**2**	**1**
Policies and Plans	Net effect	Positive	Positive	Positive
	Landtake (links to environmental protection policies)	38.4 hectares	40.4 hectares	39.5 hectares
	Rank	**1**	**3**	**2**

3.3 PREFERRED OPTION

3.3.1 Route Z was identified by Lincolnshire County Council as the preferred option for the Lincoln Eastern Bypass, following the Stage 2 assessment and public consultation.

3.3.2 Following the announcement of the preferred route, the design development process began, and the current proposals have been developed from Route Z. The Environmental Impact Assessment has been carried out alongside the design development, with close liaison with the design team to ensure that environmental considerations have been addressed where possible in the design of the road.

4 APPROACH TO ASSESSMENT

4.1 APPROACH TO ENVIRONMENTAL IMPACT ASSESSMENT

4.1.1 In keeping with the requirements of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999, the potential environmental effects of both the construction and operation of the proposed road have been predicted for each EIA topic by undertaking the following generic stages:

- Determining the baseline conditions relevant to that topic area and identifying potential environmental receptors;
- Determining the sensitivity and importance of each receptor;
- Assessing the magnitude of the change to the receptor that is likely to occur as a result of both the construction and operation of the proposed road;
- Determining the likely significance of the predicted effect on the receptor;
- Provision of appropriate measures to mitigate, reduce or offset any significant adverse environmental effects; and
- Provision of details of any residual environmental effects that may be present following the adoption of mitigation.

4.1.2 Where appropriate, the potential environmental effects of both the construction and operation of the proposed road have been assessed in accordance with current Highways Agency environmental assessment guidance including Volume 11 of DMRB.

4.1.3 Whilst the assessment has been informed by DMRB, the scheme is not strictly required to follow such guidance, as the proposed bypass would be operated by Lincolnshire County Council, which is the highway authority, rather than the Highways Agency.

4.1.4 In addition, the EIA has been undertaken in accordance with the following guidance and legislation:

- European Commission 1997 Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the Assessment of the Effects of Certain Public and private Projects on the Environment;
- Department of the Environment 1995 Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide, London, HMSO;
- European Commission 2001 Guidance on EIA: Screening;
- European Commission 2001 Guidance on EIA: Scoping;
- Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999; and
- Town and Country Planning (Environmental Impact Assessment) (England) (Amendment) Regulations 2008.

4.2 OBJECTIVES OF THE EIA PROCESS

4.2.1 The specific purpose of the Environmental Statement is defined in Chapter 1. The broader objectives of the EIA process as a whole are to:

- Facilitate the consideration of environmental effects and opportunities in the development of the scheme design, through a process of iterative feedback; and
- Ensure that decision-making about the project is based on sound environmental information and takes environmental effects into account.

4.3 STUDY AREA

4.3.1 Study areas have been individually defined for each environmental topic, according to the geographic scope of the potential impacts relevant to that topic or to the information required to assess these impacts

4.4 EXISTING, BASELINE AND FUTURE CONDITIONS AND THE 'DO MINIMUM SCENARIO'

4.4.1 In order to identify the effects of the proposed development on the environment, it is important to understand the pre-existing environment (the 'baseline conditions'). Understanding the baseline allows the measurement of changes that would be caused by the development.

4.4.2 The 'baseline' for measurement of environmental effects is not the situation as it exists now, but the situation as it would exist immediately before an impact occurs. For this purpose, environmental impacts can be divided into two groups:

- Construction impacts – i.e. those caused by the construction of the scheme; and
- Operational impacts – i.e. those caused by the presence or operation of the scheme after it has been opened to traffic.

4.4.3 Construction impacts can include temporary effects that would cease as soon as construction is finished (e.g. the effect of construction traffic or the risk of pollution from accidental spills of fuel etc. for construction plant). They can also include permanent effects, such as the destruction of protected ecological or archaeological sites or landscape features.

4.4.4 Operational impacts generally include the effects of traffic using the road (e.g. air and water pollution or increased noise). They can also include effects caused simply by the presence of the road in the landscape (e.g. visual impacts or flood risk).

4.4.5 The identification of baseline conditions must take into account predicted changes that would occur between the completion of the EIA process and the construction or opening of the scheme, and that are entirely independent of the proposed scheme. Such changes could include, for example, predicted growth in traffic levels, other planned changes in the highway network, or land-use changes (e.g. construction of new developments for which planning permission has already been granted). Identification of the baseline therefore involves two stages of work:

- First identify the existing situation; then
- Determine how likely it is to change before implementation of the scheme

4.4.6 The baseline for impacts for the construction of the proposed LEB is therefore the situation as it is predicted to be at the start of construction in 2013. For impacts that would be caused by the operation of the new road after it is open, the proposed opening year of 2016 is used. The design year is 2031, which is 15 years after opening.

4.5 DATA GATHERING AND CONSULTATION

4.5.1 The scope of data gathering and consultation carried out is defined in each of the specialist chapters. However, in most cases the work can be broken down into four elements:

- Consultation of third party organisations to obtain factual information;
- Consultation of third party organisations (including Statutory Consultees) for comment on the scope of work required, on the prediction and assessment of impacts, and in relation to mitigation requirements;
- Desk-based surveys; and
- Surveys carried out for the EIA or for other aspects of the project.

4.5.2 Further information on third party consultations is included in Chapter 5.

4.6 IDENTIFYING IMPACTS – DIRECT, INDIRECT AND CUMULATIVE

4.6.1 The Environmental Statement considers potential environmental effects that have been identified through specialist studies carried out by the EIA team or through consultation with third parties.

4.6.2 The Environmental Statement considers both direct and indirect effects.

4.6.3 Cumulative effects (Chapter 18) are considered through the following questions.

- Would any individual receptor or receptor group experience multiple impacts of the same type from this and other transport-related projects?
- Would any individual receptor or receptor group experience several different types of effect from this project?
- Would different impacts occur that would interact and therefore alter their significance?
- Would the effects of this project on any individual receptor or receptor group compound similar effects from another recent project, or would they be compounded by the effects of a future project already planned?
- Would the project interact with planned non-transport developments, or stimulate proposals for such developments, in ways that would compound its effects?
- Would any cumulative effects that are identified be temporary or permanent?

4.7 SIGNIFICANCE OF IMPACTS

4.7.1 The significance of an environmental effect is a function of the value or sensitivity of the receptor and the magnitude or scale of the impact.

4.7.2 The assessment has been carried out with reference to DMRB. DMRB provides terminology and associated criteria for the description of both sensitivity and magnitude for most topics. However, the guidance given in DMRB does not necessarily use the same scales, terminology or criteria for all disciplines.

4.7.3 The significance of any particular impact can typically be assessed through the use of a matrix, with the sensitivity of the affected receptor on one axis and the magnitude of impact on the other axis. A typical matrix for this purpose is presented below (Table 4.1 conforming to Table 2.4 in Volume 11, Section 2, Part 5 of DMRB).

Table 4.1: A Typical Significance Matrix

	Magnitude				
Value / Sensitivity	**No Change**	**Negligible**	**Minor**	**Moderate**	**Major**
Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
Medium	Neutral	Neutral or Slight	Slight	Slight or Moderate	Moderate or Large
Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

4.7.4 In some cases, the significance of impact identified using the matrix may be adjusted to take account of other qualitative criteria. Wherever this is done, a reasoned justification for the alteration is given.

4.7.5 If for any topic the significance of impact has been assessed using a variation on the above method, this is explained in the relevant chapter.

4.8 MITIGATION MEASURES, ENHANCEMENTS AND RESIDUAL IMPACTS

4.8.1 Where there would be adverse environmental effects, mitigation measures have been proposed. Impacts that would still occur with mitigation measures in place are referred to as residual impacts.

4.8.2 Enhancements (i.e. measures to improve the environment, rather than to mitigate adverse impacts) are also taken into account, usually as positive impacts in their own right.

4.8.3 Mitigation measures for one environmental impact can sometimes have adverse impacts in their own right – for example increased land-take to accommodate landscaping works. It is therefore always necessary to make decisions about mitigation measures in an integrated way, taking into account any such undesirable effects.

5 CONSULTATION WITH THIRD PARTIES

5.1 INTRODUCTION

5.1.1 During the course of this EIA, consultation has taken place with a number of organisations. Consultation was carried out for a range of purposes, as follows:

- To obtain baseline information;
- To obtain advice or comment on the scope of the EIA work;
- To obtain comments about the potential environmental effects of the proposed work;
- To obtain comments on works potentially required to avoid, reduce or mitigate the potential environmental effects of the proposed works; and
- To engage organisations and individuals most affected by the scheme in the consideration of impacts and in the development of design and mitigation proposals.

5.1.2 The consultees approached fell into four groups:

- Statutory consultation bodies – these comprise public bodies with core responsibilities relating to environmental protection;
- Public bodies or voluntary-sector organisations with responsibilities or interests relating to environmental protection or data collection;
- Public bodies or voluntary-sector organisations whose environmental interests may be affected by the proposed road; and
- Other organisations whose activities may be affected by the proposed road.

5.1.3 Statutory consultees are those that must be consulted in order to comply with the EIA Regulations. There is no requirement to consult these bodies before completing the Environmental Statement, but this is done as a matter of standard good practice. The statutory consultation bodies are:

- Any relevant 'principal council' – in this case Lincolnshire County Council, Lincoln City Council, West Lindsey District Council and North Kesteven District Council;
- The Environment Agency;
- Natural England; and
- English Heritage.

5.2 CONSULATION FOLLOWING THE STAGE 2 ASSESSMENT

5.2.1 Following the Stage 2 assessment, a series of public exhibitions were held in Lincoln and villages to the east of Lincoln, and comments were invited from organisations and individuals.

5.2.2 Statutory consultees were sent a copy of the Stage 2 Environmental Report with an invitation to provide comments.

5.2.3 The comments received were reported in the Lincoln Eastern Bypass Public Consultation Report, published in July 2007, and were taken into account by Lincolnshire County Council in their selection of the preferred route.

5.2.4 Residents living in close proximity to the potential routes expressed personal concerns about how they may be adversely affected, especially in relation to noise, air quality and visual impacts.

5.2.5 Based on questionnaire responses, Route Z received the highest level of support.

5.2.6 The Environment Agency, North Kesteven District Council and the City of Lincoln Council all supported Route Z as the most appropriate.

5.2.7 Following the Stage 2 assessment and consultation, Lincolnshire County Council announced Route Z as the preferred option for the LEB, to go forward to the detailed design stage and to be subject to a full EIA.

5.3 CONSULTATION DURING THE EIA

5.3.1 Most consultations were undertaken in respect of specific environmental topics, although some consultees were approached in relation to more than one topic. Where relevant, consultations in relation to specialist topics are referred to in the appropriate discipline-specific chapters of this Environmental Statement.

6 AIR QUALITY

6.1 INTRODUCTION

6.1.1 Emissions from road traffic can have a significant impact on air quality. Any new road scheme may result in changes to existing traffic flows and/or traffic speeds, thereby affecting air quality. Effects can be either negative or beneficial, depending on whether traffic flows are likely to increase or reduce.

6.1.2 The LEB is a proposed dual carriageway road to link Wragby Road in the north with Sleaford Road in the south. The scheme would involve a crossing of the River Witham, North Delph and South Delph, and junctions with a number of radial routes out of Lincoln.

6.1.3 This chapter includes the following elements:

- An assessment of the effect of the construction process on air quality;
- An assessment of the effects of vehicle emissions from road traffic on local air quality in line with the methodology contained within DMRB;
- An assessment of the effects of vehicle emissions from road traffic on regional air quality, in line with DMRB; and
- A generalised local appraisal based on Transport Analysis Guidance (TAG) Unit 3.3.3

6.1.4 This chapter describes the potential environmental effects of the proposed LEB and the associated improvements regarding air quality, intending to ensure that the environmental impact of the scheme is fully understood and taken into account prior to planning application.

6.2 POLICY AND LEGAL CONTEXT

6.2.1 The Government's Air Quality Strategy (AQS) and Air Quality (England) Standard Regulations 2007 set health based Air Quality Objectives (AQO) for eight specific pollutants. The pollutants covered by the AQS are benzene, 1,3-butadiene, carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particles ($PM_{2.5}$ and PM_{10}) and sulphur dioxide. The AQOs define the level of pollution below which health effects are unlikely to be experienced even by the most sensitive members of the population. The AQOs are reproduced in Table 6.1 below.

6.2.2 The key pollutants considered in this assessment are NO_2 and PM_{10}. These two pollutants are of the most concern with regard to their likelihood of compliance with the AQOs and their effects on human health within the environment.

6.2.3 Local Authorities designate Air Quality Management Areas (AQMAs) in areas where pollution levels are expected to exceed the AQOs. Each AQMA is subject to an Action Plan intended to improve local air quality.

Table 6.1: UK Air Quality Objectives (July 2007)

Pollutant	UK Objectives		
	Concentration	Measured as	Compliance
Benzene	16.25 µg/m³	running annual mean	31st Dec 2003
	5 µg/m³	annual mean	31st Dec 2010
1,3 –	2.25 µ/m³	running annual mean	31st Dec 2003

Pollutant	UK Objectives		
	Concentration	**Measured as**	**Compliance**
Butadiene			
Carbon Monoxide	10 mg/m³	running 8 hour mean	31st Dec 2003
Lead	0.5 µg/m³	annual mean	31st Dec 2004
	0.25 µg/m³	annual mean	31st Dec 2008
Nitrogen Dioxide	200 µg/m³	hourly mean, not to be exceeded more than 18 times a year	31st Dec 2005
	40 µg/m³	annual mean	31st Dec 2005
PM_{10}	50 µg/m³	24 hour mean, not to be exceeded more than 35 times a year	31st Dec 2004
	40 µg/m³	annual mean	31st Dec 2004
$PM_{2.5}$	25 µg/m³	annual mean	2020
All authorities	15% cut in urban background exposure	annual mean	2010-2020

Climate Change

6.2.4 Under the 'Kyoto Protocol' the UK has ratified a legally-binding target to cut greenhouse gas emissions. Carbon dioxide (CO_2) is the most abundant man-made greenhouse gas in the atmosphere[1], and in 2001 it accounted for 85% of UK greenhouse gas emissions[2]. CO_2 emissions are not regulated under EU emission standards, but they are used as the key indicator for assessing the impacts of transport options on climate change.

6.2.5 About 27% of the CO_2 produced in the UK is from road transport. CO_2 is not considered in local air quality assessments, as it is not toxic and causes no adverse environmental effects on a local scale. However, it is included in the regional assessments because of its potential effect on climate change.

6.3 APPROACH AND METHODS

Impact Assessment Methodology of the Construction Phase

6.3.1 The construction of the proposed scheme may result in the short-term release of dust emissions to the atmosphere. Dust can cause a nuisance in the local area and can also cause health problems through inhalation. Dust emissions will vary according to the type of activity being undertaken and the prevailing weather conditions. A qualitative assessment of the main potential sources of emissions and their impacts has been carried out which identifies potential mitigation measures.

[1] www.statistics.gov.uk/StatBase/Expodata/Spreadsheets/D7280.xls
[2] www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7280&Pos=3&ColRank=2&Rank=272

6.3.2 A qualitative assessment can be undertaken with regards to the spatial scope as defined in the Office of the Deputy Prime Minister (ODPM) Minerals Policy Statement 2, Appendix 1A:

6.3.3 *"Dust particles are dispersed by their suspension and entrainment in an airflow. Dispersal is affected by the size of the particles emitted and wind speed as well as their shape and density. Smaller dust particles remain airborne for longer, dispersing widely and depositing more slowly over a wider area. Large dust particles (greater than 30 micrometers (µm)), which make up the greatest proportion of dust emitted from mineral workings, will largely deposit within 100 metres of sources. Intermediate-sized particles (10-30µm) are likely to travel up to 200-500 metres. Smaller particles (less than 10µm) which make up a small proportion of the dust emitted from most mineral workings, are only deposited slowly but may travel 1000 metres or more. Concentrations decrease rapidly on moving away from the source due to dispersion and dilution. Large- and intermediate- sized particles are often referred to as nuisance dust, while small particles (PM_{10}) are associated with effects on human health."*

6.3.4 The spatial scope for nuisance dust impacts can therefore be defined as:

- likely within 100 metres;
- possible between 100 and 500 metres; and
- unlikely beyond 500 metres

6.3.5 A number of sensitive receptors are located within 500 metres of the extent of the construction works. It is therefore possible that construction would create nuisance issues for these receptors. The assessment will pay particular attention to mitigation measures, which will be specified so as to ensure that dust levels are minimised and therefore adverse impacts upon local residents would be avoided. Appropriate steps would be taken by the contractor to minimise dust and mud nuisance during the construction phase.

6.3.6 It is not predicted that the additional traffic due to construction would result in significant increases to traffic on the local road network (+10%) and has therefore not been assessed.

Impact Assessment Methodology of the Operational Phase

Local Assessment

6.3.7 In order to determine the extent to which air quality issues affect the proposed scheme, this assessment considers the methodology contained in the DMRB and Local Air Quality Management Technical Guidance TG (09)[3].

6.3.8 The air quality impacts from road traffic have been assessed using the DMRB Screening method taking into account the following:

- Annual average daily vehicle flows (AADT) and speeds;
- The proportion of heavy duty vehicles (HDVs; i.e. any vehicle with a gross weight greater than 3.5 tonnes, including heavy goods vehicles (HGVs) and coaches);
- Changes in future exhaust emissions due to legislation;
- Road type; and

[3] Part IV of the Environment Act 1995 Local Air Quality Management: Technical Guidance LAQM. TG(09), Defra, updated in March 2009

- Background concentrations.

6.3.9 UK Air Quality Archive presents new background concentration maps for the years 2006 to 2020 for PM_{10}, NOx and NO_2. The various source contributions to the estimated background concentration in each 1 x 1 km grid squares are provided, such that it is possible to remove the sources that are explicitly modelled to avoid double counting the emissions. TG (09) states it is important to use the results for the grid square in which the receptors are located. If a large area is being modelled, then it will be necessary to use different background values for different receptors.

6.3.10 Background concentrations for the assessment years are obtained from the UK air quality archive website[4] and used in the assessment in accordance with TG (09). Background concentrations used in this assessment for air quality predictions are presented in the Baseline Conditions.

6.3.11 The contribution of road traffic emissions to air pollution is considered to be insignificant beyond 200 metres from the roadside. The study area for the local air quality assessment can therefore be defined as a corridor extending up to 200 metres either side of the roads that are predicted to be affected significantly by the proposed LEB.

6.3.12 DMRB considers that significantly affected roads are defined as those roads which meet any of the following criteria:

- Road alignment will change by 5m or more; or
- Daily traffic flows will change by 1,000 AADT or more; or
- HDV flows will change by 200 AADT or more; or
- Daily average speed will change by 10km/hr or more; or
- Peak hour speed will change by 20km/hr or more.

6.3.13 Traffic flow data used in the predictions for all the scenarios assessed in this report has been obtained from Jacobs UK Engineering Ltd. Traffic flow information was provided for all A roads and the majority of B roads within Lincoln city area. Calculations have been undertaken for the following scenarios:

- Baseline 2006;
- Do Minimum 2016 (opening year);
- Do Something 2016;
- Do Minimum 2031 (design year); and
- Do Something 2031.

Significance of Impact

6.3.14 The assessment criteria for air quality adopted for this proposal consists of a comparison with the AQOs. The AQOs are based on an assessment of the effects of each pollutant on public health. Therefore, they are a good indicator in assessing whether, under normal circumstances, the air quality in the vicinity of a scheme is likely to be detrimental to human health.

[4] http://www.air quality.co.uk/archive/laqm/tools.php?tool=background06

6.3.15 Environment Protection UK's[5] descriptors have also been used to compare the predicted pollutant concentrations from the proposed scheme in terms of their impact magnitude and impact significance and are reproduced in Tables 6.2 & 6.3 below.

Table 6.2: Magnitude of Change in Ambient Concentrations of NO_2 and PM_{10}

Magnitude of Change	Annual Mean NO_2 / PM_{10}	Days PM_{10} >50 µg/m³
Very Large	Increase/decrease >25%	Increase/decrease >25 days
Large	Increase/decrease 15-25%	Increase/decrease 15-25 days
Medium	Increase/decrease 10-15%	Increase/decrease 10-15 days
Small	Increase/decrease 5-10%	Increase/decrease 5-10 days
Very Small	Increase/decrease 1-5%	Increase/decrease 1-5 days
Extremely Small	Increase/decrease <1%	Increase/decrease <1 days

Table 6.3: Impact Significance for NO_2 and PM_{10}

Air Quality Impact Significance Criteria						
Absolute Concentration in Relation to Standard	**Extremely Small**	**Very Small**	**Small**	**Medium**	**Large**	**Very Large**
Decrease with scheme						
Above Standard with scheme	slight beneficial	slight beneficial	substantial beneficial	substantial beneficial	very substantial beneficial	very substantial beneficial
Above Standard without scheme Below with scheme	slight beneficial	moderate beneficial	substantial beneficial	substantial beneficial	very substantial beneficial	very substantial beneficial
Below Standard without scheme, but not well below	negligible	slight beneficial	slight beneficial	moderate beneficial	moderate beneficial	substantial beneficial
Well Below Standard without scheme	negligible	negligible	slight beneficial	slight beneficial	slight beneficial	moderate beneficial

[5] Development Control: Planning for Air Quality, Environment Protection UK (formerly NSCA), September 2006

Air Quality Impact Significance Criteria						
Increase with scheme						
Above Standard without scheme	slight adverse	slight adverse	substantial adverse	substantial adverse	very substantial adverse	very substantial adverse
Below Standard without scheme Above with scheme	slight adverse	moderate adverse	substantial adverse	substantial adverse	very substantial adverse	very substantial adverse
Below Standard with scheme, but not well below	negligible	slight adverse	slight adverse	moderate adverse	moderate adverse	substantial adverse
Well Below Standard with scheme	negligible	negligible	slight adverse	slight adverse	slight adverse	moderate adverse
Well below the standard =<75% of the standard level. **'Standard' in the context of this table relates to specific air quality objective or Limit Value in question.**						

Regional Assessment

6.3.16 Pollutants can contribute to a more widespread deterioration of air quality leading to the formation of photochemical oxidants, acid deposition and the greenhouse effect. These depend on the total amount of pollution in the atmosphere as opposed to concentrations at particular locations. An assessment has been carried out to estimate the total emissions from traffic on the network for the Baseline 2006; Do Minimum 2016 and Do Something 2016 (opening year) as well as Do Minimum 2031 and Do Something 2031 (design year) using the latest DMRB spreadsheet version 1.03c released in July 2007.

6.3.17 In line with DMRB, an estimate was calculated of the total emissions of the five main greenhouse gases: carbon monoxide (CO), nitrogen oxides (NO_x), total hydrocarbons (THC), particulate matter (PM_{10}) and carbon (C).

TAG Assessment

6.3.18 The overall change in exposure to NO_2 and PM_{10} at properties within 200 metres of those roads affected by the scheme (changes of +/- 10% in traffic flows) has been assessed in accordance with the TAG guidance as contained within DMRB.

6.3.19 The DMRB screening method (as detailed above) is used to estimate pollutant concentrations for the Do Minimum and Do Something scenarios in the opening year (2016). Estimated pollutant concentrations and properties counts have been carried out in 50 metre bands up to 200 metres from the centreline of all the affected roads.

6.3.20 The pollutant concentrations estimated for a fixed central location within a band is multiplied by the number of properties within that band. The Do Minimum value is deducted from the Do Something value, giving a score that can have a positive or

negative value. Positive values indicate increased pollutant concentrations (deterioration in air quality), while negative values represent a decrease (an improvement in air quality).

Limitations and Assumptions

6.3.21 The accuracy of air quality predictions is dependent upon traffic flow data. Property names and counts in the study area are based on 2005 Ordnance Survey mapping.

6.4 BASELINE CONDITIONS

Baseline Environment

6.4.1 In order to determine the extent to which air quality issues affect the proposed scheme, this assessment considers the following documents:

- Local Air Quality Management 3rd Progress Report by City of Lincoln Council (April 2008);
- Local Air Quality Management Annual Progress Report 2008, Ref: BV/AQ/ADIX0553 by North Kesteven District Council in April 2008;
- LAQM Detailed Assessment Report, Technical Report No: ADIX0479/BV/AQ by City of Lincoln Council, October 2007;
- Local Air Quality Management – Annual Progress Report, Ref: BV/AQ/ADIX0497/Draft by Lincolnshire Environmental Protection Liaison Group, April 2007;
- Local Air Quality Management – Updating and Screening Assessment, Ref: BV/AQ/AMCX0446, Lincolnshire Environmental Protection Liaison Group in June 2006; and
- Progress Report which provided an update on air quality monitoring and local developments published by West Lindsey District Council in 2006.

6.4.2 The LEB would be within the authority area of North Kesteven District Council (NKDC), West Lindsey District Council (WLDC) and City of Lincoln Council (CoLC). No AQMAs are found within NKDC and WLDC. CoLC has declared two AQMAs. Figure 6.1 shows that all the major roads in the city centre and some arterial routes have been declared as AQMA for NO_2. Figure 6.2 shows that CoLC has declared the whole borough as an AQMA for PM_{10}.

6.4.3 CoLC is currently undertaking monitoring using passive NO_2 diffusion tubes at twenty four sites in the city including busy roadside and background sites. A continuous analyser was installed in 2005 within the AQMA at a roadside site on Canwick Road. The bias adjusted results for 2005 to 2007 with projection to 2010 show that there is one roadside diffusion tube site where there is predicted exceedence of the annual mean AQO in 2010; site: Drill Hall, Broadgate; projected annual mean 2010: NO_2 of 46.6µg/m^3.

6.4.4 A Beta Attenuation Monitor was installed in Broadgate in 2007 to measure PM_{10}. The annualised annual mean PM_{10} concentration has been projected to 2010 predicting an annual mean of 33.4µg/m^3 with 42 days of exceedences of the daily mean objective. Further detailed assessment is being undertaken by LCC to enable a targeted Air Quality Action Plan to be developed.

Baseline Predictions

6.4.5 Seventy one sample receptors have been chosen to form part of the basis of the assessment (see Table 6.4 and Figure 6.3). Sample receptors have been located on

each road link where significant traffic changes (+/-10%) are predicted to occur following the introduction of the LEB. In addition, receptors have been chosen that are considered particularly sensitive to air pollution.

Table 6.4: Sample Receptors

Receptor No.	Receptor Name	Link Name
1	2 Riseholme Lane	A15
2	1-12 Glynn View	A46
3	50 Beaufort Road	A158
4	1 Top Lodge Close	Doddington Road B1190
5	479 Skellingthorpe Road	Skellingthorpe Road B1378
6	5 Riseholme Road	Riseholme Road B1226
7	147 Burton Street	Burton Road
8	65 Yarborough Crescent	Yarborough Crescent B1273
9	30 Yarborough Road	Yarborough Road B1273
10	19 The Avenue	The Avenue B1273
11	144 Browning Drive	Nettleham Road B1182
12	Themis	Lincoln Road B1182
13	Field Farm House	Lincoln Road A46
14	82 Wolsey Way	Wolsey Way
15	8 Outer Circle Drive	Outer Circle Drive
16	68 Laughton Way	Laughton Way
17	87 Newport	Newport
18	7 Upper Long Leys Road	Upper Long Leys Road
19	24 Church Lane (Cherry Willingham)	Church Lane (Cherry Willingham)
20	1 Church Lane (Waddington)	Church Lane (Waddington)
21	Lyleston	Northgate
22	18 Eastgate	Eastgate
23	1 Greetwell Gate	Greetwell Gate
24	56 Greetwell Road	Greetwell Road
25	22 Wragby Road	Wragby Road A15
26	21 Bunkers Hill	Wragby Road A158
27	56 Monks Road	Monks Road B1308
28	12 Lindum Road	Lindum Road A15
29	148 West Parade	West Parade
30	86 Hewson Road	Hewson Road
31	34 Birchwood Avenue	Birchwood Avenue
32	7 Kinloss Close	Pershore Way
33	200 Fulmar Road	Fulmar Road

Receptor No.	Receptor Name	Link Name
34	230 Woodfield Avenue	Woodfield Avenue
35	33 Dellfield Avenue	Dellfield Avenue
36	24 Malham Drive	Malham Drive
37	61 Newark Road	Newark Road A1434
38	33 Sleaford Road	Sleaford Road A15
39	24 Canwick Avenue	Canwick Avenue B1131
40	257 Lincoln (B1188)	Lincoln Road B1188
41	Charnwood	Canwick Hill B1188
42	15 South Park	South Park A15
43	2 Eleanor Close	Cross O'Cliff Hill A15
44	33 London Road	London Road A15
45	430 Brant Road	Brant Road
46	1 Sharp Walk	Meadow Lane
47	Buena Vista	Hill Top
48	Lynwood	Tinkers Lane
49	28 Tritton Road	Tritton Road B1003
50	58 High Street	High Street B1262
51	21 St. Catherines	St Catherines A15
52	227 Lincoln Road	Lincoln Road
53	31 Mill Lane	Mill Lane
54	6 Beck Lane	Beck Lane
55	3 Long Lane	Long Lane
56	24 Newland	Newland A57
57	4 Kelsey Street	Wigford Way A57
58	1 St. Mary's Street	St Marys Street A57
59	19 Norman Street	Norman Street A57
60	12 Melville Street	Melville Street A15
61	51,53 Archer Street	Canwick Road A15
62	1-4 Hill Cottages	Canwick Road B1188
63	Rose Cottage	Washingborough Road B1190
64	46 Avondale Street	Winn Street
65	2 Lytton Street	Lytton Street
66	136 Portland Street	Portland Street
67	141 Hawthorn Chase	LEB Route
68	1-3 Westfield Farm Bungalows	Bloxholm Lane
69	103 Bunkers Hill	Bunkers Hill A15
70	15 Fiskerton Road	Fiskerton Road
71	3 B1178	B1178

6.4.6 The background concentrations used to predict air quality concentrations for the 2006 Base year are detailed in Table 6.5. They demonstrate the wide variability of pollutant concentrations across the city. The pollutant concentrations are taken from the UK Air Quality Archive and adjusted in accordance with TG (09). Background pollutant concentrations are provided in the UK Air Quality Archive for 1km grid squares, rather than for individual properties. The relevant background calculations for the grid squares within each receptor is located are shown in Table 6.5. These figures are used to calculate pollutant levels at individual properties, as shown in Table 6.6.

Table 6.5: Background Concentrations of Pollutants per Receptor (µg/m³) for 2006

Receptor No.	Receptor Name	Background Concentrations 2006		
		NOx	PM_{10}	NO_2
1	2 Riseholme Lane	14.73	16.50	11.62
2	1-12 Glynn View	19.72	18.30	14.99
3	50 Beaufort Road	17.42	18.16	12.61
4	1 Top Lodge Close	19.35	18.12	14.74
5	479 Skellingthorpe Road	17.60	17.32	13.59
6	5 Riseholme Road	19.72	18.30	14.99
7	147 Burton Street	24.31	18.58	17.87
8	65 Yarborough Crescent	24.31	18.58	17.87
9	30 Yarborough Road	34.53	19.68	23.57
10	19 The Avenue	34.53	19.68	23.57
11	144 Browning Drive	20.33	18.06	15.39
12	Themis	18.95	17.88	14.49
13	Field Farm House	16.15	17.27	12.62
14	82 Wolsey Way	17.42	18.16	12.61
15	8 Outer Circle Drive	21.49	18.46	16.12
16	68 Laughton Way	20.33	18.06	15.39
17	87 Newport	24.31	18.58	17.87
18	7 Upper Long Leys Road	24.31	18.58	17.87
19	24 Church Lane (Cherry Willingham)	15.17	16.62	11.15
20	1 Church Lane (Waddington)	14.05	16.68	11.14
21	Lyleston	24.31	18.58	17.87
22	18 Eastgate	34.53	19.68	23.57
23	1 Greetwell Gate	29.56	19.48	20.91
24	56 Greetwell Road	29.56	19.48	20.91
25	22 Wragby Road	23.62	18.59	17.45
26	21 Bunkers Hill	21.49	18.46	16.12

Receptor No.	Receptor Name	Background Concentrations 2006		
		NOx	PM_{10}	NO_2
27	56 Monks Road	29.56	19.48	20.91
28	12 Lindum Road	29.56	19.48	20.91
29	148 West Parade	27.09	18.91	19.50
30	86 Hewson Road	27.09	18.91	19.50
31	34 Birchwood Avenue	17.60	17.32	13.59
32	7 Kinloss Close	20.31	18.45	15.36
33	200 Fulmar Road	18.75	17.85	14.35
34	230 Woodfield Avenue	16.26	17.41	12.68
35	33 Dellfield Avenue	17.60	17.32	13.59
36	24 Malham Drive	17.60	17.32	13.59
37	61 Newark Road	19.34	18.29	14.74
38	33 Sleaford Road	14.42	16.71	11.40
39	24 Canwick Avenue	15.65	16.93	12.25
40	257 Lincoln (B1188)	14.96	16.66	11.01
41	Charnwood	21.32	18.27	16.01
42	15 South Park	24.02	18.69	17.67
43	2 Eleanor Close	24.02	18.69	17.67
44	33 London Road	17.02	17.42	13.19
45	430 Brant Road	14.81	16.84	11.67
46	1 Sharp Walk	15.09	16.86	11.87
47	Buena Vista	14.05	16.68	11.14
48	Lynwood	13.16	16.45	10.50
49	28 Tritton Road	18.37	17.86	14.10
50	58 High Street	35.19	19.84	23.90
51	21 St. Catherines	24.02	18.69	17.67
52	227 Lincoln Road	17.64	17.65	13.62
53	31 Mill Lane	15.09	16.86	11.87
54	6 Beck Lane	13.60	16.51	10.82
55	3 Long Lane	13.60	16.51	10.82
56	24 Newland	34.53	19.68	23.57
57	4 Kelsey Street	34.53	19.68	23.57
58	1 St. Mary's Street	35.19	19.84	23.90
59	19 Norman Street	35.19	19.84	23.90
60	12 Melville Street	34.53	19.68	23.57
61	51,53 Archer Street	35.19	19.84	23.90
62	1-4 Hill Cottages	21.32	18.27	16.01

Receptor No.	Receptor Name	Background Concentrations 2006		
		NOx	PM_{10}	NO_2
63	Rose Cottage	26.99	20.45	19.44
64	46 Avondale Street	29.56	19.48	20.91
65	2 Lytton Street	29.56	19.48	20.91
66	136 Portland Street	35.19	19.84	23.9
67	141 Hawthorn Chase	18.66	22.85	13.37
68	1-3 Westfield Farm Bungalows	13.94	16.52	11.06
69	103 Bunkers Hill	17.42	18.16	12.61
70	15 Fiskerton Road	15.40	16.75	11.30
71	3 B1178	13.24	16.36	9.87

6.4.7 Predicted baseline levels of NO_2 and PM_{10} for 2006 have been calculated for each selected receptor location, and are shown in Table 6.6.

Table 6.6: Predicted Concentrations for 2006

Receptor No.	Receptor Name	NO_2 (µg/m³)	PM_{10} (µg/m³)	
		Annual mean	Annual mean	Days > 50µg/m³
1	2 Riseholme Lane	21.44	18.88	2
2	1-12 Glynn View	15.36	18.40	2
3	50 Beaufort Road	14.56	18.59	2
4	1 Top Lodge Close	21.52	20.30	4
5	479 Skellingthorpe Road	17.08	18.20	2
6	5 Riseholme Road	20.33	19.89	3
7	147 Burton Street	21.65	19.66	3
8	65 Yarborough Crescent	22.85	20.23	4
9	30 Yarborough Road	32.26	22.91	8
10	19 The Avenue	30.66	22.30	7
11	144 Browning Drive	18.62	18.87	2
12	Themis	18.09	19.01	2
13	Field Farm House	14.55	17.77	1
14	82 Wolsey Way	13.65	18.49	2
15	8 Outer Circle Drive	17.42	18.76	2
16	68 Laughton Way	17.42	18.73	2
17	87 Newport	20.73	19.28	3
18	7 Upper Long Leys Road	20.67	19.50	3
19	24 Church Lane (Cherry Willingham)	13.83	17.29	1
20	1 Church Lane (Waddington)	15.83	17.94	1
21	Lyleston	20.08	19.35	3

Receptor No.	Receptor Name	NO_2 (µg/m³)	PM_{10} (µg/m³)	
		Annual mean	Annual mean	Days > 50µg/m³
22	18 Eastgate	31.14	22.10	6
23	1 Greetwell Gate	27.82	21.87	6
24	56 Greetwell Road	30.23	22.50	7
25	22 Wragby Road	29.80	22.51	7
26	21 Bunkers Hill	23.52	20.28	4
27	56 Monks Road	29.60	22.23	7
28	12 Lindum Road	33.64	23.71	10
29	148 West Parade	24.76	21.02	5
30	86 Hewson Road	20.51	19.22	3
31	34 Birchwood Avenue	16.06	18.19	2
32	7 Kinloss Close	20.14	19.81	3
33	200 Fulmar Road	14.93	18.01	1
34	230 Woodfield Avenue	14.53	17.85	1
35	33 Dellfield Avenue	15.56	17.82	1
36	24 Malham Drive	16.12	18.08	1
37	61 Newark Road	19.71	19.55	3
38	33 Sleaford Road	25.01	20.46	4
39	24 Canwick Avenue	18.91	18.50	2
40	257 Lincoln (B1188)	11.01	16.66	-
41	Charnwood	23.22	20.06	3
42	15 South Park	29.69	22.75	8
43	2 Eleanor Close	23.19	20.16	4
44	33 London Road	23.48	20.30	4
45	430 Brant Road	14.73	17.68	1
46	1 Sharp Walk	17.67	18.18	2
47	Buena Vista	14.88	17.61	1
48	Lynwood	14.20	17.36	1
49	28 Tritton Road	16.96	18.55	2
50	58 High Street	32.04	21.88	6
51	21 St. Catherines	32.19	23.28	9
52	227 Lincoln Road	17.11	18.62	2
53	31 Mill Lane	18.07	18.53	2
54	6 Beck Lane	12.01	16.84	1
55	3 Long Lane	12.54	16.78	1
56	24 Newland	32.54	22.70	8
57	4 Kelsey Street	33.38	22.63	7

Receptor No.	Receptor Name	NO_2 (µg/m³)	PM_{10} (µg/m³)	
		Annual mean	Annual mean	Days > 50µg/m³
58	1 St. Mary's Street	36.89	23.84	10
59	19 Norman Street	31.35	22.26	7
60	12 Melville Street	38.81	25.18	13
61	51,53 Archer Street	31.76	22.51	7
62	1-4 Hill Cottages	22.79	20.38	4
63	Rose Cottage	24.83	22.01	6
64	46 Avondale Street	22.02	19.86	3
65	2 Lytton Street	22.13	19.90	3
66	136 Portland Street	27.55	20.94	5
67	141 Hawthorn Chase	13.37	22.85	-
68	1-3 Westfield Farm Bungalows	11.06	16.52	-
69	103 Bunkers Hill	12.61	18.16	-
70	15 Fiskerton Road	15.62	17.62	1
71	3 B1178	9.87	16.36	-

6.4.8 Table 6.6 shows that most of the pollutant concentrations predicted for 2006 are well below the AQO limits. The results show elevated NO_2 levels (in the 30s µg/m³) along the main arterial roads within the city centre reflecting the heavily trafficked nature of these roads and the declaration of the areas as an AQMA for NO_2.

6.5 PREDICTED IMPACTS

Construction Phase

6.5.1 Potential disruption due to construction may occur during this period to residents in close proximity to the proposed route.

6.5.2 From an air quality perspective, the key activities related to the construction of the proposed scheme likely to create the greatest impact are as follows:

- Fugitive dust emissions from a variety of construction activities including re-profiling of cuttings and embankments;
- Off-site disposal of excavated material during construction; and
- HGV haulage of material to and from the construction site.

6.5.3 The main potential air quality impacts arising from such construction activities are likely to be associated with fugitive dust emissions. However, these are generally variable in nature and can be dependent on the type of construction activity, ground conditions and the prevailing meteorological conditions at that time. A large proportion of dust from construction activities is usually caused by entrainment of dust disturbed by vehicle movements on unsurfaced haul roads. Similarly, dust can also be entrained from uncovered stockpiles and surplus spoil materials. The majority of access routes to construction areas would be via surfaced roads minimising the potential for dust entrainment.

6.5.4 For fugitive dust from such works, a high proportion of any entrained dust is likely to be deposited within a few hundred metres of the site. The specific distance of dust deposited from the site is relative to the strength and location of prevailing winds, particle size and local topography. Consequently because of the temporary nature of the construction activities, it is likely that the potential impacts would be in relation to dust deposition and potential nuisance in the immediate vicinity of the site rather than long term air quality concerns. Appropriate mitigation measures would, however, enable these potential impacts to be reduced to acceptable levels, and would be specified in the contract with the construction contractors.

Operational Phase

Local Assessment

6.5.5 Pollutant concentrations are predicted for the representative receptors for the year of opening (2016) in the Do Minimum and Do Something scenarios. Table 6.7 contains the background concentrations at these receptors locations for 2016 produced using guidance contained within TG (09).

Table 6.7: Background Concentrations of Pollutants per Receptor (µg/m³) for 2016

Receptor No.	Receptor Name	Background Concentrations 2016		
		NOx	PM_{10}	NO_2
1	2 Riseholme Lane	10.87	15.34	9.12
2	1-12 Glynn View	13.71	16.86	11.28
3	50 Beaufort Road	12.72	16.82	9.78
4	1 Top Lodge Close	14.04	16.89	11.40
5	479 Skellingthorpe Road	12.48	16.06	10.37
6	5 Riseholme Road	13.71	16.86	11.28
7	147 Burton Street	16.95	17.06	13.56
8	65 Yarborough Crescent	16.95	17.06	13.56
9	30 Yarborough Road	25.23	18.03	18.80
10	19 The Avenue	25.23	18.03	18.80
11	144 Browning Drive	14.09	16.63	11.57
12	Themis	13.46	16.53	11.04
13	Field Farm House	11.78	16.05	9.80
14	82 Wolsey Way	12.72	16.82	9.78
15	8 Outer Circle Drive	15.34	17.01	12.34
16	68 Laughton Way	14.09	16.63	11.57
17	87 Newport	16.95	17.06	13.56
18	7 Upper Long Leys Road	16.95	17.06	13.56
19	24 Church Lane (Cherry Willingham)	11.28	15.42	8.66
20	1 Church Lane (Waddington)	10.44	15.56	8.64
21	Lyleston	16.95	17.06	13.56
22	18 Eastgate	25.23	18.03	18.80

Receptor No.	Receptor Name	Background Concentrations 2016		
		NOx	PM_{10}	NO_2
23	1 Greetwell Gate	21.02	17.87	16.21
24	56 Greetwell Road	21.02	17.87	16.21
25	22 Wragby Road	16.49	17.08	13.20
26	21 Bunkers Hill	15.34	17.01	12.34
27	56 Monks Road	21.02	17.87	16.21
28	12 Lindum Road	21.02	17.87	16.21
29	148 West Parade	20.10	17.50	15.53
30	86 Hewson Road	20.10	17.50	15.53
31	34 Birchwood Avenue	12.48	16.06	10.37
32	7 Kinloss Close	14.82	17.19	12.00
33	200 Fulmar Road	13.43	16.62	11.00
34	230 Woodfield Avenue	11.90	16.27	9.86
35	33 Dellfield Avenue	12.48	16.06	10.37
36	24 Malham Drive	12.48	16.06	10.37
37	61 Newark Road	14.20	17.08	11.48
38	33 Sleaford Road	10.71	15.54	8.86
39	24 Canwick Avenue	11.57	15.73	9.53
40	257 Lincoln (B1188)	11.06	15.46	8.52
41	Charnwood	15.53	16.94	12.41
42	15 South Park	17.72	17.37	13.87
43	2 Eleanor Close	17.72	17.37	13.87
44	33 London Road	12.58	16.19	10.25
45	430 Brant Road	10.91	15.62	9.01
46	1 Sharp Walk	11.18	15.72	9.24
47	Buena Vista	10.44	15.56	8.64
48	Lynwood	9.84	15.36	8.17
49	28 Tritton Road	13.08	16.56	10.69
50	58 High Street	26.56	18.29	19.51
51	21 St. Catherines	17.72	17.37	13.87
52	227 Lincoln Road	12.86	16.45	10.51
53	31 Mill Lane	11.18	15.72	9.24
54	6 Beck Lane	10.19	15.41	8.47
55	3 Long Lane	10.19	15.41	8.47
56	24 Newland	25.23	18.03	18.80
57	4 Kelsey Street	25.23	18.03	18.80
58	1 St. Mary's Street	26.56	18.29	19.51
59	19 Norman Street	26.56	18.29	19.51

Receptor No.	Receptor Name	Background Concentrations 2016		
		NOx	PM_{10}	NO_2
60	12 Melville Street	25.23	18.03	18.80
61	51,53 Archer Street	26.56	18.29	19.51
62	1-4 Hill Cottages	15.53	16.94	12.41
63	Rose Cottage	19.83	18.88	15.31
64	46 Avondale Street	21.02	17.87	16.21
65	2 Lytton Street	21.02	17.87	16.21
66	136 Portland Street	26.56	18.29	19.51
67	141 Hawthorn Chase	13.68	20.93	10.37
68	1-3 Westfield Farm Bungalows	10.39	15.35	8.59
69	103 Bunkers Hill	12.72	16.82	9.78
70	15 Fiskerton Road	11.44	15.54	8.77
71	3 B1178	9.85	15.25	7.66

6.5.6 Pollutant concentrations have been calculated at the proposed receptor façade nearest to the links for the Do Minimum 2016 and Do Something 2016 scenarios as seen in Table 6.8 below.

Table 6.8: Predicted Concentrations at Receptors for 2016

Rec. No.	Receptor Address	Scenario	NO_2 (µg/m^3) Annual Mean	% Change	PM_{10} (µg/m^3) Annual Mean	% Change	DM Days > 50 µg/m^3	DS Days > 50 µg/m^3
1	2 Riseholme Lane	DM	17.98	-20.24	16.91	-3.55	1	0
		DS	14.34		16.31			
2	1-12 Glynn View	DM	11.57	-0.61	16.93	-0.12	1	1
		DS	11.50		16.91			
3	50 Beaufort Road	DM	10.75	-0.28	16.99	0.00	1	1
		DS	10.72		16.99			
4	1 Top Lodge Close	DM	18.23	-15.36	18.45	-1.79	2	1
		DS	15.43		18.12			
5	479 Skellingthorpe Road	DM	15.10	-12.58	16.95	-1.24	1	1
		DS	13.20		16.74			
6	5 Riseholme Road	DM	15.56	-7.20	17.91	-0.89	1	1
		DS	14.44		17.75			
7	147 Burton Street	DM	17.83	-5.89	18.09	-0.88	1	1
		DS	16.78		17.93			
8	65 Yarborough Crescent	DM	19.01	-11.94	18.36	-1.58	2	1
		DS	16.74		18.07			
9	30 Yarborough Road	DM	27.26	-12.07	20.05	-2.44	3	3
		DS	23.97		19.56			
10	19 The Avenue	DM	26.28	-11.07	19.8	-1.92	3	3
		DS	23.37		19.42			
11	144 Browning Drive	DM	15.08	-10.15	17.3	-1.27	1	1
		DS	13.55		17.08			
12	Themis	DM	15.58	-16.05	17.59	-2.67	1	1
		DS	13.08		17.12			

Rec. No.	Receptor Address	Scenario	NO_2 (µg/m^3) Annual Mean	% Change	PM_{10} (µg/m^3) Annual Mean	% Change	DM Days > 50 µg/m^3	DS Days > 50 µg/m^3
13	Field Farm House	DM	11.32	-4.06	16.31	-0.25	0	0
		DS	10.86		16.27			
14	82 Wolsey Way	DM	11.34	-4.32	17.36	-1.04	1	1
		DS	10.85		17.18			
15	8 Outer Circle Drive	DM	13.50	-0.59	17.26	-0.17	1	1
		DS	13.42		17.23			
16	68 Laughton Way	DM	12.91	0.62	16.97	0.35	1	1
		DS	12.99		17.03			
17	87 Newport	DM	16.21	-5.86	17.61	-0.91	1	1
		DS	15.26		17.45			
18	7 Upper Long Leys Road	DM	15.62	-3.46	17.52	-0.17	1	1
		DS	15.08		17.49			
19	24 Church Lane (Cherry Willingham)	DM	11.61	-2.15	15.99	0.88	0	0
		DS	11.36		16.13			
20	1 Church Lane (Waddington)	DM	11.96	1.42	16.43	-0.24	0	0
		DS	12.13		16.39			
21	Lyleston	DM	15.69	-3.00	17.66	-0.57	1	1
		DS	15.22		17.56			
22	18 Eastgate	DM	26.54	-8.14	19.96	-1.55	3	3
		DS	24.38		19.65			
23	1 Greetwell Gate	DM	27.13	-19.83	20.52	-4.87	4	3
		DS	21.75		19.52			
24	56 Greetwell Road	DM	25.20	-12.78	20.03	-2.75	3	3
		DS	21.98		19.48			
25	22 Wragby Road	DM	26.82	-24.53	19.74	-4.91	3	2
		DS	20.24		18.77			
26	21 Bunkers Hill	DM	20.33	-16.92	18.41	-2.23	2	1
		DS	16.89		18			
27	56 Monks Road	DM	21.78	-2.53	19.55	-1.38	3	3
		DS	21.23		19.28			
28	12 Lindum Road	DM	30.49	-22.63	20.85	-5.47	5	3
		DS	23.59		19.71			
29	148 West Parade	DM	20.94	-9.46	18.66	-0.43	2	2
		DS	18.96		18.58			
30	86 Hewson Road	DM	16.84	-0.36	17.79	0.06	1	1
		DS	16.78		17.8			
31	34 Birchwood Avenue	DM	12.49	-0.16	16.66	0.30	1	1
		DS	12.47		16.71			
32	7 Kinloss Close	DM	16.79	-7.15	18.43	-1.57	2	2
		DS	15.59		18.14			
33	200 Fulmar Road	DM	11.37	0.35	16.73	0.06	1	1
		DS	11.41		16.74			
34	230 Woodfield Avenue	DM	11.38	-2.99	16.57	-0.30	1	1
		DS	11.04		16.52			
35	33 Dellfield Avenue	DM	12.35	-3.08	16.51	-0.55	1	0
		DS	11.97		16.42			
36	24 Malham Drive	DM	12.90	-3.88	16.72	-0.78	1	1
		DS	12.40		16.59			
37	61 Newark Road	DM	20.14	-25.32	18.74	-3.74	2	1

Rec. No.	Receptor Address	Scenario	NO_2 (µg/m^3) Annual Mean	% Change	PM_{10} (µg/m^3) Annual Mean	% Change	DM Days > 50 µg/m^3	DS Days > 50 µg/m^3
		DS	15.04		18.04			
38	33 Sleaford Road	DM	18.54	-9.92	17.62	-4.20	1	1
		DS	16.70		16.88			
39	24 Canwick Avenue	DM	13.16	-4.71	16.56	-1.09	1	0
		DS	12.54		16.38			
40	257 Lincoln (B1188)	DM	9.35	62.57	15.46	7.57	-	1
		DS	15.20		16.63			
41	Charnwood	DM	18.16	-7.27	17.96	-1.00	1	1
		DS	16.84		17.78			
42	15 South Park	DM	26.94	-17.78	20.42	-4.51	4	3
		DS	22.15		19.5			
43	2 Eleanor Close	DM	17.97	-6.07	18.35	-2.02	2	1
		DS	16.88		17.98			
44	33 London Road	DM	16.28	-4.98	17.58	-1.82	1	1
		DS	15.47		17.26			
45	430 Brant Road	DM	13.20	-13.26	16.59	-1.69	1	0
		DS	11.45		16.31			
46	1 Sharp Walk	DM	14.93	-16.81	16.73	-2.21	1	0
		DS	12.42		16.36			
47	Buena Vista	DM	14.26	-30.15	16.41	-3.47	0	0
		DS	9.96		15.84			
48	Lynwood	DM	13.71	-30.93	16.2	-3.46	0	0
		DS	9.47		15.64			
49	28 Tritton Road	DM	14.25	-8.91	17.27	-0.93	1	1
		DS	12.98		17.11			
50	58 High Street	DM	25.10	-2.71	19.41	-0.67	3	3
		DS	24.42		19.28			
51	21 St. Catherines	DM	26.09	-9.89	20.26	-2.96	4	3
		DS	23.51		19.66			
52	227 Lincoln Road	DM	13.83	-6.58	17.26	-0.93	1	1
		DS	12.92		17.1			
53	31 Mill Lane	DM	16.11	-24.52	17.07	-3.63	1	0
		DS	12.16		16.45			
54	6 Beck Lane	DM	9.94	-7.55	15.69	-0.89	0	0
		DS	9.19		15.55			
55	3 Long Lane	DM	9.68	-6.40	15.64	-0.70	0	0
		DS	9.06		15.53			
56	24 Newland	DM	26.35	-6.57	19.76	-1.37	3	3
		DS	24.62		19.49			
57	4 Kelsey Street	DM	28.28	-11.32	19.77	-2.28	3	3
		DS	25.08		19.32			
58	1 St. Mary's Street	DM	29.23	-7.77	20.22	-2.27	4	3
		DS	26.96		19.76			
59	19 Norman Street	DM	25.23	-6.62	19.52	-1.79	3	2
		DS	23.56		19.17			
60	12 Melville Street	DM	33.00	-17.67	21.42	-5.42	5	4
		DS	27.17		20.26			
61	51,53 Archer Street	DM	27.77	-13.79	20.19	-3.47	4	3
		DS	23.94		19.49			

Rec. No.	Receptor Address	Scenario	NO_2 (µg/m^3) Annual Mean	% Change	PM_{10} (µg/m^3) Annual Mean	% Change	DM Days > 50 µg/m^3	DS Days > 50 µg/m^3
62	1-4 Hill Cottages	DM	19.28	-13.38	18.43	-1.84	2	1
		DS	16.70		18.09			
63	Rose Cottage	DM	19.98	-5.16	19.87	-0.96	3	3
		DS	18.95		19.68			
64	46 Avondale Street	DM	17.23	0.17	18.18	-0.28	2	2
		DS	17.26		18.13			
65	2 Lytton Street	DM	17.30	0.40	18.2	-0.22	2	2
		DS	17.37		18.16			
66	136 Portland Street	DM	22.39	-2.10	19.03	-0.68	2	2
		DS	21.92		18.9			
67	141 Hawthorn Chase	DM	10.95	13.06	20.93	3.44	-	6
		DS	12.38		21.65			
68	1-3 Westfield Farm Bungalows	DM	9.42	-4.67	15.35	0.39	-	0
		DS	8.98		15.41			
69	103 Bunkers Hill	DM	10.25	40.98	16.82	6.90	-	1
		DS	14.45		17.98			
70	15 Fiskerton Road	DM	12.35	-3.08	16.14	0.12	0	0
		DS	11.97		16.16			
71	3 B1178	DM	8.49	0.59	15.25	0.59	-	0
		DS	8.54		15.34			

6.5.7 It can be seen from Table 6.8 that all the predicted pollutant concentrations are well below the AQOs. Traffic in the city of Lincoln is predicted to decrease considerably, as a result of the proposed LEB. Therefore, the majority of the receptors are predicted to experience a beneficial impact for NO_2 and PM_{10} due to reductions in pollutant concentrations as a result of the proposed scheme. For properties such as 61 Newark Road, Buena Vista and Lynwood the NO_2 impact is considered to be moderate beneficial as decreases in pollutant concentrations of a magnitude of >25% occur and the PM_{10} impact is considered negligible as the decreases are of the order of 1-5% magnitude. Similarly, for 22 Wragby Road, 12 Lindum Road and 31 Mill Lane the NO_2 impact is considered to be slight beneficial as decreases in pollutant concentrations of a magnitude of 20-25% occur and the PM_{10} impact is considered negligible as the decreases are of the order of 1-5% magnitude.

6.5.8 103 Bunkers Hill, 257 Lincoln Road (B1188) and 141 Hawthorn Chase are located in close proximity to the proposed scheme. These receptors are predicted to experience a moderate adverse (103 Bunkers Hill and 257 Lincoln (B1188)) and a slight adverse impact for NO_2 (141 Hawthorn Chase), as very large and large increases in traffic are predicted in the vicinity of these properties as a result of the scheme. The impact for PM_{10} is slight adverse for 257 Lincoln Road (B1188) and 103 Bunkers Hill and negligible for 141 Hawthorn Chase as the concentrations increase by a magnitude of 6.9%, 7.6% and 3.4% respectively.

Regional Assessment

6.5.9 Total emissions have been predicted for carbon monoxide, nitrogen oxides, total hydrocarbons, particulate matter and carbon for the baseline (2006) opening year (2016) and design year (2031). The results are displayed in Table 6.9.

Table 6.9: Regional Emissions of the Assessment Years

Scenario	Carbon Monoxide (CO) kg/year	Total Hydrocarbons (THC) kg/year	Oxides of Nitrogen (NOx) kg/year	Particulate Matter (PM_{10}) kg/year	Carbon (C) tonnes/year
Baseline 2006	839,438	114,558	626,267	21,211	49,718
Do Minimum 2016	941,390	143,517	592,886	15,628	69,584
Do Something 2016	717,455	95,607	360,357	11,045	48,436
Do Minimum 2025	1,099,337	145,565	452,982	14,989	67,020
Do Something 2025	922,933	125,883	432,937	13,727	60,262

6.5.10 The regional greenhouse assessment shows that there is a decrease in gaseous emissions for the all five pollutants in the Do Something scenario when compared to the Do Minimum scenario for 2016 and 2025.

TAG Assessment

6.5.11 A TAG assessment has been undertaken to give a quantitative indication of whether the proposed scheme would lead to an overall improvement or deterioration in air quality at residential properties in the area and within the city of Lincoln. Pollutant concentrations are predicted for all properties within 200m of links which are predicted to experience increases or reductions in traffic of 10%. Table 6.10 shows the number of properties that would experience increases and reductions in NO_2 and PM_{10} concentrations, plus the TAG assessment appraisal scores for the scheme.

Table 6.10: TAG Assessment for the Opening Year 2016

	Number of Properties with an Improvement	Number of Properties with a Deterioration	Numbers of Properties with No Change	TAG Score[1]
NO_2	86,370	8,617	53	-35,019
PM_{10}	84,720	10,320	0	-5,362

[1] Positive value reflects a net deterioration (i.e. pollutant emissions increase)

6.5.12 Table 6.10 shows that a greater number of properties would experience an improvement in air quality than would experience a deterioration. The TAG appraisal score also demonstrates an overall improvement in air quality in the area. This improvement is principally as a result of the reduction in traffic flows within the city centre due to the re-distribution of the traffic in the network after the introduction of the proposed LEB.

6.6 MITIGATION

Construction

6.6.1 Fugitive dust is the most likely pollutant to impact on air quality during the construction phase. Such dust emissions can be effectively controlled at source and can generally be avoided by good site practice. A range of mitigation measures

would be included in the Construction Environmental Management Plan to minimise the effects of airborne dust.

6.6.2 Liaison with the Local Authorities prior to the start of construction would be undertaken to agree proposed working practices and environmental controls. This would be a key element in ensuring suitable and effective mitigation.

6.6.3 Based on these discussions, the Site Contractor would be required to work to a Code of Practice, which could include measures to minimise fugitive dust emissions. As appropriate, the Code of Practice may include the measures detailed below:

- Minimisation of fugitive dust emissions from construction activities, including material storage and concrete batching:
  - adhering to relevant legislation and guidance;
  - avoiding the use of plant or machinery that would create dust wherever reasonably possible;
  - dampening down areas at risk of creating fugitive dust as appropriate;
  - controlling construction activities as appropriate to minimise dust release;
  - utilising water suppression where appropriate for material cutting such as the use of abrasive disc cutters;
  - enclosing significant material stockpiles as far as is practicable;
  - carrying out the mixing of large quantities of concrete only in enclosed or shielded areas where possible;
  - maintaining all material handling areas in a dust free state as far as is practicable; and
  - establishing procedures to ensure that the site is regularly inspected for spillage of dusty or potentially dusty materials and any such spillage would be dealt with promptly;
- Minimisation of dust from vehicle movements within the site through:
  - giving attention to maintaining medium and heavily used routes in as dust free state as is reasonably possible;
  - regularly dampening down of any unsurfaced routes using water bowsers during periods of dry weather where they have the potential to cause nuisance;
  - establishing and enforcing appropriate speed limits, as necessary; and
  - installing wheel washing facilities if appropriate and heavy vehicles leaving the site would be required to use the installation as necessary.

Operational

6.6.4 As no pollutant levels are predicted to exceed the AQOs, no mitigation is proposed.

6.7 RESIDUAL IMPACTS

Construction Impacts

6.7.1 The proper implementation of the measures set out above would eliminate the risk of any significant degree of nuisance dust emissions.

Operational Impacts

6.7.2 No mitigation measures are proposed. Operational impacts would therefore be unchanged from those described above.

7 NOISE AND VIBRATION

7.1 INTRODUCTION

7.1.1 Noise in its widest sense can be defined as unwanted sound. Such sound can be associated with industrial, domestic and transportation sources. In this assessment, any potential noise impacts would relate to changes in road traffic.

7.1.2 As traffic noise fluctuates continually, it is necessary to define it in a way that can be related to the subjective response of those experiencing it. Attitude surveys have shown a relationship between the annoyance caused by traffic and the sound level exceeded for 10% of the time during the 18-hour period between 6am and midnight. This noise level is known as the '$L_{A10,18hr}$'.

7.1.3 Vibration comprises oscillatory waves that propagate from a source through the ground or air to adjacent buildings. Vibration can be intrusive and annoying, but is highly unlikely to cause structural damage to buildings.

7.1.4 This noise and vibration chapter has been undertaken in accordance with the guidance contained in DMRB and comprises the following elements:

- An assessment of the effects on the local environment of noise and vibration that may be caused by the construction of the scheme ('construction impacts'); and
- An assessment of the effects of the noise and vibration that may be caused by road traffic after completion of the proposed road scheme ('operational impacts')

7.1.5 This assessment uses a number of technical terms, which are explained in Appendix 7A.

7.2 POLICY AND LEGAL CONTEXT

Text Noise Insulation Regulations

7.2.1 Under the Noise Insulation Regulations 1975 (as amended in 1988), the Highway Authority has a duty to offer to insulate the living rooms (which include dining rooms and studies) and bedrooms of dwellings affected by new roads and roads that have their line or level altered, if the dwellings satisfy the following criteria:

- The residential premises would be within 300m of the new or altered highway;
- The noise level 15 years after opening would be not less than 68 dB;
- The predicted noise level 15 years after opening is calculated to be at least 1 dB above the level before work commences; and
- The improved highway would contribute at least 1 dB to the final noise level.

Control of Pollution Act 1974

7.2.2 Local Authorities have powers under Section 60 of the Control of Pollution Act 1974 to impose requirements or restrictions on construction methods, including the type of plant to be used and permitted noise levels during specified hours. Restrictions can be imposed even if the noise levels would be below those causing a 'nuisance'. In doing so, the local authority must have regard to:

- The relevant provisions of any code of practice approved under this part of the Act;
- As well as the need to ensure 'best practicable means' are used to minimise noise emissions; and

- The need to protect people from the effects of noise from the site.

7.2.3 Anyone who intends to carry out construction activities is entitled under Section 61 of the Control of Pollution Act 1974 to apply to the local authority for prior consent to carry out the work. The application needs to describe the works, the construction methods to be used and the steps that are to be taken to minimise noise resulting from the works. The local authority has the power to attach conditions to any consent granted and limit the length of its duration.

7.3 APPROACH AND METHODS

Assessment Methodology for the Construction Phase

7.3.1 Construction of the proposed scheme is planned to commence in 2013 with completion expected by 2016. Disruption due to the construction phase would have the potential to occur during this period to residents and other sensitive receptors alongside the proposed route. BS 5228 contains details of construction noise prediction methods and noise levels from different types and sizes of construction equipment. The standard also suggests practical ways to mitigate excessive noise.

Assessment Methodology for the Operational Phase

Noise Assessment

7.3.2 Assessment of noise levels at various noise sensitive receivers has followed the methodology outlined in DMRB. The DMRB Noise and Vibration Chapter was updated in August 2008. This assessment considers the updated methodology contained within this Chapter. Noise levels have been calculated at all residential dwellings and other sensitive receptors within 600m of the scheme and for those roads (within 2km) on the existing road network that are predicted to result in a traffic increase of at least 25% or a reduction of 20% in the baseline year (2016) as a result of the introduction of the LEB.

7.3.3 Noise levels at the representative receivers have been calculated using CadnaA, a digital model based on the government memorandum “Calculation of Road Traffic Noise“ (CRTN). The calculations took account of traffic flow data for the Do-Minimum and Do-Something scenarios for the baseline year (2016) and design year (2031) of the scheme. The variables considered in the calculations were:

- Typical volume of traffic during the eighteen hour period from 6am to midnight;
- The percentage of Heavy Good Vehicles (HGV);
- Traffic speeds;
- Road gradient;
- Surface finish;
- The local topography;
- The nature of the ground cover between the road and the receptor; and
- The shielding effects of any intervening structures, including allowances for limited angles of view from the road and any reflection effects from relevant surfaces.

7.3.4 DMRB advises that the assessment of traffic noise and vibration impacts should use predicted traffic flows for the year (within 15 years of opening) when traffic is anticipated to be greatest, in order that the worst-case scenario is assessed. In this case the highest flow is predicted to occur in 2031.

Traffic Noise Measurements

7.3.5 Measurements of noise levels can provide understanding of the current noise environment. However, DMRB advises that the use of measured traffic noise levels alone is not recommended, stating that *"Care is needed in the interpretation of the levels of the $L_{A10,18hr}$ recorded. These would vary from day to day during the year, depending on the influence of varying traffic and weather conditions and seasonal effects".* The assessment is therefore based principally on noise levels calculated using a computer model, which can be assumed to be consistent from day to day and will therefore be more comparable between different locations.

7.3.6 Measured noise levels are used for receptors located adjacent to the scheme, where existing noise levels are not dominated by road traffic noise. Such receptors are predominately dominated by aircraft noise from RAF Waddington. DMRB states that *"where the ambient noise level is comprised of a combination of emissions, for example, in a rural setting with noise from aircraft, machinery or animals the use of the L_{A10} indice may be inappropriate and the use of the L_{Aeq} index may be more appropriate*". Therefore, for such receptors the measured L_{Aeq} has therefore been used as the baseline noise level. Noise measurements have also been undertaken at properties identified by North Kesteven Disctrict Council, West Lindsey District Council and Lincoln City Council Environmental Health Officers.

Significance of Impact

7.3.7 DMRB sets out an example of classification for determining magnitude of impact from noise for new road schemes based upon noise change. Furthermore, when considering two sounds of a similar acoustical nature, i.e. similar spectral and temporal characteristics, a change of more than 3 dB(A) is regarded as being perceptible to the human ear. Considering these levels, the classification system shown in Table 7.1 has been used in this assessment to define the magnitude of noise impacts between the Do-Minimum and Do-Something scenarios.

Table 7.1: Classification of Changes in Road Traffic Noise

Noise Change, $L_{A10,18hr}$	Magnitude of Impact		
0	No Change		
0 – 0.9 dB(A)	Negligible	↑	Insignificant
1 – 2.9 dB(A)	Minor		
3 – 4.9 dB(A)	Moderate	↓	Significant
5 + dB(A)	Major		

Noise Nuisance

7.3.8 DMRB defines the level of noise 'nuisance' by reference to the percentage of people in the affected population that are 'bothered very much or quite a lot' by traffic noise. Gradual increases in noise are expected to produce a gradual and proportionate increase in the nuisance level (i.e. the percentage of the population that is bothered). However, sudden changes in the noise level are expected to result in an initial disproportionately large increase in the nuisance level. This new level of nuisance appears to persist for several years at least but, in the longer term, nuisance levels tend back towards those expected for a gradual increase in noise.

7.3.9 In this assessment, noise nuisance predictions are based on the highest nuisance levels expected during the first 15 years after opening (Do-Something) and are compared to the nuisance levels of the Do-Minimum baseline year (2016). This approach represents a 'worst case scenario'. The assessment has been undertaken in accordance with the predictive technique presented in DMRB. The 'do something' scenario is for the scheme including the proposed noise bunds that are integral to the design.

Vibration Nuisance

7.3.10 Where properties are within 40m, DMRB recommends that, for a given level of noise exposure, the percentage of those bothered by air borne vibration is 10% lower than the corresponding figure for noise nuisance derived from tables contained within DMRB. Where noise levels are below 58 dB $L_{A10,18hr}$, it should be assumed that no-one would be bothered.

Limitations and Assumptions

7.3.11 The assessment of noise is greatly influenced by traffic data as calculations use this information in predicting noise levels. The traffic model was able to provide speeds for individual links in the area for all scenarios together with HGV percentages.

7.3.12 Property names and counts in the study area are based on Ordnance Survey mapping.

7.4 BASELINE CONDITIONS

Receptor Selection

7.4.1 A number of sample receptors were chosen for the noise assessment (see Table 7.2 and Figure 7.1). While all properties have been assessed in accordance with DMRB, for discussion purposes these sample receptors have been selected. These sample receptors are considered to have noise environments representative of those at other nearby receptors and also where people are particularly sensitive to noise and include dwellings close the proposed LEB. Furthermore, locations have been selected where it has been anticipated that properties have the potential to experience significant changes in noise level following the introduction of the scheme.

Table 7.2: Sample Receptors

Ref. No.	Receptor
1	64 Lilford Road
2	141 Hawthorn Chase
3	14 Whitefriars Road
4	Stoneleigh House, Greetwell Road
5	64 Lincoln Road (B1190)
6	Sheepwash Grange, Heighington Road
7	Glebe Farm, Heighington Road
8	257 Lincoln Road (B1188)
9	Canwick Manor, Canwick Avenue
10	42 Wells Drive
11	Westfield Farm, Folly Lane

Ref. No.	Receptor
12	1 Westfield Farm Bungalows, Bloxholm Lane
13	33 King Drive
14	7 Sleaford Road (A15)
15	33 London Road (A15)
16	80 Station Road
17	56 Greetwell Road
18	1 Tower Garden
19	335 Monks Road
20	8 Outer Circle Drive
21	107 Bunkers Hill (A15)
22	50 Beaufort Road
23	Themis, Lincoln Road (B1182)
24	176 Nettleham Road (B1182)

Noise Monitoring

7.4.2 Jacobs undertook a baseline noise survey in February 2009. Measured noise levels have been taken at properties in close proximity to the proposed scheme where existing noise levels are potentially not dominated by road traffic noise. Noise measurements have been undertaken to provide a basis for future comparison at properties identified by the local authorities Environmental Health Officers.

7.4.3 Long term unattended noise surveys were undertaken in Whitefriars Road, Canwick Manor, Glebe Farm and Westfield Farm Cottages between Thursday 19th and Thursday 26th February 2009. Noise measurements undertaken at these properties are representative of other nearby properties. The noise environment at these properties consists of general environmental noise dominated by aircraft noise from the fighter aircraft of RAF Waddington together with road traffic noise from the local residential roads together with bird song and the noise of general agricultural activities.

7.4.4 Short term noise measurements were undertaken in close proximity to Ashfield House, Sheepwash Grange, Westfield Farm and Wells Drive on the 20th and 26th February 2009. The noise environment at these receptors was dominated by road traffic noise and aircraft noise.

7.4.5 The results from the noise measurement exercise are provided in Table 7.3 and Table 7.4 and shown in Figure 7.1, The $L_{Aeq\ 18h}$ noise levels have been derived from the short term noise measurements utilising the long term noise monitoring data.

Table 7.3: Long Term Monitored Noise Levels (2009)

Ref. No.	Receptor	Measurement Type	Measured Noise Level $L_{Aeq\ 18h}$ dB
3	14 Whitefriars Road	Long Term Unattended	48.0
7	Glebe Farm	Long Term Unattended	52.8
9	Canwick Manor	Long Term Unattended	52.7
12	1 Westfield Farm Bungalows	Long Term Unattended	55.6

Table 7.4: Short Term Monitored Noise Levels (2009)

Ref. No.	Receptor	Measurement Type	Derived Noise Level $L_{Aeq\ 18h}$ dB
10	42 Wells Drive	Short Term Attended	48.9
	Ashfield House	Short Term Attended	57.3
6	Sheepwash Grange	Short Term Attended	57.4
11	Westfield Farm	Short Term Attended	52.1

7.5 PREDICTED IMPACTS

Potential Construction Impacts

7.5.1 Factors expected to influence noise levels perceived at nearby properties include:

- Existing noise levels;
- Type and number of activities;
- Type of plant;
- Distance from noise sources;
- Topography; and
- Wind direction.

7.5.2 Noise and vibration impacts would vary throughout the construction period, and are dependent on the contractor's chosen method of working and on the timing and phasing of certain operations. Whilst there is the potential for relatively high noise levels at particular locations for short periods, the long, narrow nature of the site should ensure that the location of the main working areas changes on a regular basis. This would limit the duration of exposure of any one receptor to high levels of construction noise.

7.5.3 Vibration from construction projects is generally caused by general equipment operations and tends to be highest during soil compaction, earth-moving and piling.

7.5.4 The construction of the bridges over and under the railway lines and over the River Witham are considered to have the potential to result in the greatest noise and vibration impacts. This is due to the likely duration of this phase and potential plant required, which is likely to include pilling operations. It is therefore likely that those receptors in close proximity to the bridge construction, would potentially experience the highest noise and vibration levels due to construction activities.

7.5.5 The construction methodology and programme have yet to be determined and therefore a detailed construction assessment could not be undertaken at this stage. A detailed construction noise assessment will be undertaken when construction methodologies and plant are clearly defined, and discussions held with the local authority on the conclusions and intended working practices.

Potential Operational Impacts

7.5.6 The proposed scheme passes through a mainly rural area adjacent to a number of isolated sensitive receptors. Whilst the scheme would introduce a new noise source into this area, the area would remain one of a rural nature dominated by aircraft noise from RAF Waddington.

7.5.7 The introduction of the LEB would enable the traffic to re-route and to bypass the city centre resulting in changes in flows on a number of roads in the local road network. Properties located nearby to such roads would experience changes in noise and vibration levels as a result of these changes in traffic flow.

Noise Levels at Representative Locations

7.5.8 Tables 7.5 and 7.6 below compare the measured and predicted noise levels at each sample receptor, for the baseline and Do-Something scenario in 2016 and the baseline and the Do-Something scenario in 2031. Where properties are currently not significantly affected road traffic, baseline noise levels are quoted as L_{Aeq} levels measured at the appropriate adjacent monitoring point. The noise levels have been calculated using CadnaA, with façade corrections, and at first floor level. Tables 7.5 and 7.6 below also show the magnitude of impact for noise change in accordance with the criteria contained in Table 7.1.

Table 7.5: Comparison of Predicted Noise Levels for Do-Minimum and Do-Something Scenarios (2016)

Ref. No.	Receptor	Do-Minimum 2016, $L_{A10, 18h}$ (dB) *	Do-Something 2016, $L_{A10, 18h}$ (dB)	Noise Level Change (dB)	Noise Impact
1	64 Lilford Road	61.6	61.3	-0.3	Negligible
2	141 Hawthorn Chase	58.2	64.1	5.9	Major
3	14 Whitefriars Road	48.0	48.0	0	No Change
4	Stoneleigh House, Greetwell Road	70.9	68.7	-2.2	Minor
5	64 Lincoln Road (B1190)	69.6	69.4	-0.2	Negligible
6	Sheepwash Grange, Heighington Road	57.4	57.4	0	No Change
7	Glebe Farm, Heighington Road	52.8	52.8	0	No Change
8	257 Lincoln Road (B1188)	80.1	76.9	-3.2	Moderate
9	Canwick Manor, Canwick Avenue	52.7	52.7	0	No Change
10	42 Wells Drive	48.9	48.9	0	No Change
11	Westfield Farm, Folly Lane	52.1	52.1	0	No Change
12	1 Westfield Farm Bungalows, Bloxholm Lane	55.6	55.6	0	No Change
13	33 King Drive	70.5	69.2	-1.3	Minor
14	7 Sleaford Road (A15)	74.4	73.5	-0.9	Negligible
15	33 London Road (A15)	69.1	67.6	-1.5	Minor
16	80 Station Road	66.3	62.6	-3.7	Moderate
17	56 Greetwell Road	75.2	72.2	-3.0	Moderate
18	1 Tower Garden	70.9	68.1	-2.8	Minor
19	335 Monks Road	71.9	70.2	-1.7	Minor
20	8 Outer Circle Drive	64.8	63.8	-1.0	Minor
21	107 Bunkers Hill (A15)	73.5	68.9	-4.6	Moderate
22	50 Beaufort Road	62.6	62.3	-0.3	Negligible
23	Themis, Lincoln Road (B1182)	68.1	63.7	-4.4	Moderate

Ref. No.	Receptor	Do-Minimum 2016, $L_{A10, 18h}$ (dB) *	Do-Something 2016, $L_{A10, 18h}$ (dB)	Noise Level Change (dB)	Noise Impact
24	176 Nettleham Road (B1182)	72.0	67.3	-4.7	Moderate

*** Measured LAeq noise levels used for baseline where appropriate**

Table 7.6: Comparison of Predicted Noise Levels Between Baseline and Do-Something Scenario (2031)

Ref. No.	Receptor	Do-Minimum 2016, $L_{A10, 18h}$ (dB) *	Do-Something 2031, $L_{A10, 18h}$ (dB)	Noise Level Change (dB)	Noise Impact
1	64 Lilford Road	61.6	61.9	0.3	Negligible
2	141 Hawthorn Chase	58.2	65.5	7.3	Major
3	14 Whitefriars Road	48.0	48.6	0.6	Negligible
4	Stoneleigh House, Greetwell Road	70.9	69.4	-1.5	Minor
5	64 Lincoln Road (B1190)	69.6	70.5	0.9	Negligible
6	Sheepwash Grange, Heighington Road	57.4	57.4	0	No Change
7	Glebe Farm, Heighington Road	52.8	52.8	0	No Change
8	257 Lincoln Road (B1188)	80.1	76.8	-3.3	Moderate
9	Canwick Manor, Canwick Avenue	52.7	52.7	0	No Change
10	42 Wells Drive	48.9	48.9	0	No Change
11	Westfield Farm, Folly Lane	52.1	52.1	0	No Change
12	1 Westfield Farm Bungalows, Bloxholm Lane	55.6	56.5	0.9	Negligible
13	33 King Drive	70.5	70.4	-0.1	Negligible
14	7 Sleaford Road (A15)	74.4	74.4	0	No Change
15	33 London Road (A15)	69.1	68.3	-0.8	Negligible
16	80 Station Road	66.3	63.2	-3.1	Moderate
17	56 Greetwell Road	75.2	73.3	-1.9	Minor
18	1 Tower Garden	70.9	68.8	-2.1	Minor
19	335 Monks Road	71.9	71.8	-0.1	Negligible
20	8 Outer Circle Drive	64.8	64.8	0	No Change
21	107 Bunkers Hill (A15)	73.5	69.5	-4.0	Moderate
22	50 Beaufort Road	62.6	62.6	0	No Change
23	Themis, Lincoln Road (B1182)	68.1	65.2	-2.9	Minor
24	176 Nettleham Road (B1182)	72.0	68.2	-3.8	Moderate

*** Measured LAeq noise levels used for baseline where appropriate**

7.5.9 The impacts shown in Tables 7.5 and 7.6 show that properties situated on the main arterial roads within the City of Lincoln experience noise level decreases. For properties located on roads such as Station Road, Bunkers Hill and Nettleham Road, with moderate to minor noise benefits when the Do-Minimum 2016 is compared to the With Scheme, it is likely that these noise reductions would be noticeable to

occupants of properties in close proximity to these roads. These noise benefits are as a result of redistribution of traffic within the local road network as a result of the scheme.

7.5.10 Although there are reductions in traffic flow on the B1190 Lincoln Road and A15 Sleaford Road, the noise benefits that nearby properties would experience are 'Negligible'.

7.5.11 Tables 7.5 and 7.6 indicate that 'Major' adverse noise impacts would occur to a number of properties in close proximity to the proposed alignment of the bypass. These adverse impacts occur as a result of the introduction of a new noise source into the area. The noise increases as a result of the scheme would be clearly noticeable for occupants of such properties and other sensitive receptors in this area, and the impact is considered significant.

7.5.12 Properties located in close proximity to Hawthorn Road, such as the properties in Hawthorn Chase and the new residential development in Bee Field, are predicted to experience significant adverse noise impacts as a result of the introduction of the proposed LEB.

7.5.13 Properties located in a relatively rural location such as Glebe Farm, Heighington Road, Westfield Farm, Folly Lane and Canwick Manor, Canwick Avenue currently experience high ambient L_{Aeq} noise levels due to the frequent aircraft movements from the adjacent RAF Waddington. The impact of the proposed scheme is therefore 'Negligible to No-Change' in terms of the noise environment of these properties.

7.5.14 On the wider road network 'Minor' or negligible benefits are generally predicted for properties within the City, noise level changes for such properties are likely to be noticeable as traffic is removed from the City but are not considered to be significant.

Noise and Nuisance Summary Table

7.5.15 Tables 7.7 and 7.8 provide the noise and nuisance summary tables. These tables are produced in accordance with the requirements of DMRB, comparing baseline (2016) Do-Minimum Scenario noise levels against future year (2031) Do-Minimum and Do-Something noise levels for all residential dwellings in the assessment area to show the change in noise and nuisance over time.

Table 7.7: Summary Table for Do-Minimum Scenario 2031

Change in noise/nuisance level		Number of Dwellings (façade noise band $L_{A10,18h}$ dB for Do-Minimum condition in baseline year)														
		Total	< 47.5	47.5 - 50.4	50.5 - 53.4	53.5 - 56.4	56.5 - 59.4	59.5 - 62.4	62.5 - 65.4	65.5 - 68.4	68.5 - 71.4	71.5 - 74.4	74.5 - 77.4	77.5 - 80.4	80.5 - 83.4	≥ 83.5
Increase in noise level, $L_{A10,18h}$	0															
	0.1 - 0.9	2834	1507	351	206	245	73	71	153	102	83	42	1			
	1.0 - 2.9	1394	326	296	179	146	62	11	33	55	134	146	6			
	3 - 4.9															
	5 +															
Decrease in noise level, $L_{A10,18h}$	0	1098	80	968	16	8	8	1	8	1	6	2				
	0.1 - 0.9	2044	820	538	226	127	81	40	27	41	59	59	26			
	1.0 - 2.9	3880	1832	510	357	231	124	52	37	191	270	189	85	2		
	3 - 4.9	40				2		1	1	6	3	19	8			
	5 +															
Increase in nuisance level	< 10%	4228	1833	647	385	391	135	82	186	157	217	188	7			
	10 < 20%															
	20 < 30%															
	30 < 40%															
	> 40%															
No Change	0%	1098	80	968	16	8	8	1	8	1	6	2				
Decrease in nuisance level	< 10%	5964	2652	1048	583	360	205	93	65	238	332	267	119	2		
	10 < 20%															
	20 < 30%															
	30 < 40%															
	> 40%															

Table7.8: Summary Table for Do-Something Scenario 2031

Change in noise/nuisance level		Number of Dwellings (façade noise band $L_{A10,18h}$ dB for Do-Something Condition in Baseline Year)														
		Total	< 47.5	47.5 - 50.4	50.5 - 53.4	53.5 - 56.4	56.5 - 59.4	59.5 - 62.4	62.5 - 65.4	65.5 - 68.4	68.5 - 71.4	71.5 - 74.4	74.5 - 77.4	77.5 - 80.4	80.5 - 83.4	≥ 83.5
Increase in noise level, $L_{A10,18h}$	0															
	0.1 - 0.9	1593	716	293	171	99	63	44	41	43	56	67				
	1.0 - 2.9	697	133	128	65	188	22	14	71	60	16					
	3 - 4.9	29		22	3	1		2	1							
	5 +	25		7	9	3	5	1								
Decrease in noise level, $L_{A10,18h}$	0	1515	228	949	79	57	58	24	25	28	41	26				
	0.1 - 0.9	2580	937	642	288	176	79	31	69	64	167	109	18			
	1.0 - 2.9	3662	2199	506	220	130	74	45	27	73	230	122	35	1		
	3 - 4.9	1189	352	116	149	105	47	15	25	128	45	133	73	1		
	5 +															
Increase in nuisance level	< 10%	1742	787	315	191	122	63	44	41	49	63	67				
	10 < 20%	365	62	82	30	29	22	11	66	54	9					
	20 < 30%	213		41	18	137	5	6	6							
	30 < 40%	25		12	10	3										
	> 40%															
No Change	0%	1514	228	949	78	57	58	24	25	28	41	26				
Decrease in nuisance level	< 10%	7292	3488	1264	657	411	200	91	121	265	435	293	65	2		
	10 < 20%	139									7	71	61			
	20 < 30%															
	30 < 40%															
	> 40%															

7.5.16 The summary tables indicate that the introduction of the LEB would result in a larger number of dwellings experiencing decreases in noise level in the Do-Something scenario (2344) when compared to the Do-Minimum scenario (4228). The summary tables indicate, that the number of properties experiencing significant increases (+ 3dB) in noise levels is much greater in the Do-Something scenario (1189) when compared to the Do-Minimum scenario (40).

7.5.17 The summary tables indicate, that the number of properties experiencing significant increases (< 10%) in nuisance levels is much greater in the Do-Something scenario (603) when compared to the Do-Minimum scenario (0).

7.5.18 The summary tables indicate that the number of properties experiencing noise reductions in the 2031 Do-Something scenario (7431) exceeds those experiencing reductions in the 2031 Do-Minimum scenario (5964). Correspondingly the change in nuisance follows a similar pattern, with the number of properties experiencing nuisance reductions in the Do-Something scenario (5917) exceeds those experiencing reductions in the Do-Minimum scenario (4866)

Other Affected Routes

7.5.19 For routes where traffic flows are predicted to change outside the immediate study area (within 2km of the scheme) where noise calculations have been undertaken DMRB recommends that an assessment should be undertaken through obtaining the basic noise level on these affected routes. The number of dwellings and other sensitive receptors within 50m of the centreline of these affected roads should then be assessed. The assessment has been undertaken for the Do-Minimum and Do-Something conditions in both the baseline year and the scheme design year. The results are presented in Table 7.9.

Table 7.9: Summary Table of Basic Noise Levels and Property Numbers on Affected Routes

Link Name	CadnaA® ID	Property Counts	Flow (18h AAWT)				Basic Noise Level		$L_{A10, 18h}$ (dB)	
			DM 2016	DM 2031	DS 2016	DS 2031	DM 2016	DM 2031	DS 2016	DS 2031
Cross O'Cliff Hill A15	rd_578676076	23	21360	23464	10760	13388	72.4	72.8	69.4	70.4
Cross O'Cliff Hill A15	rd_579209861	15	21356	23522	11139	13789	72.4	72.8	69.6	70.5
Cross O'Cliff Hill A15	rd_26030540	17	21363	23366	11688	14320	72.4	72.8	69.8	70.7
St Catherines A15	rd_26030088	15	11162	12251	8556	10239	69.6	70.0	68.4	69.2
High Street B1260	rd_26029963	4	20461	20737	16275	18422	72.2	72.3	71.2	71.8
High Street B1260	rd_580396570	45	19391	19456	14535	16985	72.0	72.0	70.7	71.4
High Street B1260	rd_579837071	6	22084	22423	16686	19631	72.5	72.6	71.3	72.0
Canwick Road A15	rd_26029376	79	39265	41748	29503	33769	75.0	75.3	73.8	74.4
Canwick Road A15	rd_579141443	16	41930	43808	32051	35258	75.3	75.5	74.2	74.6
Melville Street A15	rd_577369535	59	47568	50371	37314	42094	75.9	76.1	74.8	75.3
Broadgate A15	rd_577736336	2	42854	45024	34042	37220	75.4	75.6	74.4	74.8
Broadgate A15	rd_26028632	1	39036	41086	30052	32534	75.0	75.2	73.9	74.2
Broadgate A15	rd_577369493	1	36196	37824	29114	30268	74.7	74.9	73.7	73.9
Monks Road	rd_26028445	2	16883	18830	12667	14702	71.4	71.8	70.1	70.8
Monks Road	rd_579388585	32	17924	19602	14040	16362	71.6	72.0	70.6	71.2
Monks Road	rd_578392705	102	19442	20603	14819	17126	72.0	72.2	70.8	71.4
Newport	rd_580186291	94	6101	6716	4819	6672	67.0	67.4	65.9	67.3
Nettleham Road	rd_26027822	16	6738	7116	5325	5919	67.4	67.6	66.4	66.8
Northgate	rd_577368474	5	12314	12762	10130	12078	70.0	70.2	69.2	69.9
Lindum Terrace	rd_578316916	19	2475	2239	681	1030	63.0	62.6	57.4	59.2
Greetwell Road	rd_578891180	23	14349	15412	11517	13694	70.7	71.0	69.7	70.5
Greetwell Road	rd_26027963	7	19147	20548	16613	18688	71.9	72.2	71.3	71.8
Stamp End	rd_579229096	133	3374	3815	2632	3811	64.4	64.9	63.3	64.9
A15	rd_577368253	6	24763	30260	18197	23653	73.0	73.9	71.7	72.8
B1178	rd_78783550	6	3156	3691	1846	2432	64.1	64.8	61.8	63.0

7.5.20 DMRB requires the consideration of noise sensitive receptors that are not residential dwellings, and recommends the use of a summary table. Other noise sensitive receptors can include churches, recreational areas, schools and hospitals. Tables 7.10 and 7.11 compares baseline (2016) Do-Minimum Scenario noise levels against design year (2031) Do-Minimum and Do-Something noise levels for other noise sensitive receptors in the assessment area.

Table 7.10: Summary Table for Do-Minimum Scenario for Other Sensitive Receptors

Change in noise level, $L_{A10,18hr}$ dB	Number of other sensitive receptors subject to a change in noise level	
	Increase in noise level	Decrease in noise level
0		
0 – 0.9		
1 – 2.9		10
3 – 4.9		11
5 +		

Table 7.11: Summary Table for Do-Something Scenario for Other Sensitive Receptors

Change in noise level, $L_{A10,18hr}$ dB	Number of other sensitive receptors subject to a change in noise level	
	Increase in noise level	Decrease in noise level
0		
0 – 0.9		3
1 – 2.9		13
3 – 4.9		5
5 +		

7.5.21 Tables 7.10 and 7.11 indicate that the number of other sensitive receptors in the assessment area that experience noise changes as a result of the introduction of the scheme is similar between the Do-Minimum and Do-Something scenario.

Noise Insulation

7.5.22 As stated in Section 7.2.1, the Noise Insulation Regulations 1975 (as amended in 1988) specify the circumstances in which a property should be fitted with insulation. It has been provisionally predicted that there are no properties that are likely to be eligible for insulation in accordance with the relevant criteria in Section 7.2.1.

Vibration

7.5.23 The change in vibration nuisance levels for the sample receptors, comparing the baseline Do-Minimum scenario with the design year Do-minimum and Do-Something scenarios, are shown in Table 7.12 and 7.13 respectively. In accordance with DMRB guidance, only those sample receptors located with 40m of a road are considered in the assessment of vibration nuisance.

Table 7.12: Vibration Nuisance Assessment for Do-Minimum Scenario

Ref. No.	Receptor	DM % bothered by vibration (2016)	DM % bothered by vibration (2031)	Difference in % bothered by Vibration
2	141 Hawthorn Chase	0.0	0.0	0.0
13	33 King Drive	25.0	25.3	0.3
14	7 Sleaford Road (A15)	36.2	37.7	1.5
15	33 London Road (A15)	21.3	21.8	0.5
16	80 Station Road	14.5	8.8	-5.7
17	56 Greetwell Road	38.6	34.7	-3.9
18	1 Tower Garden	26.1	23.4	-2.7
19	335 Monks Road	28.9	32.9	4.1
20	8 Outer Circle Drive	11.3	11.6	0.2
21	107 Bunkers Hill (A15)	33.5	25.5	-8.0
23	50 Beaufort Road	18.7	15.0	-3.8
24	176 Nettleham Road (B1182)	29.2	23.1	-6.1

Table 7.13: Vibration Nuisance Assessment for Do-Something Scenario

Ref. No.	Receptor	DM % bothered by vibration (2016)	DM % bothered by vibration (2031)	Difference in % bothered by Vibration
2	141 Hawthorn Chase	0.9	12.8	11.8
13	33 King Drive	25.0	24.7	-0.3
14	7 Sleaford Road (A15)	36.2	36.2	0.0
15	33 London Road (A15)	21.3	19.2	-2.0
16	80 Station Road	14.5	8.3	-6.2
17	56 Greetwell Road	38.6	32.9	-5.7
18	1 Tower Garden	26.1	20.5	-5.6
19	335 Monks Road	28.9	28.6	-0.3
20	8 Outer Circle Drive	11.3	11.3	0.0
21	107 Bunkers Hill (A15)	33.5	22.3	-11.2
23	50 Beaufort Road	18.7	12.2	-6.6
24	176 Nettleham Road (B1182)	29.2	19.0	-10.2

7.5.24 Tables 7.12 and 7.13 show that in the Do-Something scenario the change in vibration nuisance varies depending on the sample receptors location within the local road network. At the majority of properties located on roads within the City vibration nuisance levels are predicted to decrease with the LEB. Such changes are as a result of re-distribution of traffic on the road network as a result of the opening of the bypass.

7.5.25 The sample receptor 141 Hawthorn Road, which is located in close proximity to the proposed scheme would experience an 11.8% increase in vibration nuisance. This is due to the high levels of traffic that would be introduced along the new section of the carriageway.

7.6 MITIGATION

Construction Phase

7.6.1 It is anticipated that the following mitigation measures should be employed on site to ensure that noise levels are attenuated as far as possible:

- The use of 'best practicable means' during all construction activities;
- Switching off plant and equipment when it is not in use for longer periods of time;
- Establish agreement with the local authority on appropriate controls for undertaking significantly noisy works or vibration-causing operations close to receptors;
- Programming works so that the requirement for working outside normal working hours is minimised (taking into account the highway authority's statutory duties under the Traffic Management Act 2004). Limits to working hours would be included in the contract documents;
- Use of low noise emission plant where possible;
- The use of temporary noise screens around particularly noisy activities; and
- Regular plant maintenance.

Operational Phase

7.6.2 This assessment predicts that receptors that are located in close proximity to the LEB would experience significant adverse noise impacts.

Noise Barriers and Earth Bunds

7.6.3 Extensive use is made of earth bunding throughout the scheme particularly through the southern section. Noise barriers and earth bunds set close to a road can provide protection to both internal and external environments at residential developments. They can take the form of substantial fences, walls, earth mounds, or willow walls.

Low Noise Road Surface

7.6.4 The carriageway of the proposed bypass would be constructed with a quieter road surface, this would reduce noise levels by up to 3.5 dB(A) when compared to that if standard hot rolled asphalt were to be used.

7.7 RESIDUAL IMPACTS

Construction Impacts

7.7.1 Noise and vibration levels are likely to be elevated in the immediate vicinity of the proposed scheme due to various construction activities taking place. The extent of noise and vibration impacts would vary throughout the construction period and would depend on the contractor's chosen method of working, as well as the timing and phasing of certain operations.

7.7.2 Through the implementation of suitable mitigation proposals and the undertaking of noise and vibration monitoring, in agreement with the Local Authorities, the impacts arising from the construction activities would be minimised.

Operational Impacts

7.7.3 No additional mitigation measures are proposed in respect of noise caused by the use of the improved road. Operational impacts would therefore be unchanged from those described above.

8 CULTURAL HERITAGE

8.1 INTRODUCTION

Definition and Scope of the Topic

8.1.1 This chapter has been prepared in accordance with guidance provided in DMRB, Volume 11, Section 3 Part 2, Cultural Heritage (HA 208/07). It considers Cultural Heritage under the sub-headings of 'archaeological remains', 'historic buildings' and 'the historic landscape'.

Legal and Policy Background to the Cultural Heritage Assessment

National Policy and Guidance

8.1.2 Scheduled Ancient Monuments (SAMs) are by definition of National Importance and are protected by law under the Ancient Monuments and Archaeological Areas Act 1979.

8.1.3 PPG 16[6] gives advice on archaeology in the planning system and the use of planning conditions. PPG 16 states that the preferred option for mitigating impacts on archaeological sites is preservation *in situ* (for example by avoiding the site all together or by careful burial of known remains under controlled conditions) or, where this is not feasible, 'preservation by record' through the archaeological recording of sites, production and retention of an archive and wide dissemination of results. PPG16 also emphasises the importance of setting.

8.1.4 Listed Buildings are protected under the Town and Country Planning Act 1971, as amended by the Planning (Listed Buildings and Conservation Areas) Act 1990. Conservation Areas are designated under the Planning (Listed Buildings and Conservation Areas) Act 1990. PPG 15[7] provides a full statement of Government policy for the identification and protection of historic buildings, conservation areas and other elements of the historic environment.

8.1.5 The Register of Parks and Gardens of Special Historic Interest in England is complied and maintained by English Heritage. Sites are assessed against nine criteria to determine special historic interest, including age, designer, associations and group value. Inclusion on the Register does not provide any statutory protection for the site, but is a material consideration in the planning process.

8.1.6 Important Hedgerows are protected under the Hedgerows Regulations 1997[8]. Archaeological and historical criteria for designating Important Hedgerows are set out in Schedule I, Part II of the regulations. The removal of an Important Hedgerow or part of an Important Hedgerow would require submission of a hedgerow removal notice. The regulations detail permitted work, where a removal notice would normally be approved, in Section 6 – 1. This section states:

6 - (1) The removal of any hedgerow to which these Regulations apply is permitted if it is required -

(a) for making a new opening in substitution for an existing opening which gives access to land, but subject to paragraph (2);

[6] Planning Policy Guidance Note 16: Archaeology and Planning (PPG16).
[7] Planning Policy Guidance Note 15: Planning and the Historic Environment. (PPG 15), as amended by DCMS circular PP9927.
[8] Statutory Instrument 1997 No. 1160 The Hedgerows Regulations 1997

(e) for carrying out development for which planning permission has been granted or is deemed to have been granted, except development for which permission is granted by article 3 of the Town and Country Planning General Permitted Development Order 1995 in respect of development of any of the descriptions contained in Schedule 2 to that Order other than Parts 11 (development under local or private Acts or orders) and 30 (toll road facilities)[.]

Regional and Local Planning Policy

8.1.7 A range of Regional and Local planning policies provide guidance and control over development affecting archaeology, historic buildings and the historic landscape. Policies 26 and 27 of the Regional Spatial Strategy for the East Midlands (RSS8) provide the regional policies for the historic environment of the East Midlands as a whole.

8.1.8 Policy 26 defines the commitment to the protection, management and enhancement of natural and cultural assets and their setting. Of the principles outlined in this policy those relevant to cultural heritage are:

- A commitment to the highest level of protection for nationally and internationally designated sites;
- Avoidance or minimisation of damage to sites and their settings;
- The need for strong justification for and mitigation of damage to cultural assets; and
- A commitment to the preservation of heritage assets across the region.

8.1.9 Policy 27 defines the regional priorities for the historic environment to be the understanding, conservation, and enhancement of the historic environment of the region and the promotion of sensitive change. Actions recommended to Local Planning Authorities under this policy include the identification and assessment of the significance of specific historic assets and their settings; and the use of characterisation to understand the contribution of a site to the landscape or townscape in areas of change.

8.1.10 More detailed policies for the area around Lincoln are provided in the Sub Regional Strategy for the Lincoln Policy Area. The core strategy recognises the protection and enhancement of the historic and architectural character of Lincoln and its setting to be important in strengthening the regional role of this policy area. The historic setting of Lincoln is protected under policy SRS3 through the definition of green wedges to protect the urban fringes of Lincoln. Policy SRS10 protects the dominance and approach views of Lincoln Cathedral on the skyline.

8.1.11 Archaeology is considered under the following Local Plan policies:

- Policy NBE7 of the West Lindsey Local Plan First Review (Adopted June 2006); and
- Policies HE1, HE2 and HE3 of the North Kesteven Local Plan (Adopted September 2007).

8.1.12 In accordance with the guidance provided by PPG16, the main requirements of these policies are:

- Pre-application evaluation for developments which are considered likely to impact upon sites of archaeological importance or their settings,
- The preference for preservation *in situ*;
- The presumption against development which would detrimentally affect archaeological remains of national or international importance; and

- Preservation by record of archaeological remains where appropriate.

8.1.13 Protection of listed buildings is provided by the :

- Policy NBE3 of the West Lindsey Local Plan First Review; and
- Policy HE5 of the North Kesteven Local Plan.

8.1.14 These policies follow the guidance provided in PPG15 and seek to preserve the designated structures by exercising control over alteration, demolition and changes to setting, that are considered to adversely affect the listed building.

8.1.15 Policy 31 of the City of Lincoln Local Plan (Adopted 1998) provides additional protection for buildings and structures of local importance. This policy states that planning permission will not be granted for development which would harm the appearance, setting or townscape contribution of such a building, unless there is an overriding economic, social or environmental case.

8.1.16 Historic Parks and Gardens are protected under Policy NBE8 of the West Lindsey Local Plan. This policy states that development which would have a detrimental effect on character appearance or setting of historic parks and gardens will not be permitted. Within West Lindsey this is applied to both to parks and gardens included on the English Heritage Register of Parks and Gardens of Special Historic Interest and those considered by the council to be worthy of protection.

8.1.17 A number of policies are included within Local plans to protect the setting of, and views of Lincoln City Centre, and particularly landmark views of the Cathedral.

8.1.18 Policy 55 of the Lincoln City Local Plan defines 16 views into and out of the city which are to be protected from obstruction or other impingement. Two of these views have been identified as relevant to this assessment. Views from Lindum Terrace are protected under Policy 14. This street defines the northern edge of Lindum & Arboretum Conservation Area No. 3 (Site 783) and these views form a significant element of the character of this designated area. Views from the historic city, including the Cathedral's main tower, the Castle's walls and the Observatory Tower are protected under View 15. This view has been identified as important to this assessment due to the distinctive topographical location of the Upper City, and the role of long views in defining the setting of historic structures and streets in this area.

8.2 APPROACHES AND METHODS

Sources of Information and Study Area

8.2.1 In order to assess the cultural heritage baseline, a cultural heritage baseline study was undertaken. The results of this survey, including detailed information on the sources consulted, are provided in Appendix 8B. The study area for archaeological remains and built heritage was defined as an area extending 200m in all directions from the edge of the proposed scheme. For the Historic Landscape, a study area was defined as a buffer extending 1km from the centreline of the scheme

8.2.2 In order to identify SAMs, Listed Buildings and Conservation Areas on which impacts on setting may arise, a study area was defined covering an area extending 1km from the scheme. Of the 19 sites identified within this 1km area, five were excluded from further assessment due to their strongly urban settings and lack of inter-visibility with the scheme. Five sites outside the 1km study area were also included in the Historic Buildings baseline study due to their sensitivity and topographic location. These are listed in Appendix 8B.

8.2.3 The baseline study includes the results of a staged programme of archaeological evaluation, comprising surface artefact collection with metal detecting, geophysical

survey, trial trenching and a palaeoenvironmental assessment, of the proposed road alignment. The results of the evaluation are presented in Appendices 8C – 8J.

8.2.4 The majority of geophysical anomalies within the footprint of the road have been tested by trial trenching and the assessment of value for these sites is based on the results of the trial trenching. Some potential sites outside the roadline have been identified by geophysical survey, but have not been tested by trial trenching. In these cases an attempt has been made to characterise the likely nature of these sites based on similar features which have been tested. Where this has not been possible, the value of these potential sites has been assessed as Unknown.

8.2.5 Numerous findspots have been recorded by the National Monuments Record (NMR), Historic Environment Record (HER) and Sites and Monuments Record (SMR) and identified in fieldwork undertaken to inform this assessment. These consist of artefacts found on the ground surface, either singly or as scatters of material. The evidence from both the geophysical survey and trial trenching indicates that that the majority of medieval and post medieval finds relate to the practice of manuring fields with refuse from the surrounding settlements rather than evidence of settlement or other activity. For the purposes of assessment, all findspots and artefact scatters have been assessed to have been destroyed (by the act of removing the artefacts from the field), therefore they are assessed as of Negligible Value

Assessment of Impacts

8.2.6 Based on the framework described in Chapter 4, the significance of any impact has been assumed to be a function of the value of the individual receptor and the magnitude of the change in baseline conditions caused by the scheme. The methodology for the assessment of cultural heritage value and the magnitude of change are set out in Appendix 8A and are summarised below.

8.2.7 Based on the guidance set out in DMRB, the value of each archaeological site, historic building and historic landscape type was assessed according to the following criteria:

- Archaeological Remains:
  - Legal designation; and
  - Potential of the site to contribute to local, regional, national and international research objectives;
- Historic Buildings:
  - Legal designation; and
  - Architectural or historical importance;
- Historic Landscape:
  - Legal designation; and
  - State of preservation, coherence and time depth.

8.2.8 The magnitude of impact is judged to be the degree of change to elements of the site and/or its setting. The degree of change can be to different elements of an archaeological site, historic building or historic landscape type. These elements themselves vary in their importance to our understanding of the site. The guidance in DMRB for each sub topic states that changes to key elements should be assessed as of a higher magnitude than changes to less important elements.

8.2.9 The significance of impact has been assessed using the matrix reproduced in Chapter 4 (Table 4.1).

8.2.10 Potential impacts at three stages have been assessed:

- **Construction impacts** – Predicted to occur during the construction period, prior to the opening of the scheme;
- **Operation impacts** – Predicted to occur in the year of the scheme's opening (2016); and
- **Residual impacts** – Predicted to occur 15 years after opening of the scheme (2031).

ARCHAEOLOGICAL REMAINS

8.3 BASELINE CONDITIONS

Known Sites

8.3.1 A detailed description of the archaeological baseline, incorporating the results of evaluation, is provided in the baseline study (Appendix 8B).

8.3.2 A total of 200 archaeological sites have been identified within the study area. These are described in detail in the Gazetteer of Archaeological Remains in Appendix 8C and shown on Figures 8.1a-g. The value of each if these sites has been assessed using the methodology detailed in Appendix 8A and is summarised in Table 8.1 below:

Table 8.1: Summary of Value of Archaeological Remains

Value	Number of Sites
Very High	0
High	5
Medium	14
Low	65
Negligible	100
Unknown	16
Total	**200**

Sites of High Value

8.3.3 Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains (Site 105, Figure 8.1c) is a Scheduled Ancient Monument and as such is of High Value. The extent of the scheduled area provided by English Heritage differs from the extent of the site provided by Lincolnshire Historic Environment Record (HER). For the purposes of assessment, the areas recorded by the HER which fall outside of the scheduled area have been identified as a separate site (Site 94, Figure 8.1c), which has been assessed as being of Medium Value. The upstanding buildings within the site are listed and are excluded from the Scheduled area. These are dealt with individually in the Historic Buildings section below, however, it should be noted that the key aspect of the setting of the earthwork remains of the Scheduled Ancient Monument is their relationship with these buildings.

8.3.4 Another site assessed as of High Value is a Multi-Period Occupation Site (Site 184, Figure 8.1d) with evidence for activity from the Mesolithic period through to the medieval period. The earliest remains of this site comprise a Mesolithic land surface with many flint artefacts and evidence for a high-status Roman site (possibly a villa), as well as some Early Medieval findspots and evidence of medieval agricultural activity in the form of ditches.

8.3.5 A settlement site dating from the late Iron Age through to the Roman period (Site 376, Figure 8.1b) has been identified by a combination of geophysical survey and trial trenching. This site comprises evidence of agricultural and domestic activity, spread over a wide area south of Bunkers Hill. English Heritage's national research agenda sets out the importance of identifying and investigating sites such as this with the potential to contribute to our understanding of the Iron Age/Roman transition. Therefore the value of the site has been assessed as High.

8.3.6 A further site of High Value is a multi-period site on the north bank of the Witham (Site 757, Figure 8.1d) This site comprises remains dating from the Mesolithic,

Bronze Age, Iron Age and possibly the early Roman period, including a series of timbers, preserved by peat deposits and interpreted as a possible boundary or timbers dating to the Iron Age/Roman transition period.

8.3.7 Remains of the medieval monastic farmstead Sheepwash Grange (Site 173, Figure 8.1d) have been identified within the study area. These comprise evidence of structures and agricultural features identified through geophysical survey and trial trenching. The site is known to occupy most of the triangular field immediately south of the Witham, and has been bisected by two Railway embankments (Sites 364 and 365, Figure 8.1d). Any remains within the footprint of the railways are assumed to have been destroyed. Some elements of the agricultural remains, such as ditches may extend south of the railways and overlap with the multi-period possible villa site (Site 184) described above.

Sites of Medium Value

8.3.8 In addition to Site 94 described above, other sites of Medium Value include remains of single period prehistoric occupation sites (Sites 50 151,and 289), and boundary ditches (Sites 26 and 250).

8.3.9 Located in the River Witham Valley, Site 151 (Figure 8.1d) is a buried land surface/flint knapping floor dating to the Mesolithic period. This land surface is thought to represent sand banks in the former Witham floodplain and numerous artefacts dated to the late Mesolithic or Early Neolithic have been found associated with it. On the north side of the river, the land surface has been buried by later deposits, such as peat and river deposits from dredging. Here, the surface is up to a meter below the current land surface. On the south side of the river, the prehistoric land surface is much closer to the surface, in some cases lying just below the topsoil.

8.3.10 Palaeoenvironmental surveys undertaken on the line of the proposed scheme have investigated the prehistoric land surface (Site 151) and peat deposits in the Witham Valley. The peat deposits have been found to be patchy, especially on the north side of the valley, with the best preservation of evidence due to waterlogging closest to the river. In addition to pollen and plant remains, these deposits have preserved organic artefacts such as waterlogged timbers described above (Site 757).

8.3.11 There are two Bronze Age barrow cemeteries in the Witham Valley (Sites 129 and 146, Figure 8.1c and d). The group of barrows to the immediate north of the Witham (Site 129) consists of 12 barrows, identified from aerial photography. The barrows are not well preserved and most are not visible above the ground surface. The group to the immediate south of the Witham (Site 146) consists of 7 barrows and is better preserved, with several barrows clearly visible above ground.

8.3.12 A cropmark site (Site 50, Figure 8.1a) identified by the National Monuments Record has been provisionally dated to the Prehistoric period. It is also suggested that there may be some Roman remains associated with the site. As this site lies off the proposed road alignment, no archaeological testing has taken place to verify these theories. Likewise, a curvilinear enclosure (Site 289, Figure 8.1g) has been noted as of possible Iron Age or Roman date South of Canwick Heath Farm. This feature also lies outwith the proposed road footprint, however evaluation nearby to the west of the site did not identify any remains associated with it. In the absence of definite evidence of the date and function of these remains, the Value of the sites has been assessed as Medium.

8.3.13 Another cropmark site (Site 26, Figure 8.1a and b) has been tested by trial trenching on several occasions, and has been found to date to the late Iron Age period. This triple-ditch feature runs from Nettleham in the north to south of Bunkers Hill, with several breaks along its line. This has been interpreted as an important boundary,

possibly noting the edge of a tribal territory. The Value of this site has been assessed as Medium.

8.3.14 A double-ditch feature to the south of Heighington Road (Site 250, Figure 8.1e) has been identified from aerial photographs and geophysical survey and tested by trial trenching. Only one large ditch was identified in the trench, dating to the Iron Age. This feature can be seen on aerial photographs, running across the crest of the hill which divides the Witham Valley (also known as the Lincoln Gap in this location) from the southern dip-slope of the Lincoln Edge. Due to its size and location, this feature is likely to have been an important boundary similar to the triple ditch system described above. The value of the site is therefore assessed as Medium.

8.3.15 Two Roman sites have also been assessed as Medium value, a settlement site possibly related to the military outpost in Lincoln (Site 76, Figure 8.1a and b), and a smaller farmstead (Site 110).

8.3.16 Early Medieval activity (Site 563 see Figure 8.1d) has been identified by trial trenching on Canwick Hill. Pottery found in shallow ditches and postholes has been dated to the late 7th – mid 9th centuries. A 9th – 13th century iron knife was recovered, as were animal and fish bones. Some of these bones bore signs of butchery and/or burning, which indicates domestic activity here. Of great interest are the fish bones, which include herring, an exclusively marine species. Sites of this period are scarce, and as this site seems to contain the potential to contribute to our understanding of the wider region, its value has been assessed as Medium.

8.3.17 Associated with this Sheepwash Grange (Site 173, Figure 8.1d) is documentary evidence of other medieval activity including the possible site of a wharf on the south bank of the Witham (Site 154). To date, no physical traces of the wharf have been discovered.

8.3.18 The Witham Navigation (Site 362, Figure 8.1d) was the chief waterway of the Lincolnshire Fens, and the City of Lincoln. While the Witham has been navigable since the Roman period, large scale improvements such as widening, deepening and straightening were undertaken in the 18th century. The Value of this site has been assessed as Medium, due to its historic importance to trade and communications in the Fens and the city of Lincoln.

Sites of Low Value

8.3.19 There are a total of 65 sites of Low Value within the study area. These are characterised by sub-surface remains of sites related to agricultural activity such as, lime kilns, ridge and furrow and drainage ditches. These include two “Important Hedgerows” described below.

8.3.20 One of the criteria for the definition of an Important Hedgrows under Schedule I, Part II, Section 1 of the Hedgerow regulations 1997 is

“1. The hedgerow marks the boundary, or part of the boundary, of at least one historic parish or township; and for this purpose "historic" means existing before 1850”

8.3.21 As the hedgerows marking the boundaries of Bracebridge Heath and Canwick Parishes (Sites784 and 785, Figure 8.1g) are shown on Bracebridge Heath Tithe map (1842) and on the Canwick Enclosure plan (1787) these have been identified as Important Hedgerows. The Value of these hedgerows has been assessed as Low due to the fact that they denote the boundaries of local parishes rather than county or national borders.

Sites of Negligible Value

8.3.22 There are 100 sites of negligible value. These are characterised by individual findspots or artefact scatters and sub-surface remains of post medieval agricultural ditches and pits.

Sites of Unknown Value

8.3.23 There are a total of 16 sites of unknown value. Twelve of these are non-ferrous metal detecting signals where the object was not tested by trial trenching. All of these signals are located within the proposed scheme footprint.

8.3.24 A further three sites of unknown value are all geophysical anomalies within the scheme footprint, interpreted as of archaeological origin, which were not tested by trial trenching. Of these, a curvilinear anomaly (Site 448, Figure 8.1d) located close to the site of Sheepwash Grange (Site173, Figure 8.1d) has been interpreted as of possible Roman or Prehistoric date, or it may be related to the medieval grange site. The two other geophysical anomalies are linear anomalies (Sites 755 and 756, Figure 8.1a) which are interpreted as modern features.

8.3.25 The remaining site of unknown value is a possible ploughed mound, identified from aerial photography by the HER. This site is located well outside the proposed scheme footprint, in the northeast of the study area (Site 72, Figure 8.1a)

Unknown Sites

8.3.26 A number of archaeological evaluations have been undertaken within or near the study area, both for this scheme and for other unrelated developments. These have mostly taken the form of non-intrusive surveys such as surface artefact collection and geophysical surveys over large areas, followed by targeted intrusive surveys such as trial trenching and palaeoenvironmental coring. Some schemes of works have also included small scale excavations and watching briefs. To date, the following studies have been undertaken within the footprint of the proposed scheme:

- Surface Artefact Collection Survey, Proposed Route of Lincoln Eastern Bypass, 2003 (PCA 2003 – see ES Appendix 8D) undertaken on a survey area defined as a 20m wide transect along the centreline of the proposed scheme;
- Lincoln Eastern Bypass Geophysical Survey 2003 (PCA 2003 – see ES Appendix 8E) undertaken on a survey area defined as a 20m wide transect along the centreline of the proposed scheme;
- Report on a Programme Of Archaeological Trial Trenching Lincoln Eastern Bypass, Lincolnshire 2004(PCA 2004 – see ES Appendix 8F); and
- Topographic and Auger Survey of the Northern Floodplain of the River Witham, Lincoln Eastern Bypass, Greetwell 2004 (The Environmental Consultancy 2004 – see ES Appendix 8G).

8.3.27 In 2006, Jesus College commissioned a programme of fieldwalking and geophysical survey on two alternative route corridors (BFAU 2006) south of the River Witham.

8.3.28 As the alignment of the currently proposed scheme north of the River Witham is virtually identical to the previous scheme, which gained planning permission in April 2005, no further archaeological fieldwork was undertaken along this section. As the alignment to the south of the River Witham is different, the following archaeological evaluation was undertaken on the entire scheme footprint:

- Non-Intrusive Archaeological Survey on the Route of the Lincoln Eastern Bypass, Lincolnshire (APS 2008 see ES Appendix 8I); and

- Archaeological Trial Trenching on the Route of the Lincoln Eastern Bypass, Lincolnshire (APS 2009 see ES Appendix 8J).

8.3.29 Based on the results of these surveys, the potential for any further unknown remains throughout the scheme has been assessed as low. However, the Witham Valley peat deposits are known to partly overlie the Mesolithc land surface (Site 151, Figure 8.1d) and the barrow cemeteries (Sites 129 and 148, Figure 8.1c and d). Other more ephemeral remains may exist that have been masked by these deposits and not identified by the evaluation. The peat deposits themselves are also of geoarchaeological importance.

8.4 PREDICTED IMPACTS

Do Minimum / Do Nothing

8.4.1 If the scheme was not constructed, agricultural activities such as ploughing would continue to gradually damage archaeological remains identified in arable fields. The significance of these impacts has been assessed as Imperceptible Negative.

Predicted Impacts During Construction and Operation of the scheme

8.4.2 As outlined in Chapter 4, potential impacts may occur in different phases of the scheme such as during construction or operation. Impacts may also have different durations, some being permanent (e.g. removal of elements of a site during ground works) and some temporary (e.g. presence of construction machinery).

8.4.3 Based on the guidance in DMRB[9], the following broad categories of potential impacts to archaeological remains have been identified:

- Short Term Construction Impacts:
  - Impacts on the setting of archaeological remains from site lighting, construction traffic and large moveable equipment such as cranes, coffer dams or formwork. These impacts would not last beyond the duration of site works;
- Permanent Construction Impacts:
  - Physical impacts on sensitive sites by removal or truncation of upstanding or sub-surface features. These impacts are most likely to derive from groundbreaking works or the driving of piles. Other sources of physical impacts could be tracking and compaction damage from movement of vehicles and equipment outside of the footprint of the road. These impacts are permanent and irreversible;
- Long Term Construction Impacts:
  - Impacts on the setting of archaeological remains from the physical presence of the road which would start during the construction phase, such as visual impacts caused by the carriageway, embankments and cuttings. These impacts have all been classed “long term” as they would only last as long as the road which, in theory could be removed, is present and/or in use; and
- Long Term Operational Impacts:
  - Impacts on the setting of archaeological remains deriving from the presence of the road once built and opened to traffic. Potential sources of specific

[9] Design Manual for Roads and Bridges, Volume 11, Section 3, Part 2, Chapter 4

impacts could derive from elements such as traffic, roadside planting or road lighting. These impacts have all been classed “long term” as they would only last as long as the road is in use. The potential effects of proposed planting have been grouped into this category of impact and are calculated on the effect of mature planting, 15 years after construction.

Short Term Construction Impacts

8.4.4 Short term construction impacts have been identified on a single archaeological site, the Scheduled Ancient Monument, Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains (Site 105). This is summarised in Table 8.2 below.

Table 8.2: Short Term Construction Impacts on Archaeological Remains

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
105	Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains	Visual presence of formwork and plant during construction of the Witham Crossing, foreshortening views upstream. Visual presence of areas of topsoil stripping and related machinery altering the post medieval agricultural character in long views towards Lincoln and across the Witham.	High	Negligible

8.4.5 As described in the detailed archaeological baseline (Appendix 8B) and the Gazetteer of Archaeological Remains (Appendix 8C), the key elements of the setting of this site are the surviving structures of Greetwell Hall and the Church of All Saints (see Historic Buildings below). Another important aspect of setting is the medieval village’s relationship to the agricultural land around it, in particular to the surviving areas of ridge and furrow. The medieval open fields of the village are located to the north, but are not well preserved in the landscape. Surviving areas of ridge and furrow are noted to the north, southeast and southwest of the village core. None of these relationships would be affected by the scheme. A minor aspect of the setting of the site is its long views out over the surrounding post-medieval agricultural landscape.

8.4.6 The construction activities of the scheme would temporarily change the agricultural character of the post-medieval landscape in long views from the site towards and across the river. These changes would result from the visual presence and noise from construction traffic, removal of topsoil, the creation of cuttings and embankments and the visual presence of formwork and other temporary structures. Most of the scheme north of the river would be screened from view by the local topography and by existing trees and field boundaries which would not be removed. The magnitude of this impact has been assessed as Negligible, as the elements of setting being affected are not key to our understanding of the site and its context.

Permanent Construction Impacts

8.4.7 A total of 61 potential construction impacts to archaeological remains have been identified. These would all arise from the physical removal of remains during groundbreaking works or by potential damage caused by movement of site vehicles and plant. All impacts are listed below in table 8.3.

8.4.8 The extents of sites as shown on Figures 8.1a-g were defined in some cases by fieldwork, and in others by mapping provide by the National Monuments Record and/or the Lincolnshire Historic Environment Record. The full extents of some sites

are not known and may extend outside of the archaeological survey areas. This can be assumed with a good degree of confidence for sites such as areas of ridge and furrow recorded as geophysical anomalies, but with less confidence for other sites. Assumptions are made on a case-by case basis, applying the precautionary principal. This means that, in general, where a site cannot be assumed to extend beyond the survey area with a good degree of certainty, it shall be assumed that it does not.

Table 8.3: Permanent Construction Impacts on Archaeological Remains

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
1	Roman Road	Potential damage to unknown remains possibly preserved beneath the present Wragby Road.	Low	Unknown
57	Medieval Pit, Ditches and Artefact Scatter	Removal of all known sub-surface features as defined by geophysical survey and trial trenching	Low	Major
69	Medieval To Post Medieval Field System, Bunkers Hill/Greetwell Quarry	Site extent provided by the HER. The scheme would remove part of the western end of one extant field boundary, and part of the southern end of another.	Low	Negligible
76	Romano-British Farm, Greetwell Quarry	The site extent as defined by the HER is located outside the proposed scheme footprint. While no traces were identified by the evaluation works, there is however potential for an impact on unknown sub-surface remains associated with this site	Medium	Negligible
90	Sheffield and Lincolnshire Extension Railway	The proposed carriageway would bridge over this site and would remove a small part of the sides of the cutting	Low	Negligible
121	Post Medieval Ditch	Removal of all known sub-surface features as defined by geophysical survey	Negligible	Major
122	Undated Pits, Ditches and Postholes	Removal of all known sub-surface features as defined by geophysical survey and trial trenching	Low	Major
129	Bronze Age Round Barrow Cemetery North of the Witham	The site consists of 12 poorly preserved barrows. The scheme would remove one barrow. Possible damage to surviving barrows from movement of vehicles and plant outside the scheme footprint or groundbreaking for temporary works.	Medium	Moderate
146	Bronze Age Round Barrow Cemetery South of the Witham	The site consists of seven barrows. The scheme would remove two barrows and related sub-surface features. Possible damage to surviving barrows from movement of vehicles and plant outside the scheme footprint or groundbreaking for temporary works.	Medium	Major

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
151	Prehistoric Land Surface South of The Witham	The scheme would result in removal of land surface deposits and potential Mesolithic artefacts identified through trial trenching and auger survey. It is possible that this site extends beyond the geophysical survey area and beyond the scheme footprint to the east and west along the river valley bottom. The precise site extent however, is impossible to estimate. It has been assumed that most of the surviving land surface is within the geophysical survey area. Therefore,construction of the proposed road carriageway, bridge footings, balancing ponds and access roads would remove most of the site.	Medium	Major
173	Original Site of Sheepwash Grange	The extent of this site has been established through geophysical survey and trial trenching. Construction of the carriageway, embankments for the Witham bridge, balancing ponds and access roads would remove most of this site north of the railway line.	High	Moderate
184	Multi-Period Occupation Site, including possible Roman Villa	Proposed carriageway, ponds and access roads would remove all known sub-surface features as defined by geophysical survey and trial trenching.	High	Major
199	Undated Limekilns	This site consists of two pits filled with burnt limestone and a partially robbed-out wall identified by trial trenching and geophysical survey. The proposed scheme would remove all remains of this site.	Low	Major
250	Prehistoric Boundary Ditches, South of Heighington Road	The presence and character of this site has been identified from geophysical survey and trial trenching. Aerial photographs show this site extending far to the east and west of the proposed scheme. The scheme would bisect this site and remove all sub-surface features, identified within the scheme footprint.	Medium	Minor
289	Possible Iron Age or Roman Cropmark Enclosure, South of Canwick Heath Farm	The western edge of this site extent as defined by the HER is located within the scheme footprint. However, this includes a buffer zone around the extent of the site as shown on aerial photography. While no related remains were identified within the road footprint by the evaluation works, there is however potential for an impact on unknown sub-surface remains associated with this site.	Medium	Negligible
320	Romano-British Pit and Gully	Removal of all sub-surface features as identified by geophysical survey and trial trenching. This site may extend further southwards within the proposed scheme footprint but outside the area of geophysical survey.	Low	Major
325	Part of A Post Medieval Field System	The extent of this site, as defined by the HER, crosses the southern end of the scheme footprint. The scheme would remove part of two hedgerows.	Negligible	Minor
361	Continuation of Mareham Lane, North of Sleaford, Along Bloxholm Lane	Potential for removal of unknown deposits associated with the former Roman Road	Low	Unknown

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
363	Probable Roman Road	Potential for removal of unknown deposits associated with the former Roman Road	Low	Unknown
367	Geophysical Anomaly - Land Drain	This feature was identified by geophysical survey but was not tested by trial trenching. The proposed scheme would remove all remains within the scheme footprint, however it is likely that a significant part of this site extends beyond the geophysical survey area.	Negligible	Minor
368	Geophysical Anomaly - Land Drain	As above	Negligible	Minor
371	Field Boundary (site of)	This site extent as shown was identified through geophysical survey. Historic mapping shows the field boundary extending well beyond the proposed scheme footprint. The scheme would remove the known subsurface features of this site within the scheme footprint.	Negligible	Minor
372	Ridge and Furrow	The extent of this site is taken from geophysical survey results. It is likely that some parts of the site extend beyond the geophysical survey area. However, trial trenching has shown that the remains are in a very poor state of preservation, and it is not likely that they are extensive. The scheme would therefore probably remove most of the surviving remains of the site.	Negligible	Major
376	Multi-Period Prehistoric Site	The full extent of this site is uncertain, as it almost certainly extends beyond the surveyed area. However, the scheme footprint also extends slightly beyond the surveyed area at this location. It is assumed that the majority of the surviving remains of the site fall within the scheme footprint and would be removed during construction.	High	Major
377	Ridge and Furrow	These features were identified by geophysical survey, but no trace was found during trial trenching. It is likely that further geophysical survey outside the scheme footprint would identify more traces of this site. It is possible however, that some individual furrows may survive within the scheme footprint, and would be removed during construction of the scheme.	Negligible	Minor
423	Undated Agricultural Features	The extent of this site as shown is defined by geophysical survey. It is likely that these features extend beyond the survey areas for an unknown distance. The scheme footprint (including embankments) in this location also exceeds the geophysical survey area. Applying the precautionary principle, it is assumed that all surviving traces of this site would be removed by the scheme.	Low	Major
424	Geophysical Anomaly - Ridge and Furrow	As above	Low	Major

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
440	Possible Trackway	The extent of this site as shown is defined by geophysical survey. Historic mapping shows a trackway in this location, extending to the east and west of the proposed scheme. Therefore it is assumed that this site extends beyond the scheme footprint and that the overall proportion of the site that would be removed by the scheme is small.	Low	Minor
441	Linear Geophysical Anomaly	The scheme would remove approximately half of the known extent of this feature as defined by geophysical survey, however, it is likely that the site extends beyond the geophysical survey area.	Negligible	Minor
445	Ridge and Furrow	These features were identified by geophysical survey, and a few isolated traces were found during trial trenching. It is likely that further geophysical survey outside the scheme footprint would identify an extensive area of ridge and furrow. The scheme would remove any surviving traces within the footprint of the road	Negligible	Minor
448	Curvilinear Geophysical Anomaly - Possible Prehistoric or Roman Feature	The scheme would remove all known traces of this site as defined by geophysical survey	Unknown	Major
452	Geophysical Anomaly - Possible Ditch	The scheme would remove all known traces of this site as defined by geophysical survey	Low	Major
456	Geophysical Anomaly - Curvilinear Feature	The scheme would remove all known traces of this site as defined by geophysical survey	Low	Major
501	Medieval Field Boundaries	The extents of these field boundaries have been determined by geophysical survey. The scheme would remove most of the eastern part of this site	Low	Major
503	Undated Possible Limekiln	The full extent of this site is known from geophysical surveys and trial trenching. the scheme would remove most of this site.	Low	Moderate
513	Undated Ditch	The extent of this site has been determined by geophysical survey. The scheme would remove all known traces of the site.	Low	Major
514	Post Medieval Pond with Animal Bone	The extent of this site has been established by geophysical survey and trial trenching and is noted on historic mapping. The scheme would remove all remaining traces of the site	Negligible	Major
526	Post Medieval Field Boundaries	The extents of these field boundaries have been determined by geophysical survey. Trial trenching identified only fragmentary remains, badly truncated by ploughing. It is likely that further geophysical survey outside the scheme footprint would identify more boundaries. The scheme would remove all traces of this site within the scheme footprint	Negligible	Moderate

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
563	Early Medieval Settlement Site	The full extent of this site is unknown, although the results of geophysical survey and trial trenching indicate that the site extent within the scheme footprint is limited to the western half of the proposed carriageway and cutting. It is possible that further remains associated with the site survive to the west, although this is not possible to state with confidence. It is therefore assumed that the scheme would remove all surviving remains of this site.	Medium	Major
556	Non Ferrous Metal Detecting Signal	This site was identified by metal detector survey. The signal may relate to a buried artefact, which was not recovered and therefore is of unknown value. The scheme would remove the potential artefact.	Unknown	Major
583	Non-Ferrous Metal Detecting Signal	As above	Unknown	Major
596	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
602	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
612	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
613	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
623	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
631	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
644	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
646	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
655	Non Ferrous Metal Detecting Signal	As above	Unknown	Major
693	Post Medieval Field Boundary and Ditch	These features run parallel to an extant field boundary. It is likely that they extend well beyond the extents identified by geophysical survey. The scheme would remove all remains within the scheme footprint, however, this is likely to be a small proportion of the overall site	Negligible	Minor
740	Romano-British Gully	The extent of this feature was identified by geophysical survey and trial trenching. Construction of a proposed noise bund would remove all known traces of the site	Low	Major
741	Non Ferrous Metal Detecting Signal	This site was identified by metal detector survey. The signal may relate to a buried artefact, which was not recovered and therefore is of unknown value. The scheme would remove the potential artefact.	Unknown	Major

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
755	Linear Geophysical Anomaly	This extent of this feature is as determined by geophysical survey. It is likely that the feature extends beyond the geophysical survey area, however without knowing the nature of the feature, this cannot be stated with confidence. The scheme would remove all known traces of this site	Unknown	Major
756	Linear Geophysical Anomaly	As above	Unknown	Major
757	Multi-Period Occupation Site	The extent of this site is derived from geophysical survey and trial trenching. It is possible that some parts of the site extend beyond the scheme area, both to the east and the south. However, the core of the site is clearly located within the scheme footprint and would be removed during construction. The area to the south, outside the scheme footprint, may suffer damage from temporary works related to the construction of the Witham bridge.	High	Major
761	Two Post Medieval pits possibly relating to Greetwell North Farm	The full extent of this site has been determined from trial trenching. The scheme would remove all remains of the site.	Negligible	Major
765	Iron Age Ditch	The full extent of this site has been determined by geophysical survey and trial trenching. The scheme would remove all remaining traces of the site.	Low	Major
781	Possible Medieval Ditch	The full extent of this site has been determined by geophysical survey and trial trenching. The scheme would remove all remaining traces of the site.	Low	Major
784	Important Hedgerow 1 – Parish Boundary	The scheme would remove the corner of this hedgerow	Low	Minor
785	Important Hedgerow 2 – Parish Boundary	The scheme would remove part of the hedgerow	Low	Minor

Long Term Construction Impacts

8.4.9 Long term impacts on the setting of three sites have been identified for the construction phase. These derive from the physical presence of the road embankments, cuttings and structures in the landscape.

Table 8.4: Long Term Construction Impacts on Archaeological Remains

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
105	Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains	Minor loss of post medieval agricultural context in long views to the south. Foreshortening of long views upstream Severance of the settlement and parts of its related post medieval field system.	High	Negligible

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
129	Bronze Age Round Barrow Cemetery	The scheme would increase the severance of the barrow sites on either side of the carriageway. Imposition of urban character of a lit carriageway and bridge at night in the rural setting of the site	Medium	Minor
146	Bronze Age Round Barrow Cemetery	Severance of the barrow sites on either side of the carriageway. Imposition of urban character of a lit carriageway and bridge at night in the rural setting of the site	Medium	Moderate

8.4.10 Impacts predicted upon "Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains" (Site 105, Figure 8.1c) are similar in nature to those discussed above for temporary construction impacts, except that the character of the road would be urban, rather than industrial. The magnitude of impact is assessed as Negligible.

8.4.11 Our understanding of northern barrow cemetery (Site 129, Figure 8.1c and d) has been reduced by the presence of field boundaries and ditches which have reduced the visual relationship between the barrows. In addition the poor preservation of many barrows also means that they are not highly visible or identifiable. Thus while the presence of the carriageway on an embankment would visually sever four barrows from the main group, the magnitude of impact on this site has been assessed as Minor.

8.4.12 The barrows of the southern barrow cemetery (Site 146, Figure 8.1d) are better preserved and therefore more visible and identifiable than those of the northern cemetery. Only one extant barrow is separated from the main group by a post-medieval boundary ditch and a broken tree line. This group of barrows is therefore more understandable as a cemetery. The proposed carriage would visually sever the poorly preserved barrows to the east of the barrow from the better preserved barrows to the west, affecting or understanding of the entire group. The magnitude of impact on this site has been assessed as Moderate.

Long Term Operation Impacts

8.4.13 Long term impacts on the setting of three sites have been identified for the operation phase. These start in the construction period, extend into the operation period and derive from the increased traffic noise, road lighting and mature landscape planting.

Table 8.5: Long Term Operation Impacts on Archaeological Remains

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
105	Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains	Increased road noise and lighting across the Witham Valley and along Greetwell Road would increase the urbanisation of the surrounding area, detracting from the rural, agricultural context of the site.	High	Negligible
129	Bronze Age Round Barrow Cemetery	Increased road noise and lighting across the Witham Valley and along Greetwell Road would increase the urbanisation of the surrounding area, detracting from the rural context of the site.	Medium	Negligible

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
146	Bronze Age Round Barrow Cemetery	Increased road noise and lighting across the Witham Valley would increase the urbanisation of the surrounding area, detracting from the rural context of the site.	Medium	Negligible

8.4.14 These sites are currently situated near the busy local roads radiating out from Lincoln. Traffic on the proposed carriageway would add to the existing road noise, increasing the sense of urban character. Lighting of the carriageway and adjacent roads at night would accentuate this effect.

8.4.15 Landscape planting proposals are broadly designed to be in keeping with the present makeup of hedgerows, and trees and areas of scrub and wildflower planting would act to reduce the visual impact of the road. These would however still have the effect of removing existing agricultural land which contributes to the present setting of these sites.

8.4.16 In each of these cases, the key elements of the sites and their settings are not affected. The magnitude of all long-term operational impacts are therefore assessed as Negligible

8.5 MITIGATION

Short Term Construction Impacts

8.5.1 No mitigation measures are proposed for temporary construction impacts as these would cease once construction activities were completed.

Permanent Construction Impacts

8.5.2 In accordance with DMRB Volume 10 Section 6 Part 1, mitigation measures to reduce or avoid impacts on archaeological remains were incorporated during the development of the scheme. These included the avoidance of physical impacts on Scheduled Ancient Monuments and other designated sites and design of ecological and landscape mitigation measures to minimise impacts on known archaeological sites.

8.5.3 The preferred mitigation option for any sites or archaeological deposits affected by the scheme would be to preserve the remains *in situ*. However, where preservation *in situ* is not feasible, then preservation by record would be the appropriate alternative mitigation strategy. This may be achieved by a combination of the following techniques:

- No further action: where remains of low or negligible Value are known and evaluation works undertaken to date are considered to be sufficient mitigation of predicted impacts;
- Photographic and topographic surveys: where upstanding archaeological remains are present, recording to an appropriate level of detail would be undertaken prior to construction;
- Detailed assessment and analysis of geoarchaeological deposits in the Witham Valley. this could be achieved through geoarchaeological sampling, possibly including extraction of a transect of cores across the valley, and by the incorporation of a robust palaeoenvironmental sampling strategy into other archaeological works in this area;
- Detailed archaeological excavation: where particularly significant, complex or densely-concentrated archaeological remains are expected to be present, and

the occurrence of an impact cannot be avoided, then a detailed archaeological excavation in advance of construction would be undertaken;

- Strip and record: where archaeological remains of relatively low significance and/or complexity are expected to be present, and particularly where they are expected to be spread over a large area at low density, then strip and record works may be appropriate. Topsoil/overburden would be stripped over relatively large, defined areas using methods designed to maximise archaeological visibility, followed by inspection to define the scope of any archaeological recording works that might be required; and
- Archaeological watching brief: where there is some potential for archaeological remains to be present, but the risk is considered to be low, then archaeological monitoring of the main topsoil/overburden stripping operations, and other excavation works as appropriate, would be applied, followed by appropriate archaeological investigation and recording of any remains that are identified. In the case of a general watching brief, the monitoring archaeologist would have no control over the choice of plant but would be able to call a halt to works in order to enable recording. A targeted watching brief would give the archaeologist control of the choice of plant used for topsoil stripping and to exercise a level of control over topsoil stripping operations. The targeted watching brief would also have a provision for metal detecting on exposed surfaces and excavated spoil where appropriate.

8.5.4 Table 8.6 lists proposed site specific mitigation measures for Permanent Construction Impacts:

Table 8.6: Summary of Proposed Mitigation for Permanent Construction Impacts on Archaeological Remains

Site No.	Site Name	Proposed Mitigation
1	Roman Road	Strip, map and sample on a 10m buffer of the existing road and a watching brief on removal of the existing modern road layers.
57	Medieval Pit, Ditches and Artefact Scatter	Strip, map and sample
69	Medieval To Post Medieval Field System, Bunkers Hill/Greetwell Quarry	No mitigation proposed- A sufficient record of this site has been made by previous archaeological surveys
76	Romano-British Farm, Greetwell Quarry	Strip, map and sample
90	Sheffield and Lincolnshire Extension Railway	No mitigation proposed – potential impacts are to the cutting only.
121	Post Medieval Ditch	Targeted watching brief
122	Undated Pits, Ditches and Postholes	Detailed excavation
129	Bronze Age Round Barrow Cemetery North of the Witham	Detailed excavation, Level 2 Earthwork survey (to include detailed topographic survey and modelling of the buried land surface between the barrows)
146	Bronze Age Round Barrow Cemetery South of the Witham	Detailed excavation, Level 2 Earthwork survey (to include detailed topographic survey and modelling of the buried land surface between the barrows)
151	Prehistoric Land Surface South of The Witham	Detailed excavation of one or several transects across the site.
173	Original Site of Sheepwash Grange	Detailed excavation
184	Multi-Period Occupation Site, including possible Roman Villa	Detailed excavation

Site No.	Site Name	Proposed Mitigation
199	Undated Limekilns	Strip, map and sample
250	Prehistoric Boundary Ditches, South of Heighington Road	Detailed excavation
289	Possible Iron Age or Roman Cropmark Enclosure, South of Canwick Heath Farm	Strip, Map and Sample of the area of the carriageway immediately adjacent to the west of the site
320	Romano-British Pit and Gully	Strip, map and sample
325	Part of A Post Medieval Field System	No mitigation proposed- A sufficient record of this site has been made by previous archaeological surveys
361	Continuation of Mareham Lane, North of Sleaford, Along Bloxholm Lane	Strip, map and sample on a 10m buffer of the existing road and a watching brief on removal of the existing modern road layers.
363	Probable Roman Road	Strip, map and sample on a 10m buffer of the existing road and a watching brief on removal of the existing modern road layers.
367	Geophysical Anomaly - Land Drain	Targeted watching brief
368	Geophysical Anomaly - Land Drain	Targeted watching brief
371	Field Boundary (site of)	Targeted watching brief
372	Ridge and Furrow	Targeted watching brief
376	Multi-Period Prehistoric Site	Detailed excavation
377	Ridge and Furrow	Targeted watching brief
423	Undated Agricultural Features	Strip, map and sample
424	Geophysical Anomaly - Ridge and Furrow	Targeted watching brief
440	Possible Trackway	Strip, map and sample
441	Linear Geophysical Anomaly	Detailed excavation
445	Ridge and Furrow	Targeted watching brief
448	Curvilinear Geophysical Anomaly - Possible Prehistoric or Roman Feature	Detailed excavation
452	Geophysical Anomaly - Possible Ditch	Detailed excavation
456	Geophysical Anomaly - Curvilinear Feature	Detailed excavation
501	Medieval Field Boundaries	Strip, map and sample
503	Undated Possible Limekiln	Strip, map and sample
513	Undated Ditch	Strip, map and sample
514	Post Medieval Pond with Animal Bone	Strip, map and sample
526	Post Medieval Field Boundaries	Targeted watching brief
556	Non Ferrous Metal Detecting Signal	Targeted watching brief
563	Early Medieval Settlement Site	Detailed excavation
583	Non-Ferrous Metal Detecting Signal	Targeted watching brief
596	Non Ferrous Metal Detecting Signal	Targeted watching brief
602	Non Ferrous Metal Detecting Signal	Targeted watching brief
612	Non Ferrous Metal Detecting Signal	Targeted watching brief
613	Non Ferrous Metal Detecting Signal	Targeted watching brief

Site No.	Site Name	Proposed Mitigation
623	Non Ferrous Metal Detecting Signal	Targeted watching brief
631	Non Ferrous Metal Detecting Signal	Targeted watching brief
644	Non Ferrous Metal Detecting Signal	Targeted watching brief
646	Non Ferrous Metal Detecting Signal	Targeted watching brief
655	Non Ferrous Metal Detecting Signal	Targeted watching brief
693	Post Medieval Field Boundary and Ditch	Detailed excavation
740	Romano-British Gully	Strip, map and sample
741	Non Ferrous Metal Detecting Signal	Targeted watching brief
755	Linear Geophysical Anomaly	Targeted watching brief
756	Linear Geophysical Anomaly	Targeted watching brief
757	Multi-Period Occupation Site	Detailed excavation
761	Two Post Medieval pits possibly relating to Greetwell North Farm	No further mitigation proposed- The works undertaken to date are sufficient to mitigate the impact on this site
765	Iron Age Ditch	Detailed excavation
781	Possible Medieval Ditch	Strip, Map and Sample
784	Important Hedgerow 1 – Parish Boundary	Photographic survey and targeted watching brief during removal of the hedgerow
785	Important Hedgerow 2 – Parish Boundary	Photographic survey and targeted watching brief during removal of the hedgerow

8.5.5 In addition to the above measures, an archaeological watching brief is proposed for all remaining areas of the scheme to enable the proper investigation and recording of any archaeological deposits identified.

8.5.6 A targeted watching brief is proposed for areas between Wragby Road and Heighington Road and in the areas immediately adjacent to Bloxholm Lane and Sleaford Road.

8.5.7 A general watching brief is proposed for all other areas, roughly corresponding to the heathland on the southern dip slope between Heighington Road and Bloxholm Lane. This form of watching brief would not include provision for an archaeologist to control the type of plant used for the topsoil stripping, however they would be able to stop works to enable recording.

8.5.8 Protective fencing could be used to protect the barrow sites from damage where they are not located within the immediate footprint of the road (Sites 129 and 146, Figure 8.1c and d), however, active management would be required during construction in order to ensure that fencing is maintained and exclusion zones are respected. This would include tool box talks to raise awareness amongst the earthworks contractor's staff.

8.5.9 Removal of sections of the Important Hedgerows (Sites 784 and 785, Figure 8.1g) requires the submission of a Hedgerow removal notice as set out in Schedule 4 of the regulations. This should be submitted along with the Planning Application for the scheme or immediately after determination. Under Section 6 – 1 (e) of the Hedgerow Regulations (see policy background section above), this removal notice should be permitted if planning permission is granted.

8.5.10 The detailed design of the mitigation works will be subject to the approval of the Lincolnshire County Council's Historic Environment Team Leader and will also require consultation with English Heritage.

8.5.11 The locations and design of haul routes, site compounds, borrow pits and statutory service diversions is not yet finalised at the time of writing. These works may have an impact and would need to be included in any detailed mitigation design.

8.5.12 It is proposed to construct a flood compensation area northwest of the Washingborough Road in land between the railway and the South Delph in the valley of the River Witham. This area is considered to have a high potential for the presence of unknown archaeological remains. A staged programme of archaeological evaluation works comprising of geophysical survey followed by trial trenching is recommended to identify any present archaeological remains and design appropriate mitigation.

8.5.13 The detailed design of the archaeological mitigation should take into consideration the following objectives:

- To investigate any evidence for environmental change and the evolution of the Witham Valley;
- To investigate lithic remains dating to the late Mesolithic and Early Neolithic to contribute to our understanding of the use of sites over a period of time and/or the longevity of these types of lithic[10];
- To investigate prehistoric burial and domestic activity in the Witham Valley and on the Lincoln Edge;
- To investigate patterns of deposition around the Bronze Age barrow cemeteries as a "dry land" environment[11]
- To investigate continuity of settlement from the Iron Age through to the Roman period, and whether these overlie and mask earlier, less visible deposits[12];
- To investigate any dating evidence for the establishment of the Roman road system;
- To examine evidence of Romano-British arable farming methods and the rural economy, especially from the possible villa site (Site 184, Figure 8.1d);
- To identify and characterise any re-use or re-occupation of Roman sites after the 5th century;
- To identify any changes or hiatus in arable farming at the beginning of the Early Medieval period through palaeoenvironmental remains;
- To identify changes in cultivation, particularly intensification of arable farming and crop rotation practices from the Early Medieval through medieval periods; and
- To study the relationship between medieval Lincoln and its rural hinterland[13].

8.5.14 These may be achieved or aided by actions including but not limited to:

---

[10] Clay, P. 2006, An Archaeological Resource Assessment and Research Agenda for The Neolithic and Early-Middle Bronze Age of the East Midlands.

[11] Witham Valley Archaeological Research Committee, Archaeological Research Design for the Witham Valley, http://uk.sitestat.com/lincolnshire/lincolnshire/s?Home.A_Resident.Environment.Conservation.Archaeology.The_Witham_Valley.The_Witham_Valley.WithamResDes.pdf&ns_type=pdf&ns_url=http://www.lincolnshire.gov.uk/upload/public/attachments/550/WithamResDes.pdf Accessed 06/08/09

[12] ibid

[13] Everson, P. 2006, East Midlands Archaeological Research Framework: Resource Assessment of Medieval Lincolnshire

- Study of palaeochannels or other geoarchaeological deposits in the Witham valley;
- Analysis of various "ecofacts", such as insect remains, plant macrofossils, charred plant remains and pollen from buried peat and alluvial deposits in the Witham valley for evidence of woodland clearance and changes in cultivation and animal husbandry;
- Identification and examination any organic remains associated with the Mesolithic finds in the valley bottom;
- Examination of the composition of the Bronze Age barrow cemeteries (Sites 129 and 146, Figure 8.1c and d) and the spaces between the barrows;
- Investigation of the Iron Age linear triple and double ditch boundaries and any associated activity;
- Investigation of the waterlogged deposits north of the Witham, including possible dendrochronological and other scientific dating evidence from late Iron Age timbers identified by trial trenching (Site 376, Figure 8.1d);
- Examination of the small satellite settlements east of Lincoln (Sites 184 and 757, Figure 8.1d) and their relationship/contribution to the development of the town;
- Examination of the possible villa site and its surrounding agricultural features. The latter is particularly important, as past investigation of villa sites has focused on the buildings[14];
- Identification of possible Early Medieval phases of monastic estate activity at Sheepwash Grange (Site 173, Figure 8.1d); and
- Palaeoenvironmental sampling at the site of Sheepwash Grange (Site 173) may provide evidence for the wider rural economy.

Long Term Construction Impacts

8.5.15 In order to minimise the effect of the cutting on the south side of the Witham on Greetwell Village (Site 105, Figure 8.1c), landscape planting schemes will be designed to be in keeping with the character of the surrounding landscape. Where possible, parts of hedgerows that are removed during construction shall be re-instated on their original lines. For details of planting proposals, please refer to the Landscape and Visual chapter (Chapter 9). However, the combined effect of the planting and the cutting would still remove agricultural land from long views to the south and southwest. While the overall effect of the proposed landscape mitigation would be to soften the character of the impact by reducing the visual intrusion of the cutting, the magnitude of impact would remain Negligible.

8.5.16 The impacts identified on the barrow cemeteries (Sites 129 and 146, Figure 8.1c and d) cannot be completely mitigated. While the impact cannot be reduced through mitigation, it may be possible to partially offset the impact through provision of public interpretation of these sites. This could include interpretation boards placed on or close to the proposed paths or footbridge on the embankments north of the River Witham and between the Witham and the South Delph. This would be aided by undertaking an Earthwork survey of all known barrows to English Heritage Level 2 standards[15] and incorporating these results with the results of detailed excavation.

[14] Taylor, J, 2006, An Archaeological Resource Assessment and Research Agenda for the Roman Period in the East Midlands
[15] English Heritage 2007 Understanding the Archaeology of Landscapes. Swindon: RCHME

Long Term Operation Impacts

8.5.17 All long term operational impacts identified are of negligible magnitude. Therefore no mitigation is proposed.

8.6 RESIDUAL IMPACTS

Short Term Construction Impacts

8.6.1 No residual impacts are predicted for temporary construction impacts, as these would cease as soon as construction activities were complete.

Permanent Construction Impacts

8.6.2 While archaeological recording works can reduce impacts identified by production and retention of an archive and wide dissemination of results (preservation by record), they cannot mitigate the impact completely, as the physical damage to the site from construction works would have simply been replaced by damage from archaeological works. In the case of sites of low or negligible Value, the reduction to the predicted impact is often sufficient to reduce the significance of impact to Neutral.

8.6.3 For more sensitive sites, the reduction of the magnitude of impact may still result in a significance of impact greater than Neutral. This reflects the loss of potential information which it may be only possible to gain from future improvements in recording techniques and greater scientific understanding of archaeological remains.

8.6.4 Table 8.7 below summarises the residual permanent impacts predicted from the construction phase, with a comparison shown between the unmitigated and mitigated magnitudes of impact:

Table 8.7: Residual Permanent Construction Impacts

Site No.	Site Name	Value	Magnitude of Impact (Un-mitigated)	Magnitude of Impact (Mitigated)	Significance of Impact (Mitigated)
1	Roman Road	Low	Unknown	Unknown	Unknown
57	Medieval Pit, Ditches and Artefact Scatter	Low	Major	Negligible	Neutral
69	Medieval To Post Medieval Field System, Bunkers Hill/Greetwell Quarry	Low	Negligible	Negligible	Neutral
76	Romano-British Farm, Greetwell Quarry	Medium	Negligible	Negligible	Neutral
90	Sheffield and Lincolnshire Extension Railway	Low	Negligible	Negligible	Neutral
121	Post Medieval Ditch	Negligible	Major	Negligible	Neutral
122	Undated Pits, Ditches and Postholes	Low	Major	Minor	Neutral
129	Bronze Age Round Barrow Cemetery North of the Witham	Medium	Moderate	Minor	Slight
146	Bronze Age Round Barrow Cemetery South of the Witham	Medium	Major	Minor	Slight
151	Prehistoric Land Surface South of The Witham	Medium	Major	Minor	Slight
173	Original Site of Sheepwash Grange	High	Moderate	Minor	Slight
184	Multi-Period Occupation Site, including possible Roman Villa	High	Major	Minor	Moderate
199	Undated Limekilns	Low	Major	Minor	Neutral

Site No.	Site Name	Value	Magnitude of Impact (Un-mitigated)	Magnitude of Impact (Mitigated)	Significance of Impact (Mitigated)
250	Prehistoric Boundary Ditches, South of Heighington Road	Medium	Minor	Negligible	Neutral
289	Possible Iron Age or Roman Cropmark Enclosure, South of Canwick Heath Farm	Medium	Negligible	Negligible	Neutral
320	Romano-British Pit and Gully	Low	Major	Negligible	Neutral
325	Part of A Post Medieval Field System	Negligible	Minor	Minor	Neutral
361	Continuation of Mareham Lane, North of Sleaford, Along Bloxholm Lane	Low	Unknown	Unknown	Unknown
363	Probable Roman Road	Low	Unknown	Unknown	Unknown
367	Geophysical Anomaly - Land Drain	Negligible	Minor	Negligible	Neutral
368	Geophysical Anomaly - Land Drain	Negligible	Minor	Negligible	Neutral
371	Field Boundary (site of)	Negligible	Minor	Negligible	Neutral
372	Ridge and Furrow	Negligible	Major	Minor	Neutral
376	Multi-Period Prehistoric Site	High	Major	Minor	Slight
377	Ridge and Furrow	Negligible	Minor	Negligible	Neutral
423	Undated Agricultural Features	Low	Major	Minor	Neutral
424	Geophysical Anomaly - Ridge and Furrow	Low	Major	Minor	Neutral
440	Possible Trackway	Low	Minor	Negligible	Neutral
441	Linear Geophysical Anomaly	Negligible	Minor	Negligible	Neutral
445	Ridge and Furrow	Negligible	Minor	Negligible	Neutral
448	Curvilinear Geophysical Anomaly - Possible Prehistoric or Roman Feature	Unknown	Major	Minor	Unknown
452	Geophysical Anomaly - Possible Ditch	Low	Major	Minor	Neutral
456	Geophysical Anomaly - Curvilinear Feature	Low	Major	Minor	Neutral
501	Medieval Field Boundaries	Low	Major	Minor	Neutral
503	Undated Possible Limekiln	Low	Moderate	Minor	Neutral
513	Undated Ditch	Low	Major	Minor	Neutral
514	Post Medieval Pond with Animal Bone	Negligible	Major	Minor	Neutral
526	Post Medieval Field Boundaries	Negligible	Moderate	Minor	Neutral
563	Early Medieval Settlement Site	Medium	Major	Minor	Slight
556	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
583	Non-Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
596	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
602	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
612	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
613	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
623	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
631	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
644	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
646	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
655	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown

Site No.	Site Name	Value	Magnitude of Impact (Un-mitigated)	Magnitude of Impact (Mitigated)	Significance of Impact (Mitigated)
693	Post Medieval Field Boundary and Ditch	Negligible	Minor	Minor	Neutral
740	Romano-British Gully	Low	Major	Minor	Neutral
741	Non Ferrous Metal Detecting Signal	Unknown	Major	Negligible	Unknown
755	Linear Geophysical Anomaly	Unknown	Major	Minor	Unknown
756	Linear Geophysical Anomaly	Unknown	Major	Minor	Unknown
757	Multi-Period Occupation Site	High	Major	Minor	Slight
761	Two Post Medieval pits possibly relating to Greetwell North Farm	Negligible	Major	Negligible	Neutral
765	Iron Age Ditch	Low	Major	Minor	Neutral
781	Possible Medieval Ditch	Low	Major	Minor	Neutral
784	Important Hedgerow 1 – Parish Boundary	Low	Minor	Negligible	Neutral
785	Important Hedgerow 2 – Parish Boundary	Low	Minor	Negligible	Neutral

8.6.5 There are 15 sites where the magnitude and significance of impact is Unknown. Sites 1 (Figure 8.1a), 361 and 363 (Figure 8.1g) have not been archaeologically tested as they are all possible Roman roads, with potential remains lying under modern roads. The Roman road deposits may have been preserved beneath the present carriageways, or they may have been removed or truncated. As the condition of these sites is unknown, the magnitude and significance of any potential impacts on these sites cannot be accurately assessed.

8.6.6 The remaining impacts of unknown significance are all related to non-ferrous metal detecting signals, which may correspond to artefacts which have not been recovered (Sites 556 and 583 on Figure 8.1d, Sites 596, 602, 612 and 613 on Figure 8.1e, Sites 623, 631, 644, 646 and 655 on Figure 8.1f, and 741 on Figure 8.1g), or geophysical anomalies which were not tested by trial trenching (Sites 448 on Figure8.1d, 755 and 756 on Figure 8.1a). As the value of these sites is unknown, the significance of impact cannot be accurately assessed.

Long Term Construction Impacts

8.6.7 While mitigation planting may alter the character of the impact on the Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains Scheduled Ancient Monument (Site 105, Figure 8.1c), it is not judged to significantly reduce the magnitude of change for the setting of this site. The significance of residual impact on Greetwell village (Site 105) has therefore been assessed as Slight.

8.6.8 It is not possible to mitigate the impact on the setting of Sites 129 and 146 (Figures 8.1c and d). The residual significance of impacts on these sites has therefore been assessed as Slight. However, the provision of interpretation of the site would have a beneficial effect. The magnitude of this impact has been assessed as Minor Beneficial resulting in a Slight Beneficial significance of impact.

8.6.9 Residual long term impacts from the construction phase are summarised in Table 8.8 below.

Table 8.8: Residual Long Term Construction Impacts

Site No.	Site Name	Value	Magnitude of Un-mitigated Impact	Magnitude of mitigated Impact	Significance of mitigated Impact
105	Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains	High	Negligible	Negligible	Slight
129	Bronze Age Round Barrow Cemetery	Medium	Minor	Minor	Slight
146	Bronze Age Round Barrow Cemetery	Medium	Moderate	Moderate	Moderate
129	Bronze Age Round Barrow Cemetery	Medium	N/A	Minor Beneficial	Slight Beneficial
146	Bronze Age Round Barrow Cemetery	Medium	N/A	Minor Beneficial	Slight Beneficial

Long Term Operation Impacts

8.6.10 No measures are proposed to mitigate the negligible impacts identified on Sites 105, 129 and 146. The residual significance of impact these sites has been assessed as Slight.

Summary of Residual Impacts

8.6.11 All residual impacts on Archaeological Remains of greater than Neutral Significance are summarised in Table 8.9 below.

Table 8.9: Summary of Residual Impacts on Archaeological Remains

Significance	Count of Residual Impacts
Permanent Construction Impacts	
Moderate	1 (Site 184)
Slight	7 (Sites 129, 146, 151, 173,376, 563 and 757)
Unknown	15 (Sites 1, 361 , 363, 556, 583, 596, 602, 612, 613, 623, 631, 644, 646, 655, 741)
Long Term Construction Impacts	
Moderate	1 (Site 146)
Slight	2 (Sites 105 and 129)
Slight Beneficial	2 (Sites 129 and 146)
Long Term Operation Impacts	
Slight	3 (Sites 105, 129 and 146)

HISTORIC BUILDINGS

8.7 BASELINE CONDITIONS

8.7.1 A total of 28 sites were identified for assessment in the Historic Buildings Baseline Study (refer to Figure 8.2 and Appendices 8B and 8C for further information).

8.7.2 Lincoln Cathedral (Site 776) has been assessed to be of Very High value. Located at the core of the historic city, the Cathedral is internationally recognised as a key example of Gothic architecture.

8.7.3 Four sites of High Value have been identified. Lincoln Castle (Site 777) and the Bishop's Palace (Site 778) are located within the upper city of Lincoln and are of considerable importance, both for their history and architecture, and in terms of the historic development of the City of Lincoln. This is reflected in the designation of the Castle and Bishop's Palace complex as Scheduled Ancient Monuments. These buildings are located within the Cathedral and City Centre Conservation Area Number 1 (Site 782). Designated in recognition of its historic, archaeological and architectural interest this conservation area contains the historic core of Lincoln and includes 322 Listed Buildings. The medieval parish Church of All Saints in Greetwell (Site 98) has been identified within the study area. The value of the church has been assessed as High due to its Grade II* Listed status, and its architectural and historic importance.

8.7.4 A total of 14 sites have been assessed as being of Medium value. These comprise:

- One gentry house, comprising three Grade II Listed Buildings (Sites 91, 95 and 96);
- Six Grade II Listed formally planned farmsteads (Sites 222, 297, 309, 316, 318, and 319);
- Two Grade II Listed local gentry houses (Sites 214 and 255);
- Two Grade II Listed funerary monuments (Sites 99 and 100); and
- One conservation area (Site 783).

8.7.5 Within the study area eight sites of Low value have been identified, none of which are subject to any designations. These are:

- One farmhouse of early 19th century date (Site 772);
- One site that forms part of a formally planned farmstead (Site 775);
- Three small farmsteads or labourer's cottages dating from the 19th century (768, 773 and 774);
- Two railway underbridges (Site 770 and 771); and
- A historic airfield (Site 307).

8.7.6 One site of negligible sensitivity has also been identified. This is Greetwell Road Bridge over Greetwell Beck (Site 417).

8.8 PREDICTED IMPACTS

Do Minimum / Do Nothing

8.8.1 Traffic levels within the City of Lincoln are predicted to increase by 34% up to 2031. If the scheme was not constructed, the setting and amenity of historic buildings within the City of Lincoln would be increasingly affected by noise and visual intrusion

resulting from rising traffic levels. The significance of these impacts has been assessed as Imperceptible Negative.

Predicted Impacts During Construction

8.8.2 Potential impacts of construction are of two types:

- Permanent Construction Impacts:
  - Physical impacts resulting in partial or complete removal of historic buildings or structures. These impacts are permanent and irreversible; and
- Short-term Construction Impacts:
  - Impacts upon the setting or amenity of historic buildings or structures. These may result from site lighting, the presence and operation of construction traffic and equipment, or construction activity on site.

8.8.3 Impacts on historic buildings predicted during construction have been assessed in accordance with the methodology provided in Appendix 8A. Predicted impacts are summarised in Table 8.10 below.

Table 8.10: Predicted Impacts during Construction on Historic Buildings

Site No.	Site Name	Value	Type of Impact	Duration of Impact	Unmitigated Magnitude of Construction Impact
96	Greetwell Hall	Medium	Noise intrusion on setting	Short term	Negligible
98	Church of All Saints	High	Noise intrusion on setting. Construction activities visible from the churchyard and south doorway	Short term	Moderate
214	Sheepwash Grange (18th Century Farmhouse)	Medium	Noise and visual intrusion on setting.	Short term	Minor
255	Glebe Farmhouse	Medium	Noise and visual intrusion on setting	Short term	Negligible
309	Branston Heath Farmhouse	Medium	Noise intrusion on setting	Short term	Negligible
770	Railway Underbridge	Low	Removal of site	Permanent	Major
772	Manor Farm	Low	Noise and visual intrusion on setting.	Short term	Minor
773	Canwick Heath Farm	Low	Noise and visual intrusion on setting.	Short term	Negligible
774	Halfway House	Low	Noise and visual intrusion on setting.	Short term	Negligible
775	The Foremans House and workers' cottages	Low	Noise and visual intrusion on setting.	Short term	Negligible
776	Cathedral Church of St Mary, Cloisters, Chapter House and Libraries	Very High	Construction activities visible in long distance views from the crossing tower and the south elevation.	Short term	Minor

Site No.	Site Name	Value	Type of Impact	Duration of Impact	Unmitigated Magnitude of Construction Impact
777	Lincoln Castle	High	Construction activities visible in long distance views from the Observatory Tower and curtain walls	Short term	Minor
778	The Bishop's Palace	High	Construction activities visible in long distance views from the upper terrace	Short term	Negligible

8.8.4 Construction of the scheme would result in the removal of the Railway Underbridge (Site 770). This would be a permanent impact and was assessed to be of Major magnitude.

8.8.5 The construction of the scheme within *c.* 0.6km of the Church of All Saints (Site 98) would have a short-term adverse impact on the setting of the site. The construction of the cutting to the south of the Witham, the bridge and associated embankments across the valley floor would introduce new large-scale infrastructure elements within the setting of the Church, detracting from its quiet rural character. The association of the Church with Greetwell Hall and the shrunken medieval village would be maintained, however the scheme would be particularly prominent in views from the south doorway and the churchyard, and would urbanise the rural setting of the church. The unmitigated magnitude of impact is assessed to be Moderate for the Church of All Saints.

8.8.6 Construction works for the cutting would be located *c.*0.16km to the west of Sheepwash Grange (Site 214) and within *c.*0.24km of Manor Farm (Site 772). This would introduce a major new element of infrastructure into the rural landscape surrounding these buildings. Construction of the scheme would be visible in views southwards from the principal elevations of both buildings. There would be no impact upon the gardens or outbuildings associated with either site. Our understanding of these buildings would not be affected. The magnitude of impact is predicted to be Minor for both sites.

8.8.7 Negligible impacts are predicted to result from the construction of the scheme upon Greetwell Hall (Site 96), Glebe Farmhouse (Site 255) and Branston Heath Farmhouse (Site 309). Construction activities would be visible on approach to the buildings; however, views towards the scheme from the buildings themselves would be limited. Construction of the scheme would increase the urbanisation of the setting of these sites due to the introduction of a major new element of infrastructure; however, our understanding of these buildings would remain unchanged. The magnitude of construction upon these sites is predicted to be Negligible.

8.8.8 New noise and visual impacts would result from construction activities upon Canwick Heath Farm (Site 773), Halfway House (Site 774) and the Foreman's House and Worker's Cottages (Site 775), whilst the introduction of a new infrastructure element would urbanise their setting. Our understanding of these sites, however, would be maintained, particularly in relation to the roadside location of Canwick Heath Farm and Halfway House. The magnitude of the impact on these sites has been assessed as Negligible.

8.8.9 Construction work and activity would be visible in views from the crossing and south elevation of Lincoln Cathedral (Site 776) and from the Observatory Tower, and the south and east curtain walls of Lincoln Castle (Site 777). These views are protected under Policy 55 of the City of Lincoln Local Plan (referred to in the plan as View 15)

and have been assessed to constitute one of the contributory characteristics of their settings (details of the other characteristics are given in Appendix 8C). Activity visible in these views would include the movement of construction vehicles, the construction of earthworks, construction compounds and temporary lighting. The construction of the cutting to the south of the River Witham and the erection of the bridge would be particularly visible in these views. The scheme would impact upon one element of the setting of these sites; however this would not detract from their understanding or that of their setting. The visual dominance of the Cathedral and views towards it from the approach roads would be maintained. The magnitude of impact has been assessed as Minor for these two sites.

8.8.10 Construction activity would be visible in limited views to the southeast from the upper terrace of the Bishop's Palace (Site 778). Principal views from the terrace look directly to the south and would not be affected by construction activities. The magnitude of construction impact upon the Bishop's Palace complex has been assessed as Negligible.

8.8.11 No change is predicted to result from the construction of the scheme upon the remaining 15 sites.

8.8.12 Views of construction activity would be possible from the upper storeys of some buildings within the Cathedral and City Centre Conservation Area (Site 782); however, these views take in much of the townscape and views to the countryside beyond. Construction of the scheme would form another element in these views and would not be detrimental. Views from street level are largely contained by surrounding buildings. Where longer views are possible, particularly around Steep Hill, these look principally to the south and do not include significant views of the scheme. No change is predicted to result from construction of the scheme upon the conservation area.

Predicted Impacts During Operation

8.8.13 Predicted operation impacts upon Built Heritage are assessed to occur in the year of the scheme's opening in 2016. The predicted impacts of operation are summarised in Table 8.11 below. All operation impacts are predicted to commence during the construction phase and continue in the long term during operation of the scheme.

Table 8.11: Predicted Impacts during Operation on Historic Buildings

Site No.	Site Name	Value	Type of Impact	Unmitigated Magnitude of Operation Impact
96	Greetwell Hall	Medium	Operation of the scheme would be visible on approach to the Hall. Relationship to key elements of setting would not be affected.	Negligible
98	Church of All Saints	High	Urbanisation of setting resulting from the visibility of the river crossing and cutting in views from the south doorway and churchyard. Introduction of major element infrastructure into predominantly rural setting.	Minor
214	Sheepwash Grange (18th Century Farmhouse)	Medium	Damage to rural landscape setting, introduction of new noise and visual impacts	Minor
255	Glebe Farmhouse	Medium	New infrastructure element in rural landscape setting. Introduction of noise impacts	Negligible

Site No.	Site Name	Value	Type of Impact	Unmitigated Magnitude of Operation Impact
309	Branston Heath Farmhouse	Medium	New infrastructure element in rural landscape setting. Introduction of noise impacts. Understanding of the site would be unaffected.	Negligible
772	Manor Farm	Low	Damage to rural landscape setting, introduction of new noise and visual impacts	Minor
773	Canwick Heath Farm	Low	Scheme would form a new element within the site's setting. Understanding of the site would be unaffected.	Negligible
774	Halfway House	Low	Scheme would form a new element within the site's setting. Understanding of the site would be unaffected.	Negligible
775	The Foremans House and workers' cottages	Low	Scheme would form a new element within the site's setting. Understanding of the site would be unaffected.	Negligible
776	Cathedral Church of St Mary, Cloisters, Chapter House and Libraries	Very High	Scheme visible in protected views from the tower and south elevation during the day and night. Views to rural hinterland beyond would be maintained.	Minor
777	Lincoln Castle	High	Scheme visible in protected views from the tower and south elevation during the day and night. Views to rural hinterland beyond would be maintained.	Minor
778	The Bishop's Palace	High	Operation of the scheme would be visible in limited long distance views from the upper terrace to the southeast.	Negligible

8.8.14 Operation of the scheme is predicted to impact upon the setting of All Saints Church (Site 98). The presence of the bridge and embankment crossing the floor of the Witham Valley and the cutting to the south of the river would form intrusive elements within the rural setting of the church, and particularly in long views from the south doorway and graveyard. Night time impacts would also result from operation due to the lighting of the scheme across the valley floor. Operation of the scheme would result in the urbanisation of the rural setting of All Saints Church; however, its relationship to Greetwell Medieval Village (Site 105) and Greetwell Hall (Site 98) would be maintained. The unmitigated magnitude of impact has been assessed as Minor.

8.8.15 The operation of the scheme would impact upon the setting of Sheepwash Grange Farmhouse (Site 214) and Manor Farm (Site 772) due to the presence of an intrusive, large-scale element of infrastructure and the introduction of noise impacts. The scheme would form a new element in views south from the principal elevation of both buildings, however, their relationships with associated gardens and outbuildings would be maintained. The unmitigated magnitude of impact is predicted to be Minor for both sites.

8.8.16 During operation, the valley crossing and the cutting to the south of the Witham would be visible in protected views from Lincoln Cathedral (Site 776) and Lincoln Castle (Site 777), as defined under Policy 55 of the City of Lincoln Local Plan. Views from the Cathedral and the Castle are wide and expansive, covering much of the city and the surrounding countryside (see Figures 9.33 and 9.35). The operation of the scheme would intrude into views across the rural landscape which extends along the Witham valley towards Lincoln; however, views to the open countryside beyond the scheme would be maintained, retaining the visual link between the city and the surrounding landscape. Visual impacts would also occur at night time due to the lighting of the scheme across the valley floor. Whilst the scheme would result in a

noticeable change to protected views, it would not detract from the understanding of the sites or their appreciation. The visual dominance of the Cathedral and views towards it from the approach roads would be maintained during operation of the scheme. The unmitigated magnitude of operation upon these three sites is predicted to be Minor.

8.8.17 During operation, the scheme would be visible in limited views to the southeast from the upper terrace of the Bishop's Palace (Site 778; see Figure 9.34). Principal views to the south would not be affected. The unmitigated magnitude of operation has been assessed to be Negligible.

8.8.18 During operation of the scheme the river crossing and the cutting to the south would be visible on approach to Greetwell Hall (Site 96) through the shrunken medieval village of Greetwell (Site 105, see para 1.6.5 above); however relationship of the Hall to the Church of All Saints and to the shrunken medieval village would be maintained, whilst views from the principal elevation towards the scheme would be largely screened by existing planting. The understanding of the Hall would not be adversely affected by the scheme. The unmitigated magnitude of operation upon Greetwell Hall is predicted to be Negligible.

8.8.19 Operation of the scheme would introduce a major element of infrastructure into the arable landscape surrounding Glebe Farmhouse (Site 255) and Branston Heath Farm (Site 309), resulting in the urbanisation of their setting. The scheme would be visible on approach to these sites; however, views from the principal elevations would not be affected. The relationship of the buildings to associated gardens and outbuildings would be maintained. The understanding of these buildings would be maintained by the scheme. The unmitigated magnitude of impact of operation is predicted to be Negligible for both sites.

8.8.20 The scheme would form a large new element within the setting of Canwick Heath Farm (Site 773), Halfway House (Site 774) and The Foreman's House and Worker's Cottages (Site 775), and would be visible at night time due to the presence of lighting around junctions. Our understanding of these sites would not be damaged by the scheme: the setting of Canwick Heath Farm and Halfway House with regards to their roadside location would not be affected, whilst the relationship of the Foreman's House and Worker's Cottages to Manor Farm would be maintained. The unmitigated magnitude of impact upon these sites is therefore assessed to be Negligible.

8.8.21 Operation of the scheme would remove *c.*18,000 cars per day from the City of Lincoln, reducing visual and noise impacts upon Listed Buildings and Conservation Areas within the city centre. The significance of this impact has been assessed as Imperceptible Positive.

8.8.22 No change is predicted to result from the construction of the scheme upon the remaining 16 sites.

8.8.23 As for the construction phase, views towards the scheme would be possible from the upper storeys of some buildings within the Cathedral and City Centre Conservation Area (Site 782); however, this would not affect our understanding of the buildings or that of their setting. Significant views of the scheme would not be possible from ground level. No change is predicted to result from operation of the scheme upon the conservation area.

8.9 MITIGATION

8.9.1 The following measure is recommended to mitigate the predicted Major impact upon the Railway Underbridge (Site 770):

- A scheme of historic building recording undertaken to Level 2 standards, as defined by English Heritage (English Heritage, 2006, 14). This would comprise a written, drawn and photographic record of the structure as appropriate. These reports would be lodged with the Lincolnshire Historic Environment Record and available for public consultation.

8.9.2 Predicted impacts upon the setting of the Church of All Saints (Site 98) would be mitigated by the use of hedgerow, tree and shrub planting along the road embankment to the north of the river (refer to Chapter 9, Landscape and Visual Impacts for further information). When mature, this would help to integrate the structure into the low-lying landscape.

8.9.3 Mitigation of predicted impacts upon protected views from Lincoln Cathedral (Site 776), Lincoln Castle (Site 777), the Bishop's Palace (Site 778), and upon the setting of Sheepwash Grange (Site 214) and Manor Farm (Site 772) would be undertaken by the use of landscaping and detailed design to aid the integration of the scheme with the surrounding landscape (refer to Chapter 9, Landscape and Visual Impacts). To the south of the river this would be achieved by the use of wildflower planting along the cutting and the retention of existing hedgerows to the west of the cutting may to aid the integration of the scheme into the landscape.

8.9.4 The use of directional lighting would reduce the visual impacts of the valley crossing at night time by decreasing light pollution. This would imperceptibly reduce the impact upon views from built heritage sites.

8.9.5 No mitigation is proposed for the remaining 21 sites.

8.10 RESIDUAL IMPACTS

8.10.1 Residual effects of the scheme construction and operation upon Historic Buildings have been assessed to occur in 2031. Predicted impacts are as described in Tables 8.12 and 8.13 below.

Table 8.12: Predicted Residual Construction Impacts on Historic Buildings

Site No.	Site Name	Value	Magnitude of Impact	Mitigation	Magnitude of Mitigated Impact	Significance of Residual Impact
96	Greetwell Hall	Medium	Negligible	None proposed	Negligible	Neutral
98	Church of All Saints	High	Moderate	None proposed	Moderate	Moderate
214	Sheepwash Grange (18th Century Farmhouse)	Medium	Minor	None proposed	Minor	Slight
255	Glebe Farmhouse	Medium	Negligible	None proposed	Negligible	Neutral
309	Branston Heath Farmhouse	Medium	Negligible	None proposed	Negligible	Neutral
770	Railway Underbridge	Low	Major	English Heritage Level 2 Building recording	Negligible	Neutral
772	Manor Farm	Low	Minor	None proposed	Minor	Slight
773	Canwick Heath Farm	Low	Negligible	None proposed	Negligible	Neutral
774	Halfway House	Low	Negligible	None proposed	Negligible	Neutral
775	The Foremans House and workers' cottages	Low	Negligible	None proposed	Negligible	Neutral
776	Cathedral Church of St Mary, Cloisters, Chapter House and Libraries	Very High	Minor	None proposed	Minor	Slight
777	Lincoln Castle	High	Minor	None proposed	Minor	Slight

Site No.	Site Name	Value	Magnitude of Impact	Mitigation	Magnitude of Mitigated Impact	Significance of Residual Impact
778	The Bishop's Palace	High	Negligible	None proposed	Negligible	Neutral

Table 8.13: Predicted Residual Operation Impacts on Historic Buildings

Site No.	Site Name	Value	Magnitude of Impact	Mitigation	Magnitude of Mitigated Impact	Significance of Residual Impact
96	Greetwell Hall	Medium	Negligible	None proposed	Negligible	Neutral
98	Church of All Saints	High	Minor	Landscape planting along the road embankment. Use of directional lighting.	Minor	Slight
214	Sheepwash Grange (18th Century Farmhouse)	Medium	Minor	Grading of road cutting and retention of existing hedgerows	Minor	Slight
255	Glebe Farmhouse	Medium	Negligible	None proposed	Negligible	Neutral
309	Branston Heath Farmhouse	Medium	Negligible	None proposed	Negligible	Neutral
772	Manor Farm	Low	Minor	Grading of road cutting and retention of existing hedgerows	Minor	Slight
773	Canwick Heath Farm	Low	Negligible	None proposed	Negligible	Neutral
774	Halfway House	Low	Negligible	None proposed	Negligible	Neutral
775	The Foremans House and Workers' Cottages	Low	Negligible	None proposed	Negligible	Neutral
776	Cathedral Church of St Mary, Cloisters, Chapter House and Libraries	High	Minor	Landscape planting along the valley crossing and cutting. Retention of existing hedgerows to the west of the cutting. Use of directional lighting.	Minor	Slight
777	Lincoln Castle	High	Minor	Landscape planting along the valley crossing and cutting. Retention of existing hedgerows to the west of the cutting. Use of directional lighting.	Minor	Slight
778	The Bishop's Palace	High	Negligible	Landscape planting along the valley crossing and cutting. Retention of existing hedgerows to the west of the cutting. Use of directional lighting.	Negligible	Neutral

8.10.2 Preparation of a record of the Railway Underbridge (Site 770) to English Heritage Level 2 standards would provide a permanent record of the structures in their current condition and enable their preservation by record. Due to the nature and value of this structure the recording works are considered to effectively mitigate its loss. The magnitude of impact predicted after mitigation is therefore assessed to be Negligible, and the residual impact of the scheme is predicted to be Neutral.

8.10.3 When mature, landscape mitigation would aid the integration of the scheme into the landscape, however, it is not considered that this would reduce the magnitude of impacts predicted upon the setting of the Church of All Saints (Site 98), or upon the protected views from Lincoln Cathedral (Site 776), Lincoln Castle (Site 777) or the

Bishop's Palace (Site 778). The residual impact of construction and operation of the scheme upon the Church of All Saints (Site 98) is predicted to be Moderate. The residual impacts of construction and operation upon Sheepwash Grange (Site 214), Manor Farm (Site 772), Lincoln Cathedral (Site 776), and Lincoln Castle (Site 777) are predicted to be Slight. The residual impact upon the Bishop's Palace is predicted to be Neutral.

Summary of Residual Impacts

8.10.4 Within the study area 28 sites of Built Heritage value were identified (Figure 8.2).

8.10.5 After mitigation, the following short-term impacts are predicted at *construction*:

- A moderate adverse impact on one site;
- Slight adverse impacts on four sites; and
- Neutral impacts on the remaining 23 sites.

8.10.6 After mitigation, the following impacts are predicted to continue at *operation*:

- Slight adverse impacts on five sites; and
- Neutral impacts on the remaining 23 sites.

8.10.7 A slight positive impact during operation has been identified for Listed Buildings and Conservation Areas within the City of Lincoln, resulting from the reduction of traffic within the city centre.

8.10.8 Historic building recording to English Heritage Level 2 standards is recommended to mitigate a major impact on Site 770, a railway bridge of low value. The residual impact of this impact has been assessed to be Neutral. Impacts upon setting and protected views would be mitigated as far as possible by the use of landscaping.

HISTORIC LANDSCAPE

8.11 BASELINE CONDITIONS

Known sites

8.11.1 A total of 13 Historic Landscape Types have been identified within the study area. These Types are shown on Figure 8.3 and are described in detail in Appendices 8B and 8C.

8.11.2 The study area is characterised by the 18th century enclosure landscape, with nucleated farmsteads and a system of fairly straight roads radiating out from Lincoln. The dominant land use is arable fields, with broken hedgerow boundaries and few trees. The study are is bisected by the River Witham, pasture fields on both banks, and is flanked on the west by the 19th and 20th century urban fringe of Lincoln.

8.12 PREDICTED IMPACTS

8.12.1 Historic Landscape Type 12, Shrunken Historic Settlement, is concurrent with, and identical to Archaeological Site 105 “Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains”, a Scheduled Ancient Monument. Impacts on Historic Landscape Type 12 have been assessed in the Archaeological Remains Section above. To avoid double-counting, impacts on this site/character type are not repeated below.

Do Minimum / Do Nothing

8.12.2 If the scheme was not constructed, there would be no changes to the historic landscape as it currently stands within the study area.

Temporary Construction Impacts

8.12.3 Impacts on the historic landscape during construction were assessed according to the methodology set out in Appendix 8A. These impacts are listed in Table 8.14 below.

Table 8.14: Short Term Construction Impacts on the Historic Landscape

No.	Type	Description of Impact	Value	Magnitude of un- mitigated impact
1	18th century enclosure with modern boundary loss and isolated farmsteads	Temporary impacts from the movement and presence of site traffic and plant, topsoil stripping, creation of earthworks/cuttings and site lighting.	Low	Moderate
2	18th Century Enclosure with modern sub-division and isolated farmsteads	Temporary impacts from the movement and presence of site traffic and plant, topsoil stripping, creation of earthworks/cuttings and site lighting.	Low	Moderate
3	18th Century Enclosure	Temporary impacts from the movement and presence of site traffic and plant, topsoil stripping, creation of earthworks/cuttings and site lighting.	Low	Minor
11	Riverside	Temporary impacts from the movement and presence of site traffic and plant, topsoil stripping, creation of earthworks/cuttings and site lighting.	Low	Moderate

Long Term Construction Impacts

8.12.4 Long term impacts on the historic landscape, deriving from construction, were assessed according to the methodology set out in Appendix 8A. These impacts are listed in Table 8.15 below.

Table 8.15: Long Term Construction Impacts on the Historic Landscape

No.	Type	Description of Impact	Value	Magnitude of un-mitigated impact
1	18th Century Enclosure with boundaries removed in the modern period and isolated farmsteads	Severance of some field boundaries. Imposition of a curving route at right-angles to established road pattern. Severance of this landscape type where it extends towards the city of Lincoln. Grade separated junctions, roundabouts and elevated walkways are out of keeping with the established road pattern. Proposed noise mitigation bunds are out of keeping with the local, gently rolling topography and would block views across the landscape from ground level.	Low	Moderate
2	18th Century Enclosure with boundaries added in the modern period and isolated farmsteads	Severance of some field boundaries. Imposition of curving route at right-angles to established road pattern. Grade separated junctions, roundabouts and elevated walkways are out of keeping with the established road pattern. Proposed noise mitigation bunds are out of keeping with the local, gently rolling topography and would block views across the landscape from ground level.	Low	Moderate
3	18th Century Enclosure	Roundabout at Sleaford Road and elevated walkway over Bloxholm Lane are out of keeping with the established road pattern.	Low	Negligible
11	Riverside	Severance of this character type as it continues into Lincoln. Route would create a main crossing point of the Witham in this character type.	Low	Moderate

Long Term Operation Impacts

8.12.5 The impacts on the historic landscape from the operation phase consist of lighting of the carriageway at night and road noise adding to the already present sense of urbanisation caused by existing roads and lighting of settlements.

Table 8.16: Long Term Operation Impacts on the Historic Landscape

No.	Type	Description of Impact	Value	Magnitude of un-mitigated impact
1	18th Century Enclosure with boundaries removed in the modern period and isolated farmsteads	Increased sense of urbanisation due to increased level of road noise and road noise present in more parts of this type. Lighting of junctions would increase this sense of urbanisation at night.	Low	Minor

No.	Type	Description of Impact	Value	Magnitude of un-mitigated impact
2	18th Century Enclosure with boundaries added in the modern period and isolated farmsteads	As above.	Low	Minor
3	18th Century Enclosure with isolated farmsteads	Lighting of the junctions with Bloxholm Lane and Sleaford Road would increase the sense of urbanisation at night.	Low	Negligible
11	Riverside	Increased urbanisation due to increased level of road noise and road noise present in more parts of this type. Lighting of junctions would increase this sense of urbanisation at night.	Low	Minor

8.13 MITIGATION

8.13.1 There is currently no national consensus on appropriate mitigation measures for impacts on the historic landscape. It is widely agreed, however, that highly sensitive landscapes should be preserved *in situ*, preferably by altering scheme design to avoid impacts. There are no highly sensitive landscapes within the study area.

8.13.2 For less sensitive landscapes, impacts may be reduced by the provision of landscape recording works and the production, retention and wide dissemination of the results. These works would typically consist of archaeological survey and photography of existing field boundaries and landscape elements, as well as wider photographic survey of the surrounding area to provide context. These results could also be combined with the results of baseline studies such as those undertaken in support of this report (see Appendix 8B).

8.13.3 The design of Landscape mitigation measures (see Chapter 9, Landscape and Visual amenity) has resulted from an iterative process between the heritage, landscape, ecology and highways design teams throughout the development of the scheme.

Temporary Construction Impacts

8.13.4 No mitigation measures are proposed for these impacts.

Long Term Construction Impacts

8.13.5 Long term construction impacts on Historic Landscape Types 1, 2 and 3 would be partially mitigated by the retention, where possible, of existing hedgerows and by the reinstatement of hedgerows that are removed during construction.

8.13.6 Where the proposed carriageway cuts across the corners or edges of exiting fields, small remnant fields would be created. In these cases, it is proposed to retain the original field boundaries and plant the remnant fields with scrub and wild flowers (see Chapter 9, Landscape and Visual amenity) or in the case of one remnant field north of Greetwell road, to establish a small pond for ecological mitigation (see Chapter 10, Ecology and Nature Conservation). While this would remove areas of arable cultivation, the retention of field boundaries would help to retain the legibility of the pre-scheme field pattern.

8.13.7 A programme of historic landscape survey to English Heritage Level 1 standards[16] prior to construction is also proposed to record Historic Landscape Types 1, 2, 3 and 11 within the study area. The design of these works should include measured survey of any field boundaries to be removed, as well as photographic survey of the wider area and long views to and from the Historic Landscape Types. The production, retention and wide dissemination of the results would serve to further reduce the magnitude of the impact on these Historic Landscape Types.

Long Term Operation Impacts

8.13.8 The character of proposed landscape planting has been designed to be in keeping with the existing local character, consisting mostly of scrub and shrubs, with gaps between areas of planting to retain open views across the landscape. As this planting matured, it would provide some, but not total screening of road traffic. In particular, high-sided vehicles would still be visible on the road where the proposed carriageway is at grade or on an embankment. However, it is considered that planting taller trees along the entire route and the subsequent loss of views would constitute a larger impact than the presence of vehicles.

8.13.9 The proposed landscape mitigation includes two areas between Bloxholm Lane and Lincoln Road where raised bunds adjacent to the carriageway which are proposed to reduce visual and noise impacts to the east and west of the scheme. In order to reduce the visual profile of these bunds themselves, it is also proposed to build up the existing agricultural land to provide a more gentle gradient (see Appendix 9E). At the time of writing, it is envisioned that these graded areas would be built up from the existing ground level with topsoil, and that no excavation is required which may damage known or unknown archaeological remains.

8.13.10 The proposed noise mitigation bunds would reduce some of the road noise present for some of the southern part of historic landscape Type 2, where these are proposed for both sides of the carriageway.

8.14 RESIDUAL IMPACTS

Temporary Construction Impacts

Table 8.17: Residual Short Term Construction Impacts

Type No.	Type Name	Value	Magnitude of Un-mitigated Impact	Magnitude of mitigated Impact	Significance of mitigated Impact
1	18th century enclosure with modern boundary loss and isolated farmsteads	Low	Moderate	Moderate	Slight
2	18th Century Enclosure with modern sub-division and isolated farmsteads	Low	Moderate	Moderate	Slight
3	18th Century Enclosure	Low	Minor	Minor	Neutral
11	Riverside	Low	Moderate	Moderate	Slight

[16] English Heritage 2007 Understanding the Archaeology of Landscapes. Swindon: RCHME

Long Term Construction Impacts

Table 8.18: Residual Long Term Construction Impacts

Type No.	Type Name	Value	Magnitude of Un-mitigated Impact	Magnitude of mitigated Impact	Significance of mitigated Impact
1	18th Century Enclosure with boundaries removed in the modern period and isolated farmsteads	Low	Moderate	Minor	Slight
2	18th Century Enclosure with boundaries added in the modern period and isolated farmsteads	Low	Moderate	Minor	Slight
3	18th Century Enclosure	Low	Negligible	Negligible	Neutral
11	Riverside	Low	Moderate	Moderate	Slight

Long Term Operation Impacts

Table 8.19: Residual Long Term Operation Impacts

Type No.	Type Name	Value	Magnitude of Un-mitigated Impact	Magnitude of mitigated Impact	Significance of mitigated Impact
1	18th Century Enclosure with boundaries removed in the modern period and isolated farmsteads	Low	Minor	Minor	Neutral
2	18th Century Enclosure with boundaries added in the modern period and isolated farmsteads	Low	Minor	Minor	Neutral
3	18th Century Enclosure with isolated farmsteads	Low	Negligible	Negligible	Neutral
11	Riverside	Low	Minor	Minor	Neutral

Table 8.20: Summary of Residual Impacts on the Historic Landscape

Significance	Count of Residual Impacts
Temporary Construction Impacts	
Slight	3 (Types 1, 2 and 11)
Long Term Construction Impacts	
Slight	3 (Types 1, 2 and 11)
Long Term Operation Impacts	
Slight	3 (Types 1, 2 and 11)

8.14.1 There is an overall residual impact on historic landscape Types 1, 2 and 11 of Slight significance. These impacts first occur in the construction phase and change in character through the life of the scheme. The temporary construction zone created during construction would give way to an increased sense of urbanisation once the

road is built and opened to traffic. This impact continues through the operational life of the scheme. The impacts are partially mitigated by a combination of:

- Landscape planting;
- Creation of noise mitigation bunds to reduce road noise;
- Grading back of bunds for return to agriculture and integration with the local topography;
- Retention and re-establishment where possible of existing hedgerows; and
- Historic landscape recording works prior to construction.

9 LANDSCAPE AND VISUAL IMPACTS

9.1 INTRODUCTION AND SCOPE

9.1.1 This chapter examines the potential landscape and visual effects of the preferred route between the A158 Wragby Road and the A15 Sleaford Road. The preferred route is Option Z in the Stage 2 Assessment.

9.2 METHODOLOGY

9.2.1 This assessment has been undertaken in accordance with guidance set out in the DMRB, Guidelines for Landscape and Visual Impact Assessment (GLVIA), and Countryside Agency (now Natural England), taking account of Transport Appraisal Guidance (TAG).

9.2.2 The Stage 2 Landscape and Visual Assessment baseline information gathered during the desk study carried out in 2007 has been further checked and updated to recognise any changes. Further to this, two separate field studies have been carried out in January and February 2009 to assess in detail any landscape and visual effects to determine sensitive visual receptors and locations for photomontages. The study area for the landscape appraisal and the landscape character assessment has been set at 1km offset from the line of the preferred route. The visual appraisal study area is defined by the Zone of Theoretical Visibility (ZTV) (see section 9.7) and is more extensive.

9.2.3 Data sources used in the desk-based survey were as follows:

- Lincoln Eastern Bypass Stage 2 Environmental Assessment 2008;
- City of Lincoln Local Plan (Adopted 1998);
- West Lindsey Local Plan (Adopted June 2006);
- North Kesteven Local Plan (Adopted September 2007);
- Natural England's - Character of England Landscape, Wildlife and Cultural Features Map 2005 (updated from the Character of England Map and the Countryside Initiative Map (Countryside Agency);
- North Kesteven Landscape Character Assessment;
- West Lindsey Landscape Character Assessment August 1999;
- Tree Preservation Order information from North Kesteven District Council and West Lindsey District Council; and
- OS 1:50,000 scale Landranger map.

9.2.4 The information was used both to identify the existing conditions (2008) and predict any changes that may occur before 2013 (start of construction), independent of the proposed route.

9.3 ASSUMPTIONS/LIMITATIONS

9.3.1 The design year (2031) has been assessed for the 'do minimum scenario' in terms of known built development. For the 'do something' scenario it is assumed that establishment of any mitigation would have been achieved by this date.

9.3.2 The scheme would be lit at junctions and up to 350m back on each arm. The section from Greetwell Road to Washingborough Road would be fully lit. Lighting is assumed to be directional only lighting the road surface.

9.3.3 Townscape character assessments undertaken for areas that would experience direct or close range / perceptible impacts only. Where visual impacts are identified to urban areas further afield these effects have been assessed within the visual assessment.

9.3.4 Residual impacts are assessed as those that would remain after implementation of mitigation proposals which can be either immediate (Construction / Opening year) or effective after a recognised period of time (Design Year 15 years onwards after Opening Year).

9.4 RELEVANT LANDSCAPE PLANNING POLICY

9.4.1 The following relevant landscape planning documents and policies have been considered:

National:

- PPS 1 – Delivering Sustainable Development 2005 – promotes sustainable and inclusive design of rural and urban development;
- PPG 2 – Greenbelt – provides guidance on the protection of rural land to restrict urban sprawl and preserve special character. This also includes the visual amenity within the greenbelt;
- PPS 7 – Sustainable Development in Rural Areas – promotes protection and enhancement of the wider countryside encouraging economic growth, recreation and enjoyment by improving access to the countryside from urban edges;
- PPS 9 – Biodiversity and Geological Conservation (August 2005) – provides guidance on the protection of biodiversity and geological conservation including international sites such as SPAs, SACs and SSSIs and regional and local sites;
- PPG17 – Planning for Open Space, Sport and Recreation – promotes the protection and enhancement of rights of way and recreational areas;

Regional:

- Regional Spatial Strategy for the East Midlands (RSS8) March 2005 which provides a broad development strategy for the East Midlands up to 2021 and a spatial strategy outlining regional policies for rural and urban communities;

Local:

- Local Plan (adopted 1998), Lincoln City Council;
- Local Plan First Review (adopted June 2006) West Lindsey District Council; and
- Local Plan (adopted September 2007) North Kesteven District Council .

9.4.2 Where appropriate to particular landscape features or designations, relevant local plan policies are referenced as footnotes within the text.

9.5 EXISTING CONDITIONS

9.5.1 The proposed scheme is located to the east of the city of Lincoln and extends from the north-eastern edge at the Wragby Road to the south eastern edge of Bracebridge Heath at the A15 Sleaford Road. For further details for the scheme proposals refer to Chapter 2.

9.5.2 The existing conditions are described below under a series of headings that relate to the main features and elements that make up the broad characteristics of the landscape. These features are shown underlined in the text e.g. Plateau, and have

been assessed for their sensitivity to change (Appendix 9A), as shown in brackets e.g. (**low**).

Topography and Hydrology (see also Chapter 11 and Figures 9.1 to 9.3)

9.5.3 The north and south areas of the study area consist of undulating upland plateau topography of the limestone escarpment (the 'Lincoln Edge'); which descends steeply to the west towards the Trent Valley. To the east, the topography falls gently down the dip slope where it is bisected by a number of dry valleys, giving the landform greater topographical variation towards Washingborough and Branston. The River Witham dissects the escarpment in the centre of the study area creating the 'Lincoln Gap' where topography descends steeply into the River Witham Valley orientated in an east-west direction.

9.5.4 The northern section of the 'Lincoln Edge' (northern upland plateau : **medium**), extends from Wragby Road, where it lies at approximately 30-35m AOD to Greetwell Road at 25m AOD.

9.5.5 Greetwell Road itself forms the noticeable northern ridgeline (**medium**) running east west at around 25m AOD. From here the slope falls sharply to 5m AOD to the south of the Lincoln to Market Rasen railway which passes through the slope in cutting.

9.5.6 To the south of the Lincoln to Market Rasen railway, the low lying topography flattens out within the Witham valley (**high**). The land remains level over the floodplain dropping to a low point of 4m AOD at the river edge. Beyond the flood plain south of the river, the land rises gradually to Washingborough Road, which defines the foot of the southern valley slope.

9.5.7 The slope rises steeply up the valley side to the southern slope and ridgeline (**high**) which follows the line of Heighington Road at approximately 40m AOD.

9.5.8 Beyond the Heighington Road, the landform reverts to southern upland plateau (**medium**) where the land rises in a gentle, undulating fashion up to 66m AOD at the junction with the A15 Sleaford Road, with localised undulations and incised valleys falling eastwards along stream courses.

9.5.9 There are various man-made topographical features in the area including Greetwell Quarry, the cuttings and embankments for the Lincoln to Market Rasen and Lincoln to Spalding railways and a disused railway. Greetwell Quarry (**high**) covers an area to the west of the scheme on the eastern edge of Lincoln and is particularly sensitive due to its designation as a geological Site of Special Scientific Interest (SSSI)[17]and protection from adverse effects through local planning policy[18]. The railway embankments (**low**) of the Lincoln to Spalding line and disused railway cross the valley floor to the south of the River Witham extending east from industrial areas in Lincoln. Vegetation is intermittent on the embankments and they appear as raised, linear elements in the landscape.

9.5.10 The River Witham (**high**) flows west to east through Lincoln, has been canalised and is slightly raised above the surrounding flood plain. It is flanked by flood embankments and the North and South Delphs (South Delph is designated as a Critical Natural Asset in the City of Lincoln Local Plan[19] . There is also a stream (**low**) which crosses the line of the preferred route close to Canwick Heath Farm.

9.5.11 Across the valley floor the soils are peat based and relatively wet and there are numerous drainage ditches and localised ponds. On the higher ground to the north

[17] Greetwell Quarry SSSI
[18] City of Lincoln Local Plan – Policy 44A Sites of Special Scientific Interest and Other Critical Natural Assets.
[19] City of Lincoln Local Plan 1998 – Policy 44A Sites of Special Scientific Interest and other Critical Natural Assets

and south the soils are shallow, well drained, light calcareous brashy loams on underlying limestone.

Land Use and Pattern (see also Chapter 13 and Figure 13.1)

9.5.12 Agriculture is the predominant land use and intensively managed arable farmland covers the majority of the study area. Arable crops such as wheat, barley and intensively managed and semi-improved grassland dominate the landscape with other crops such as sugar beet and green vegetables scattered in places.

9.5.13 The upland field pattern (**low**) to the north consists of large, irregularly shaped fields bounded predominantly by gappy hedgerows in a north-south and east-west orientation, with occasional stone walls notably along Greetwell Road. Similar land use to the southern upland areas (**medium**) is noticeable by more regular shaped fields of slightly smaller size.

9.5.14 Smaller rectilinear arable and partial pasture fields make up the lowland field pattern (**medium**) of the fens along the River Witham. Fields are divided by drainage dykes which run into the river.

9.5.15 The Greetwell Quarry occupies an extensive area on the eastern edge of Lincoln which, now disused is predominantly used for recreational pursuits. There are other typical urban fringe open space uses found to the eastern edge of Lincoln including playing fields, allotments and local parks to the edges of residential estates as well as a bowling alley (**low**) Canwick Park Golf Course (**medium**) and a driving range along the Washingborough Road.

9.5.16 Settlement pattern varies from the built up area of Lincoln, which includes a mix of residential, commercial and retail uses, to smaller rural towns and villages such as Canwick, Bracebridge Heath, Branston, Heighington and Washingborough as well as North Greetwell and Cherry Willingham on the outskirts of Lincoln and isolated, scattered residential properties and farmsteads.

9.5.17 Numerous transport routes cross the study area linking Lincoln to surrounding towns and villages, extending radially from the city west to east. The key main transport corridors include the Lincoln to Market Rasen and Lincoln to Spalding railways; the A158 Wragby Road and the A15 Sleaford Road. The smaller B and C roads running predominantly east to west Include Greetwell Road, Washingborough Road, Heighington Road, Lincoln Road and Bloxholm Lane.

9.5.18 The River Witham is an important feature within the valley landscape historically used as a transport route into and out of Lincoln. Navigation on the River Witham now is restricted to recreational uses[20,21].

9.5.19 Industrial units are present to the west of Greetwell Quarry, adjacent to the River Witham and on the eastern edge of Bracebridge Heath.

9.5.20 Along the northern urban edge the northern Strategic Development Area consists of housing and mixed use areas nearing completion, situated to the north east of Lincoln between Wragby Road and Hawthorn Road and south of Greetwell Road.

9.5.21 To the north of the River Witham individual properties and small groups of houses are mainly found along existing roads; to the south isolated farmsteads and properties occur away from roads amongst a network of green lanes and tracks.

[20] Regional Spatial Strategy For The East of England (RSS8): Policy 33 Strategic River Corridor
[21] Viking Way – European Long Distance Footpath E2

Land Cover (see also Chapter 10 and Figures 9.1, 10.1 and 10.2)

9.5.22 Hedgerows in the northern section (**low**) and southern section (**medium**) form a distinct but declining pattern within the landscape of the study area. They are mostly single species and are kept well trimmed and cut low. Hedgerows in the south are generally more prominent and substantial and grow up to a height of 2.5 metres or more in some locations, particularly along roads and adjacent to settlement edges, farms and individual properties. Hedgerow trees are infrequent throughout the area and often occur as an isolated remnant of a lost field boundary within an expansive field. Substantial hedgerows exist along the southern bank of the River Witham and along Heighington Road adjacent to Glebe Cottages on the southern valley slope ridge.

9.5.23 Woodland (**medium**): Small copses of broadleaved trees and small woodlands occur infrequently throughout the study area, with small groups of trees generally associated with isolated settlements and found scattered within the fenland to the north, along within parkland trees and vegetation noticeable at Greetwell Hall. Woodland and tree groups are noticeable within and around Canwick Park Golf Course and along Washingborough Road itself. Shelter belts are more common in the southern section and willow trees, and wet woodland scrub is establishing along the River Witham and adjacent dykes.

9.5.24 The larger woodlands in the area include 'The Pits' at Canwick, a large wood to the east of the village, Greetwell Wood SNCI, located between the River Witham and Greetwell Road; and Greetwell Hall Woods SNCI to the south of Greetwell Hall.

9.5.25 Canwick Wood and The Pits (**medium***)* form a strong and extensive feature of mainly deciduous trees on the southern ridge line and southern plateau. The woods are noticeable to the western extent of the southern plateau and are visible from Lincoln and the northern part of the study area.

9.5.26 At Greetwell, Greetwell Wood SNCI (**high**) is a mature beech stand adjacent to the River Witham and Greetwell Hall Wood SNCI, south of Greetwell Road and are both prominent features in the wider valley landscape. Greetwell Hall woods cover a large area below Greetwell Hall extending parkland from here to the river.

9.5.27 Grassland areas (**low**) are concentrated either side of the River Witham, across the northern valley slopes and the grounds of Greetwell Hall and SAM and on parts of the southern slope of the Witham valley. They are mostly improved grassland areas with a small proportion of semi-improved areas between the South Delph and the Lincoln to Spalding railway. In addition there are scattered areas of marsh and amenity grassland within the urban fringe. There is a County Wildlife Site[22] to the south of the River Witham which is predominantly wet grassland extending along the banks of the river and delphs.

Cultural Influences on the Landscape (see also Chapter 8)

9.5.28 There is considerable archaeological evidence dating back to the Bronze Age along the Lincolnshire Edge and the River Witham Valley is of national importance for archaeological finds. Lincoln City and the surrounding area has also been heavily influenced by the Romans as well as by engineering works during the industrial revolution and agricultural and aircraft industries.

[22] North Kesteven Local Plan (2003): Policy LW6 County Wildlife Site

9.5.29 There are noticeable earthworks indicating the site of Greetwell Medieval Village which is a designated Scheduled Ancient Monument as well as Locally Important Historic Parks and Gardens at Greetwell Hall[23].

9.5.30 There area also Historic Parks and Gardens located at Branston Hall and St. John's Hospital in Bracebridge Heath[24]. There is also a Registered Historic Park and Garden at Lincoln Arboretum in Lincoln.

9.5.31 Buildings within the study area which are notable for their distinctive and prominent locations and landmark status are Lincoln Cathedral, Greetwell Church, the large farm buildings at Greetwell Hall Farm and Washingborough Church.

9.5.32 Lincoln Cathedral is a major landmark which is located prominently on top of the Lincoln Cliff and is highly visible throughout the study area. The old town of Lincoln is designated a Conservation Area and includes the Castle which dates from Norman times, the Medieval Bishops Palace, which is an English Heritage guardianship monument, and many fine houses lining the narrow streets on the slopes of the Cliff below the Cathedral and Castle.

9.6 DIFFERENCES AT BASELINE YEAR (2013)

9.6.1 Affordable housing is currently under construction to the north eastern extent of Lincoln. It is anticipated that these areas are to be completed by 2013, and existing planting undertaken as part of the building works would have 3-5 years growth by the anticipated start of construction.

9.7 LANDSCAPE CHARACTER ASSESSMENT

National / Regional Landscape Character Assessment

9.7.1 The study area extends across four different National Character Areas (NCAs) as defined by Natural England's - Character of England Landscape, Wildlife and Cultural Features Map 2005 and within three Natural Areas (NAs):

- The greater part of the study area in upland areas falls within two NCAs: NCA45 & 47 – Northern Lincolnshire Edge with Coversands and Southern Lincolnshire Edge. These are located also within the North Lincolnshire Coversands and Clay Vales Natural Area (NA34);
- The smaller areas to the central and eastern parts of the valley bottom lie within NCA44 Central Lincolnshire Vale and NCA46 – The Fens character areas, and either fall within the Lincolnshire and Rutland Limestone (NA38) or The Fens (NA37) Natural Areas; and
- NCA 48 – The Trent and Belvoir Vales extend to the west of the study area from the foot of the Lincolnshire Edge escarpment.

9.7.2 The Lincolnshire Edge areas NCA45 and NCA47 are characteristically large scale arable 'upland' areas with the prominent slope of the Lincoln 'Cliff' forming the western edge. The landscape is open, broadening to the south, with rectilinear fields enclosed by discontinuous hedges and shelter belts. There is sparse settlement along the upper areas, spring line villages to the west along the foot of the 'cliff' and occasional parklands on the eastern edge towards the clay vale. Tree lined roads and green lanes occur in the southern area and Roman roads and ancient trackways cross the area.

[23] West Lindsey Local Plan (2006): Policy NBE8 Historic Parks and Gardens
[24] North Kesteven Local Plan 2003: Policy HE9 Historic Parks and Gardens

9.7.3 The Central Lincolnshire Vale consists of a broad, low-lying arable vale of underlying clayland situated north of the River Witham on the eastern edge of the dip slope. There is a regular pattern of medium sized fields enclosed by clipped hedgerows of limited species and scattered trees supporting crops of winter cereals, oilseed rape, sugar beet and grazing land. There are sparse nucleated settlements throughout the area with frequent fields of ridge and furrow and deserted medieval villages.

9.7.4 The Fens character area forms a large-scale flat open landscape with extensive views to level horizons and large skies. An extensive system of embanked rivers, drains and ditches permeate the area and create local enclosure and grassland habitats. The rectilinear drainage pattern gives rise to a geometric road pattern with roads and railways on embankments. Most settlement is situated on 'islands' of locally elevated land and most tree cover is associated with these areas. The rich agricultural land has resulted in intensive agricultural cultivation including arable, root and vegetable crops with horticultural greenhouses a prominent feature. Archaeological finds from Bronze Age, Iron Age and Roman times are found within the peat, particularly towards the fen margins and throughout the River Witham Valley.

Local Landscape Character Assessments - (refer to Figure 9.2)

9.7.5 The scheme crosses two local authority districts who have undertaken landscape character assessments to inform policy or planning decisions. These have been reviewed and assessed for relevance to the landscape character within or adjacent to the study area. The key characteristics have been summarised below:

North Kesteven Landscape Character Assessment

9.7.6 The study area crosses two local character areas identified by the North Kesteven Landscape Character Assessment, The Limestone Heath character area and the Waddington to Washingborough Green Wedge. The Central Clays and Gravels and Fenland character areas are also in close proximity to the east of the preferred route.

9.7.7 The Limestone Heath key characteristics:

- Situated on the upper reaches of the Lincoln Cliff;
- Empty, open landscape with wide views and a feeling of elevation and exposure;
- The landform is gently undulating landform which falls to the east and the area is dry due to the underlying limestone geology;
- Small woodland blocks are scattered throughout the area and are prominent due to the openness of the landscape;
- Hedgerows and stone walls demarcate large, rectilinear field boundaries with stone walls generally in poor condition;
- Soil in the area is a striking reddish brown colour and agriculture is intensively arable;
- Settlement is limited to isolated farmsteads and occasional ribbon development with larger settlement situated to the edge of the area;
- Utility infrastructure is prominent in the landscape and RAF installations and mineral workings are a feature; and
- Pressures for change include mineral workings, decline of field boundaries, particularly walls, and intensive agricultural practices.

9.7.8 The Waddington to Washingborough Green Wedge key characteristics:

- Landform follows the scarp slope of the Lincoln Cliff northwards and then the Lincoln Gap eastwards between Waddington and Washingborough, dominated by the steep scarp of the cliff with more level ground in the Lincoln Gap and to the top of the plateau;
- Views to and from it are significant, especially from the City of Lincoln and the Lincoln Cathedral;
- Land use within the area is mixed but predominantly arable agriculture defined by gappy hedgerows and sometimes only ditches. Within the Lincoln Gap land use becomes more associated with recreation and urban fringe development;
- The Viking Way and various associated circular routes are important recreational features in the area; and
- Pressures for change include agricultural development, loss of field boundaries and the expansion of telecommunications and electricity infrastructure.

9.7.9 The Central Clays and Gravels key characteristics:

- Gently undulating, lowland area with small irregular fields of arable and grazing land. Soil in the area is dark brown in colour and surface water is drained into small streams and drainage ditches;
- Well kept hedgerows bound roads and fields with small copses and larger areas of broadleaved woodland throughout;
- There are three distinctive lines of settlement; limestone villages following the spring lines from the limestone plateau, the line of villages on the clay strip and the villages edging the fens;
- Main roads in the area predominantly run north-south with more minor roads running east-west; and
- Pressures for change include inappropriate development on the edge of villages and the loss of hedgerows and tree cover.

9.7.10 The Fenland key characteristics:

- A low lying, flat area with occasional islands of higher land;
- Large, rich arable fields divided by drainage channels;
- Rivers, drains and ditches create linear patterns in the landscape with the road layout following this geometric pattern and small roads raised above the level of the fields;
- There are extensive views to level horizons and huge skies with the exception of to the north east where the Lincolnshire Wolds provide an ‘upland’ horizon;
- Tree cover is limited to occasional trees and shelter belts within the intensively farmed and almost entirely man made landscape; and
- The area is unsettled apart from scattered farmsteads and farm buildings with power lines and large scale agricultural buildings prominent in the landscape.

West Lindsey Landscape Character Assessment

9.7.11 In the West Lindsey Landscape Character Assessment the preferred route crosses the Lincoln Fringe character area and is in close proximity to the Fenland character area.

9.7.12 The Lincoln Fringe key characteristics:

- A flat agricultural area with medium sized fields, low hawthorn hedgerows and few hedgerow trees;
- There are a number of expanded settlements with approaches to settlements dominated by built form;
- Views are often long and relatively open with significant views of Lincoln Cathedral particularly from the A158; and
- There are ongoing pressures for built development in the area as well as associated urban fringe pressures.

9.7.13 The Fenland key characteristics:

- A low lying, flat fen-like landscape along the River Witham;
- Large agricultural fields with some boundaries marked with clumps of shrubby vegetation including ash and willow trees which indicates the wetland nature of the landscape;
- The River Witham flood defence bund is a prominent feature in the landscape as well as large scale agricultural buildings; and
- The relatively high levels of visibility render most areas sensitive to change.

Local Character Units

9.7.14 Local landscape and townscape character units from the Stage 2 Assessment have been reviewed and updated (as shown on Figure 9.2) to reflect the smaller scale differences from the character areas highlighted by the local authority assessments.

9.7.15 The key characteristics of the landscape and townscape character units have been summarised in Appendix 9B. A quality score has been assigned to each unit (based on methodology in Appendix 9A) and its sensitivity to change assessed.

Landscape Character Units:

- LCU1: Northern Upland Plateau — Quality: **Ordinary** — Sensitivity: **Med.**
- LCU2: North Valley Slopes — Quality: **Ordinary** — Sensitivity: **Med.**
- LCU3: Parkland at Greetwell Hall — Quality: **Good** — Sensitivity: **High**
- LCU4: Witham Fen — Quality: **Ordinary** — Sensitivity: **Med.**
- LCU5: Southern valley Slopes — Quality: **Ordinary** — Sensitivity: **High**
- LCU6: Southern Upland Plateau — Quality: **Ordinary** — Sensitivity: **Med.**

Townscape Character Units:

- LCU T1: Lincoln North-east Residential Edge
  Quality: **Ordinary** Sensitivity: **Low.**
- LCU T2: Lincoln Eastern Industrial Fringe:
  Quality: **Ordinary** Sensitivity: **Low.**
- LCU T3: Waddington Residential Edge:
  Quality: **Good** Sensitivity: **Med.**
- LCU T4: Bracebridge Heath Village:
  Quality: **Good** Sensitivity: **Med.**

Zone of Theoretical Visibility and Visual Receptors

9.7.16 The visual envelope or Zone of Theoretical Visibility (ZTV) has been produced through desk top survey of contours and confirmed through field surveys as well as further enhanced using computer modelling to produce separate areas of visibility (landscape and urban). Figure 9.3 Visual Appraisal shows the possible areas that might experience views of the scheme assuming a worst case scenario of lorries (4.2m tall) visible on the road once the scheme is opened.

9.7.17 Visual barriers have been identified and include ground levels and built form that block views (e.g. local hills, large scale warehouse, extensive residential properties etc.) and vegetation that blocks views (e.g. woodland, significant hedgerows and shrub areas).

9.7.18 The visual receptors are locations from which the scheme might be seen, and include private housing, public rights of way, open space areas as well as places of work. These have been surveyed and assessed for their sensitivity within the Visual Impact Assessment Tables in Appendix 9D). A number of these receptors are designated for their long distance views[25] to and from the landmark features of Lincoln City (Cathedral, Castle and the historic city extents) which add importance. There is also provision by this local plan policy that protects views from "the line of the Eastern By-pass where it crosses the floor of the Witham Gap".

9.7.19 The urban ZTV area assumes some upper floor / roof light windows of properties in the more elevated areas of settlements would have views to the scheme, however, it is also accepted that many views from ground and first floor windows within the urban areas would in most cases be screened by intervening buildings / structures.

9.7.20 Photographs have been taken from locations where significant views of the site have been recognised, either through consultation or surveys carried out as part of this assessment. The locations of these can be found on Figure. 9.4 Photograph Locations and refer to photographs on Figures 9.5 to 9.14.

9.8 PREDICTED IMPACTS

"Do Minimum Scenario"

9.8.1 As there are no other known proposed developments at present with planning permission that would directly affect similar landscape elements in the study area, the baseline conditions are expected to be a fair representation of likely conditions in the baseline , operational and design years in the absence of the scheme. There are small areas highlighted to the east of Lincoln in the City of Lincoln Local Plan[26] that would introduce potential additional urban fringe encroachment south of Greetwell Road.

9.8.2 There may be some changes to landscape character or land use adjacent to the slope which leads up to the northern ridgeline.

"Do Something Scenario"

9.8.3 The scheme proposals as described in Chapter 2 would have a number of impacts on the landscape and visual resources within the study area. These would include impacts at construction (2013) and operational (2016) years:

- Introduction of a widened roundabout junction at Wragby Road with associated loss of vegetation adjacent on the road;

[25] City of Lincoln Local Plan: Policy 55: "Long" Views Into and Out of the City.
[26] City of Lincoln Local Plan: Policy 102 – Special Policy Areas and Zones

- Realignment of Hawthorn Road on embankments and overbridge as the main carriageway passes the new housing edge in cutting having impacts on the topography of the area and a visual impact to houses adjacent;
- The location of a noise bund 2.5m high within the rolling countryside in views from the edge of housing to the north east of Lincoln;
- Cuttings to the north upland hillside and adjacent to Greetwell Quarry;
- Minor loss of hedgerow vegetation on northern upland field boundaries;
- Earthworks to the south east edge of Greetwell Quarry SSSI as well as introduction of a footbridge in the area;
- A new roundabout and realignment of Greetwell Road to the northern ridgeline;
- Bridge over the Lincoln to Market Rasen railway line cutting;
- Large-scale embankments on the approach to the bridge over the Witham, extending out from the northern slope into the lower flatter fenland area;
- Loss of the edge of Greetwell Wood SNCI, deciduous woodland habitat;
- Minor loss of vegetation on the Lincoln to Spalding railway embankments and loss of hedgerows at Washingborough Road for the construction of the roundabout;
- Significant earthworks to the southern slope and ridgeline of the Lincoln Gap topography to incorporate cuttings for the proposed route;
- Loss of hedgerows on Heighington Road and new bridge for the road itself would be noticeable on the horizon;
- Loss of more intact hedgerow boundaries and severance of field pattern along the southern upland rural areas;
- Introduction of 2.5m high noise bunds within the lower depression of land between Canwick Manor Farm and Sleaford Road, visible in views from isolated properties in the area;
- Introduction of raised elements at Bloxholm Lane (bridleway bridge and embankments); and
- Views into and out of Lincoln compromised from both within the Witham valley and from elevated positions to the north and south of the study area.

9.9 MITIGATION

9.9.1 The mitigation proposals are intended to reduce where possible any visual impact that may arise from the implementation of the scheme on any properties, users of footpaths, businesses and adjacent highways. Landscape mitigation proposals are described within the Landscape and Visual Assessment Tables – Appendices 9C & 9D, and are illustrated in Appendix 9E – Environmental Masterplan. The objectives of these are summarised below:

- Integrate the road with the existing landscape and contribute to the protection of the existing landscape;
- Limit and mitigate, wherever possible, the visual impact of the road on the existing landscape and social environment;
- Maximise visual benefit for road users;

- Sympathetic ground modelling and scheme alignment would be prioritised over planting to integrate the road with the landscape;
- Planting would be used to screen critical views from adjacent visual receptors, reduce the impact of large scale earthworks and integrate the scheme with existing landscape features reinforcing the pattern of hedgerows and enhancing the existing landscape character and quality as promoted by national and local authorities;
- Where appropriate reflect or enhance the character of the developing urban edge of Lincoln while retaining the open gently undulating character of the wider landscape. Direct guidance as referred to in both the North Kesteven Landscape Character Assessment 2007 and West Lindsey Landscape Character Assessment 1997 has been used to influence the mitigation design;
- Plant species would be indigenous, used to reflect those found locally, and the planting proposals reflect and where possible enhance the existing vegetation pattern; and
- Planting design and integration of the road with the landscape to follow guidance in the DMRB Volume 10, Good Roads Guide.

Residual Impacts

9.9.2 Residual impacts are those that would remain after implementation of mitigation proposals which can be immediate (construction year) or effective after a recognised period of time (Design Year 15 years onwards after Opening Year).

9.9.3 Residual impacts after the Design Year would include:

- The embankments of the road within lowland fens across the valley bottom;
- The bridge over the Witham, noticeable in views within the valley bottom; and
- The cuttings on the southern slope of the valley in views to the south and from within the valley bottom.

9.9.4 Other, less perceptible impacts would be the alignment of the road in conflict with the field pattern on the southern plateau.

Landscape and Visual Effects

9.9.5 The following assessment summaries have been undertaken on the “Do Something“ scenario with the mitigation measures being committed to. It assesses the direct and indirect effects of the works at all three stages of the proposed route development. For the purposes of this chapter, the significant effects only have been summarised. For full assessment information refer to Appendix 9C Landscape Assessment Tables and Appendix 9D Visual Assessment Tables.

Table 9.1: Landscape Effects Summary Table

Landscape Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
TOPOGRAPHY			
Northern Upland Plateau	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)	MODERATE A (Construction Year 2013) SLIGHT A (Opening Year 2016) SLIGHT A (Design Year 2031)
Northern Ridgeline	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)
River Witham Valley	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MAJOR A (Design Year 2031)	VERY LARGE A (Construction Year 2013) VERY LARGE A (Opening Year 2016) LARGE A (Design Year 2031)
Southern Ridgeline (southern slope)	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MAJOR A (Design Year 2031)	VERY LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) LARGE A (Design Year 2031)
Greetwell Quarry SSSI	HIGH	MINOR A (Construction Year 2013) MINOR A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) SLIGHT A (Opening Year 2016) SLIGHT A (Design Year 2031)
LANDSCAPE PATTERN			
Valley Slope Field Pattern (northern and southern sections)	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)

Landscape Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
Lowland Field Pattern	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
VEGETATION			
Greetwell Wood SNCI	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
LANDSCAPE CHARACTER			
Regional – North Lincolnshire Edge with Coversands	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
Regional – South Lincolnshire Edge	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
Local – North Kesteven – Limestone Heath	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
Local – North Kesteven – Waddington to Washingborough Green Wedge	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)

Landscape Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
Local – North Kesteven – Fenland	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
Local – West Lindsey – Lincoln Fringe	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
LUC1 Northern Upland Plateau	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
LUC2 Northern Valley Slopes	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
LUC3 Parkland at Greetwell Hall	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
LUC4 Witham Fen	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)

Landscape Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
LUC5 Southern Valley Slopes	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MAJOR A (Design Year 2031)	VERY LARGE A (Construction Year 2013) VERY LARGE A (Opening Year 2016) LARGE A (Design Year 2031)
LUC6 Southern Upland Plateau	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)

Table 9.2: Visual Effects Summary Table

Visual Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
1. Ramper Farm	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
5. Hawthorn Chase	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
9. Stoneleigh House	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)

Visual Receptor	**Sensitivity**	**Magnitude (with mitigation)** **(A= Adverse B=Beneficial)**	**Effect** **(A= Adverse B=Beneficial)**
14. Lincoln County Hospital	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
15. Lincoln Cathedral	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
17. Lincoln Castle	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)
18. Shuttleworth House	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)
19.Lincoln Road / Granson Way Washingborough	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)
24. Sheepwash Grange Farm	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)

Visual Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
26. Manor Farm	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	VERY LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
29. Glebe Farm & Childrens Nursery	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	VERY LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
30. Highfield House, Highfield Grange & Byre Cottage	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
31. Canwick Heath Farm	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
37. Canwick Manor Farm	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
41. Eastern edge of Bracebridge Heath	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)

Visual Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
44. The Manor House	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
45. Semi detached cottages at Manor House	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
46. Westfield Farm Bungalows	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
PUBLIC RIGHTS OF WAY			
P1. Wragby Road – Hawthorn Rd	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	VERY LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) LARGE A (Design Year 2031)
P2. Greetwell Quarry	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
P3. Cherry Willingham – Greetwell Road	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)

Visual Receptor	**Sensitivity**	**Magnitude (with mitigation)** **(A= Adverse B=Beneficial)**	**Effect** **(A= Adverse B=Beneficial)**
P4. Allenby Industrial Estate to Greetwell Road	MEDIUM	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) MODERATE A (Design Year 2031)
P5. Viking Way	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MODERATE A (Design Year 2031)	VERY LARGE A (Construction Year 2013) VERY LARGE A (Opening Year 2016) LARGE A (Design Year 2031)
P6. Greetwell Hall to River Witham	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MODERATE A (Design Year 2031)
P7. North bank of River Witham	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MAJOR A (Design Year 2031)	VERY LARGE A (Construction Year 2013) VERY LARGE A (Opening Year 2016) LARGE A (Design Year 2031)
P8. South bank of River Witham	HIGH	MAJOR A (Construction Year 2013) MAJOR A (Opening Year 2016) MAJOR A (Design Year 2031)	LARGE A (Construction Year 2013) LARGE A (Opening Year 2016) LARGE A (Design Year 2031)
P10. Glebe Cottages to Sewage Works	MEDIUM	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)

Visual Receptor	Sensitivity	Magnitude (with mitigation) (A= Adverse B=Beneficial)	Effect (A= Adverse B=Beneficial)
P12. Lincoln Road to Cliff Farm	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)
P13. Westfield Farm Bridleway	HIGH	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) MINOR A (Design Year 2031)	MODERATE A (Construction Year 2013) MODERATE A (Opening Year 2016) SLIGHT A (Design Year 2031)

9.10 CONCLUSION

Effects on Landscape Features / Resource

9.10.1 The most significant landscape effects of the proposed route would be on topography, pattern and landscape character of the area.

9.10.2 The effects on topography would be due to its alignment running in contrast to both the distinctive slopes of the Witham Valley and the openness of its lowland areas adjacent to the River Witham (very large adverse - Witham valley and southern slope, moderate adverse to northern slopes (construction year)). Mitigation proposals aim to retain local character as well as to integrate the main earthwork features into the receiving landscape and screen views, through planting. Effects on topography in these areas are partially lessened by established mitigation planting but residual impacts of the earthworks would remain after the design year 2031 (large or moderate) due to the scale and extent of the features in the sensitive area.

9.10.3 There would be moderate adverse effects to the landscape pattern to the northern and southern slopes and southern upland agricultural fields due to the diagonal alignment of the scheme. Mitigation in the form of replacement hedgerows and woodland planting would reduce these effects to slight adverse once established.

9.10.4 There would be a large adverse effect to Greetwell Wood SNCI due to loss of trees as result of the scheme alignment; mitigation to replace and extend the area of woodland on embankment and adjacent areas would reduce this effect to moderate adverse after establishment.

9.10.5 Whilst there would be some slight adverse effect to hedgerows during construction and operational years, effects would be neutral if not slight beneficial at or during the design year, as a result of establishment of mitigation proposals to introduce a greater extent of hedgerows and woodland planting.

9.10.6 There would also be slight beneficial effects on grassland in the study area by the design year due to introduction of numerous areas of wildflower grassland around balancing ponds and on cuttings and embankments. Other ecological enhancement areas are also proposed to improve local habitat sites (refer to Chapter 10).

Effects on Landscape and Townscape Character

9.10.7 There would be moderate adverse impacts experienced by two national character areas (North Lincolnshire Edge with Coversands and South Lincolnshire Edge) due to the impact on the distinctive topographical elements of the Witham valley. However, there would be greater impacts on local character units and areas with particular effects on the southern slope and the bottom of the valley.

9.10.8 There would be large adverse effects to Waddington - Washingborough Green Wedge Character Area and a very large adverse effect on the Local Character Unit 5 Southern Valley Slope due to the cutting affecting the distinctive southern slope topography. Mitigation to reduce the effects of the earthworks and planting to integrate the scheme would reduce the effect to moderate after establishment.

9.10.9 There would be moderate adverse effects on the local character in the Witham valley bottom (North Kesteven – Fenland, LCU 3 Parkland at Greetwell Hall & LCU 4 Witham Fen) due to the introduction of embankments and bridge structure into the open valley landscape. Effects would be reduced in most cases by mitigation planting providing some screening of these elements by the design year. Views into and out of these areas however would still be reduced.

9.10.10 There would be a moderate adverse effect on the landscape pattern of character areas to the northern and southern upland areas (North Kesteven – Limestone Heath, LCU 6 Southern Upland Plateau, LCU 1 Northern Upland Plateau) whereby the alignment of the route would contrast with the orientation of field boundaries. Mitigation to replace these boundaries would help to reduce these effects by the design year.

9.10.11 There would be a slight adverse impact on the townscape of Washingborough as a result of the road being perceived as intruding into the rural setting of views to the north. These would be reduced however to neutral by the design year.

9.10.12 By the design year, there would be slight beneficial impacts on the townscape character of the Lincoln Eastern Industrial Edge (LCU T2), due to greater access and boundary treatment provided by mitigation. There would also be slight beneficial effects to Bracebridge Heath village townscape as a result of reduced perception of vehicle dominance (reduced HGVs and traffic) and also the integration of the southernmost junction into the gateway of the village.

Effects on Visual Amenity

9.10.13 Due to the nature of the topography, there would be a number of different visual impacts experienced within the study area ranging from elevated, long distance views to close range and direct views towards the scheme. The largest adverse effects would be experienced by properties with close range views within the rural landscape (e.g. Canwick Heath & Canwick Manor Farms, Manor House and cottages), views out from urban edges to a rural landscape (Bracebridge Heath eastern edge, Hawthorn Chase / Washingborough Road) and elevated views to the scheme over rural landscape areas. Where properties have open or elevated views over the valley (Washingborough edge, Stoneleigh House, Sheepwash Grange Farm, Manor Farm) the effects are exacerbated due to views to both northern and southern parts of the proposed scheme.

9.10.14 Important “Long Views Into and Out of Lincoln” from/to historic areas would also be adversely affected. Views from Lincoln Cathedral tower and the Lincoln Castle Observatory would still have moderate adverse effects due to their high sensitivity as

tourist attractions. Views into the city, as recognised by the Lincoln City Policy[27] on Wragby Road and Greetwell Road would also be adversely affected (refer to Chapter 15 Vehicle travellers). Mitigation proposals to reduce these impacts would seek to screen major elevated sections within the valley, whilst allowing for valued views into and out of the city (Lincoln Cathedral).

9.10.15 There would be particularly adverse visual effects experienced from the public right of way network in the more elevated areas to the south (Lincoln Road to Cliff Farm Bridleway and the bridleway between Westfield cottages and Westfield Farm). Some more sensitive rights of way within the valley bottom either pass through historic parkland (Greetwell Hall SAM) or are aligned on a European Long Distance Route (Viking Way) with views to Lincoln hill top landmarks. The openness and long distance nature of these views to and from the edge of Lincoln are affected when travelling in these directions with the scheme located within the view.

9.10.16 Other moderate adverse impacts would be experienced from particularly elevated east facing windows of tall buildings within the city centre (Hospital / Shuttleworth House flats) where views are focused to the east along the valley.

9.10.17 Lighting proposed on the scheme would also have adverse impacts on views from properties with current dark views. These include properties on the eastern edge of Lincoln (Hawthorn Chase, Whitefriars Road) as well as properties on the edges of villages to the south of the study area (Branston, Bracebridge Heath). Views looking toward Lincoln would also be affected but existing light pollution lessens the impact.

Effects on Landscape Policy

9.10.18 There are a number of Green Wedge designations within all three local plan documents that the scheme proposals are in conflict with. The scheme passes through the Canwick to Washingborough Green Wedge (Policy LW2 – North Kesteven Local Plan) whereby it would introduce a cutting to the southern slope detrimental to one of the main landscape characteristics of the area.

9.10.19 Other smaller Green Wedge designated areas include a linear Green Wedge to the edge of Lincoln and along the river, within the Witham Valley; Greetwell Hollow and an area to the south of Greetwell Road (Policy 43 - Lincoln City Local Plan). There would be a conflict with the policies due to the embankments of the proposed route affecting the openness of views and character of linked spaces in the valley.

9.10.20 There would a conflict with policy relating to protection against adverse effect on Nature Conservation Sites (SNCI etc) in the West Lindsey Local Plan (Policy NBE 12) which protects Greetwell Wood SNCI against loss of habitat. Whilst the proposals would mean partial loss of the woodland, mitigation proposals would seek to replace and extend the woodland from the Design Year onwards.

9.10.21 Greetwell Quarry SSSI is protected by City of Lincoln Local Plan - Policy 44A & West Lindsey Local Plan Policy NBE 1. The scheme alignment would pass through the south east corner of area and therefore be in conflict with the policies. Mitigation to retain as much open rock face as possible here as well as to provide a footpath link over the junction area helps to increase the recreational access to the countryside and support recreational opportunities.

9.10.22 The embankments proposed within the Witham valley and cuttings on the southern slopes, would both support and conflict with policies protecting " Long Views Into and Out of the City"(City of Lincoln Local Plan Policy 55). The scheme would conflict with views from the recognised viewpoints of the Lincoln Cathedral and Castle out to the

[27] City of Lincoln Local Plan: Policy 55: "Long" Views Into and Out of the City

Witham valley. However, the alignment design and mitigation proposals would support views from the line of the proposed bypass (as recognised by the policy) from the Witham bridge towards the Lincoln hill top area.

9.10.23 There is a Scheduled Ancient Monument and Historic Park designated at Greetwell Hall (West Lindsey Local Plan - Policy NBE 8), however the site is not physically affected by the scheme. Effects on setting are assessed in Chapter 8

9.10.24 As the bridge crosses the River Witham, it would conflict with RSS8[28] Policy 33 Strategic River Corridor which protects the landscape value of the river corridor. The proposals would have a impact on landscape value / character of the corridor due to the introduction of the bridge and embankments within the valley. The footbridge link proposed would however, support opportunities to provide greater pedestrian links to the corridor footpath network.

9.10.25 The proposed route alignment also clips a number of other local policy areas. These include: Lincoln City Council Local Plan Policy 44B Basic Natural Stock; West Lindsey District Council Local Plan Policy CORE 9 Important Open Spaces in Settlements and North Kesteven Local Plan Policy LW3 Visual Amenity Area. However, there would be no significant conflict with these policies.

Landscape Losses and Gains – Summary Table

9.10.26 Table 9.3 below compares the approximate loss of landscape elements against the amount of elements proposed through mitigation (gains) as shown on the Environmental Masterplan.

Table 9.3: Summary of Landscape Losses and Gains

Landscape Elements	Loss	Gain
Woodland	0.42 ha	59.8ha (including tree and shrub areas*)
Species-poor hedgerows	7km	11.6km
Neutral, semi-improved grassland	1.8 ha	6.9ha (wildflower grassland to limestone cuttings)
Standing water	113 square metres	25, 010 square metres (including balancing ponds)
Marshy Grassland	0.07 ha	3.5ha (wildflower grassland to pond areas)

*Native scrub areas not accounted for due – lack of existing area information for comparison.

[28] Regional Spatial Strategy for the North East (RSS8)

10 ECOLOGY AND NATURE CONSERVATION

10.1 OBJECTIVES OF THIS CHAPTER

10.1.1 This chapter describes implications of the proposed Lincoln Eastern Bypass for nature conservation, including any legal implications associated with ecological features that may be affected. The objectives of the report are to assess the effects of the scheme on ecology and nature conservation and identify mitigation measures.

10.1.2 A general description of the scheme is included in Chapter 1. In brief, the scheme involves the creation of a new dual carriageway link between the A158 Wragby Road Roundabout, to the northeast of the city, and the A15 north-south primary route to the south of the city. The route would be approximately eight kilometres long. As part of the scheme, a new bridge would be constructed to carry the road over the river corridor formed by the North Delph, River Witham and South Delph.

10.1.3 Ecological features are the subject of a wide variety of legislation and policy. In some cases, the legislation constrains the timing of works that affect the features, or the method by which the work is carried out, or requires the work to be undertaken under a licence from Natural England. If these constraints are not complied with, an offence may be committed. Potential impacts on a wider range of ecological features may also be a 'material consideration' within the planning system. Such potential impacts would therefore come under the scrutiny of statutory consultees and other interested parties as well as the consenting authorities.

10.2 APPROACH AND METHODOLOGIES

10.2.1 'Best practice' in Ecological Impact Assessment is deemed to be represented by the Guidelines published by the Institute of Ecology and Environmental Management (2006; the IEEM Guidelines). These guidelines set out an approach that is significantly different from that proposed in Volume 11 of DMRB (whose ecological guidance was published in 1993), and do not adopt the matrix-based approach used in DMRB.

10.2.2 The approaches and methodologies applied in this ecological assessment are based on the IEEM Guidelines rather than DMRB, and do not therefore comply fully with the typical generic methods outlined in Chapter 4 of this Environmental Statement.

10.2.3 However, the principles for ecological assessment set out in DMRB Volume 11, Section 3, Part 4 were fully taken into account. Potential ecological impacts of the proposed scheme were reviewed against the DMRB method, to ensure that the determination of significant impacts for the proposed scheme using the IEEM Guidelines would be consistent with a determination made using only the DMRB guidelines.

Institute of Ecology and Environmental Management (IEEM) Guidelines

10.2.4 The assessment follows the process outlined below:

- Identification of features of ecological interest;
- Identification of key attributes of the features;
- Identification of the level of importance of the features;
- Identification of any legal protection offered to the features;
- Identification of activities in the proposal that may impact on the features;
- Characterisation of the potential impacts;

- Assessing the significance of the impacts on the nature conservation interest of the features;
- Assessing the legal implications of the impacts;
- Outlining the proposed mitigation measures; and
- Assessing the residual impacts of the proposals.

10.2.5 Throughout, the assessment has followed guidance from the Institute for Ecology and Environmental Management (IEEM) Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM, 2006), hereafter referred to as 'the IEEM Guidelines'.

10.2.6 The assessment within this report has been carried out by expert ecologists in Jacobs and reviewed by a senior expert ecologist. The surveys and assessments of individual ecological resources were carried out by suitably experienced and, where necessary, licensed ecologists.

Identification of Features of Ecological Interest

10.2.7 Baseline information for this assessment has been gathered through a desk-based study, which involved consultation with both Statutory Nature Conservation Organisations (SNCOs) and other nature conservation organisations, and through field surveys conducted at appropriate times of the year.

10.2.8 This baseline information was supplemented by information previously gathered in 2002/2003 for an EIA of an earlier route of the LEB. The northern section of the scheme, from the A158/A15 intersection to Washingborough Road, is very similar to the 2002/2003 alignment for which planning permission was granted. South of Washingborough Road, the route diverges from the 2002/2003 alignment. These are discussed in the Stage 2 Environmental Assessment (Jacobs, February 2008).

10.2.9 Information requested from consultees included: statutorily-protected sites (i.e. those designated under Acts of Parliament); any non-statutory protected sites (those designated under local government policy); any records of protected species; and other habitats and species of nature conservation importance.

10.2.10 Information relating to the study area was requested from the following organisations:

- Natural England Eastern Area Team;
- Environment Agency Area Team;
- Lincolnshire Biodiversity Partnership;
- Lincolnshire Wildlife Trust;
- Lincolnshire Amphibian and Reptile Recorder, Bird Recorder, Badger Group and Bat Group were all contacted for species records; and
- Wildlife Conservation Partnership (WCP).

10.2.11 The following online resources were consulted for information on statutory designated sites and protected species records: The National Biodiversity Network (www.nbn.org.uk), MAGIC (www.magic.gov.uk) and Natural England's website (www.naturalengland.org.uk).

10.2.12 The study area for the ecological desk-based study extended to 2km in all directions from the scheme, to ensure identification of all potentially relevant protected habitats and species. The 2km study area follows guidance in Government Circular: Biodiversity and Geological Conservation – Statutory Obligations and their Impact within the Planning System (ODPM 06/2005, Defra 01/2005). This guidance

complements Planning Policy Statement 9: Biodiversity and Geological Conservation published in 2005.

10.2.13 An extended Phase 1 Habitat Survey was conducted for the whole route in line with 'The Handbook for Phase 1 Habitat Survey' (JNCC 2003). The results of this survey, the desk-based study and consultation were used to define the scope of additional surveys that were required. The surveys related to the features listed in Table 10.1

10.2.14 Information from the desk-based study, consultees and field surveys was used to establish a list of the types of ecological features that could potentially be impacted upon by the scheme (see Table 10.1). Each feature was individually assessed according to the process set out in paragraph 10.2.1 above. The remainder of this chapter outlines the results of these assessments.

10.2.15 Detailed survey methods and the level of legislative protection for each feature recorded in the study area are described in Appendix B.

Table 10.1: Ecological Features Assessed By This Ecological Impact Assessment

Ecological Features	
Bats	Botany (includes – , hedgerows, phase 1 habitat types, woodland vegetation
Badger	Otter
Water Vole	Reptiles
Breeding Birds	Wintering Birds
Barn Owl	Amphibians

Identification of Key Attributes of the Feature

10.2.16 In addition to highlighting the presence of a feature, the assessment also outlines key attributes and/or ecological functions of each feature that could be relevant to the assessment of potential impacts and development of suitable mitigation measures.

Identification of the Level of Importance of the Feature

10.2.17 Professional judgement was used to allocate a level of importance to each feature within the study area in relation to the total resource at a given geographical scale. Evaluation of each feature's importance included consideration of:

- IEEM guidance on evaluation;
- Legislative and regulatory lists (e.g. Wildlife and Countryside Act 1981 (as amended) (WCA) Schedules, and Habitats Directive Annexes);
- Red Data Book and Nationally notable/scarce lists;
- Biodiversity Action Plan lists;
- Conservation Concern lists;
- Ecological criteria outlined in the Nature Conservation Review (Ratcliffe, 1977);
- Criteria for the selection of sites for SSSI designation (NCC, 1989);
- Local context;
- County floras; and

- Ancient and semi-natural woodland inventories.

10.2.18 Features were allocated an importance level at Local, County, National or International levels. These levels of importance were then used to assess the significance of potential impacts to decision making.

Identification of Legal Protection Offered to the Feature

10.2.19 Details of the legislative and regulatory framework is set out for each feature, and a summary of the legal protection afforded to protected species and habitats is also included in Appendix 10B.

10.2.20 European Directives and international agreements concerning biodiversity which are relevant to the proposed scheme are:

- EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive 1992) as amended (92/43/EEC);
- EC Directive on the Convention of Wild Birds (Birds Directive 1979) as amended (79/409/EEC);
- Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979);
- Bonn Convention on the Conservation of Migratory Species of Wild Animals (1979); and
- Convention on Biological Diversity.

10.2.21 These Directives and agreements are applied through the following UK Acts and Regulations:

- Wildlife and Countryside Act 1981 (as amended);
- Environmental Protection Act 1990;
- Water Resources Act 1991;
- Protection of Badgers Act 1992;
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (known hereafter as the “Habitats Regulations";
- Environment Act 1995;
- Wild Mammals Protection Act 1996;
- Hedgerow Regulations 1997;
- Countryside and Rights of Way (CROW) Act 2000; and
- Natural Environment and Rural Communities (NERC) Act 2006.

10.2.22 In a planning context, the study area spans the boundaries of North Kesteven, City of Lincoln and West Lindsey local authorities and is covered by various local plans and the regional spatial strategy. These plans contain relevant policies that are applicable to biodiversity and nature conservation. These policies are summarised in Table 10.2 overleaf.

Table 10.2: Planning Policies Applicable to Biodiversity

Development Plan	Policy
East Midlands Plan Regional Spatial Strategy	Policy 26 Protecting and Enhancing the Region's Natural and Cultural Heritage Policy 28 Regional Priorities for Environmental and Green Infrastructure Policy 29 Priorities for Enhancing the Region's Biodiversity Policy 30 Regional Priorities for Managing and Increasing Woodland Cover
Local Plan (adopted 1998), Lincoln City Council	Policy 44A: Sites of Special Scientific Interest and Other Critical Natural Assets Policy 44C Protected Species Policy 45A: Trees and Other Ecological and Landscape Features on Development Sites Policy 46A: Woodland and Other Major Planting Initiatives Policy 46B: Protecting the Water Environment
Local Plan First Review (adopted June 2006) West Lindsey District Council	Policy NBE 11 – Development Affecting Sites of Special Scientific Interest and National Nature Reserves Policy NBE 12 – Development Affecting Locally Designated Nature Conservation Sites and Ancient Woodlands
Local Plan (adopted September 2007) North Kesteven District Council	Policy LW5 – Sites of Special Scientific Interest Policy LW6 – County Wildlife Sites and Local Nature Reserves Policy LW8 – Protected Species

Identification of Activities in the Proposal that Could Impact on the Features

10.2.23 The assessment of potential impacts of activities included in the scheme has been made for each feature individually. Professional judgement by experienced ecologists was used to identify those activities associated with the proposed scheme which could potentially impact on a feature.

10.2.24 A standard list of potential activities which could impact on features was developed for the proposed scheme and applied to all features, to aid consistency and readability. This list varies between between different features, but the full list is shown below:

- Landtake;
- Land severance;
- Direct mortality;
- Changes to hydrology;
- Water pollution;
- Provision of structures;

- Effects of road lighting;
- Dust/air pollution;
- Effects of road spray;
- Noise/disturbance;
- Disease transfer e.g. Crayfish plague; and
- Alien species transfer[29,*].

Characterisation of Potential Impacts

10.2.25 Characterisation of potential impacts follows the IEEM Guidelines. This assessment used the information above to describe potential impacts in the absence of mitigation works, but did not allocate a level of significance or identify legal implications. The characterisation of each impact consists of:

- Extent/magnitude: quantified where possible;
- Direct or indirect effect and positive or negative;
- Reversibility: irreversible or reversible;
- Frequency: single event, recurring or constant;
- Duration: short term, medium term or permanent; and
- Likelihood of occurrence: certain, near certain, probable, unlikely, extremely unlikely.

Assessing the Significance of the Impact to the Nature Conservation of the Feature

10.2.26 Assessment of significance within this document is defined as 'the geographical scale at which the impact is considered to be of a material matter for decision makers in terms of maintaining the nature conservation status (species) or ecological integrity (habitats/sites) of the feature resource' (as defined in the IEEM Guidelines for Ecological Impact Assessment.

10.2.27 An impact can therefore be significant at the following levels: Less than Local; Local; County; National; or International. Professional judgement has been used by experienced ecologists to make this assessment.

10.2.28 Potential impacts that are material matters for consenting authorities must be scrutinised for acceptability by the consenting body, with reference to Statutory legislation and public consultation, before consent is given.

Assessing the Legal Implications of the Impact

10.2.29 Notwithstanding any assessment of the implications for nature conservation of any potential impact (outlined above), some species are afforded legal protection. An assessment is therefore given of the legal implications if a potential impact were to occur, - in particular, whether the potential impact could constitute an offence under current UK legislation.

10.2.30 Any activity that would give rise to an offence would be unacceptable. However, offences can be avoided through the application of suitable mitigation works,

[29] Alien species are those that are not native to the UK, and have an invasive nature that reduces ecological diversity of habitats (e.g. Japanese knotweed and rhododendron). They are not to be confused with notifiable weeds that are invasive, but are native to the UK (e.g. thistles and ragwort).

constraints on timing or methodology for the activity, or by obtaining a licence from Natural England. The nature of the appropriate measures or constraints varies according to the specific legislation relevant to each feature.

10.2.31 Any mitigation works required to avoid an offence would be undertaken by the proponent on the advice of specialists, and would be planned through a Method Statement. Any Natural England licence would be granted only after provision of sufficient documentary evidence of the mitigation, monitoring and conservation outcomes.

Outlining Proposed Mitigation Measures

10.2.32 Mitigation measures were developed to prevent, reduce or offset potential impacts. These are reported in outline in Section 10.7. Measures were developed using the following framework for the proposed scheme:

- Impact avoidance through design change;
- Prohibition of damaging activities;
- Minimisation of potential impact;
- Habitat creation;
- Habitat management / improvement;
- Translocation;
- Licences / method statements;
- Programming amendments; and
- Survey and monitoring.

10.2.33 Where reasonably practical, mitigation measures were developed to avoid potentially adverse ecological impacts, especially those that could be significant, reduce potential adverse impacts that could not be avoided, and compensate for adverse impacts that could not be reduced.

Assessing Potential Residual Impacts of the Proposals

10.2.34 All assessments of residual potential impacts are based upon, and dependent on, the implementation of mitigation measures outlined in each of this report's sections.

10.2.35 A summary impact table has been produced for each feature which indicates the following:

- Proposed activity;
- Characterisation of unmitigated impact on the feature;
- Significance without mitigation, and confidence level;
- Mitigation and enhancement measures; and
- Residual significance, and confidence level.

10.3 ASSESSMENT YEAR AND FUTURE CHANGES

10.3.1 The baseline year for impacts caused by the construction of the scheme is the programmed start of construction (2013), and the baseline year for impacts caused by the operation of the scheme, is the programmed year of opening of the development in 2016. Long-term effects have been assessed with reference to a future year, 15 years after opening (2031). This report is based on surveys undertaken in 2008.

10.4 BASELINE

Baseline Conditions

Designated Sites

10.4.1 This summary is based on the information gathered through the desk-based study process. The statutory and other designated sites within the study area are illustrated on Figure 10.1.

10.4.2 There is one site in the study area that receives statutory protection as a Site of Special Scientific Interest (SSSI):

- **Greetwell Quarry SSSI**: This site is designated for its geological features, being considered of national importance for its exposures of Lincolnshire Limestone. The quarry is no longer active, therefore in some areas dense scrub has developed on unworked ground and on spoil.

10.4.3 The site is of National value for its geological interest.

10.4.4 Five sites in the study area are designated by the pertinent Local Planning Authorities as Sites of Nature Conservation Interest (SNCIs) or Local Wildlife Sites (LWSs). These are:

- Greetwell Wood SNCI;
- Canwick Hall Wood SNCI;
- Washingborough Junction SNCI;
- Witham Corridor LWS; and,
- Greetwell Junction Railway Embankment LWS.

10.4.5 SNCIs and LWSs are designated by Local Planning Authorities as 'second tier' and 'third tier' nature conservation sites. For the purposes of this assessment, the SNCIs and LWSs are regarded as being of County value.

Introduction to the Study Area

10.4.6 The following is a summary of the general alignment and the habitat types contained within the study area. Some individual features have been identified as numbered 'Target Notes' (e.g. 'TN3'); Target Note locations are labelled on Figure 10.2.

10.4.7 The landscape in the northern section of the scheme (from the intersection of the A158 and A15, east of Lincoln City to Hawthorn Road and on to Greetwell Road), is dominated by arable fields. The fields in this section are generally large and enclosed by species poor hedgerows. Immediately south of Hawthorn Road, a pond (TN3) on the southern margin of the field lies within the scheme alignment. An associated ditch feature on the field boundary is cut by the alignment. This ditch also feeds another pond 50m west of the scheme (TN5).

10.4.8 Immediately prior to its intersection with Greetwell Road the scheme passes through the southeast corner of Greetwell Quarry SSSI (notified for its geological interest).

10.4.9 South of Greetwell Road, the scheme passes through two arable fields separated by the Lincoln to Market Rasen railway line and then through the western edge of Greetwell Wood SNCI (TN12/13). From Greetwell Wood southwards, the scheme passes through poor semi improved grassland and crosses the River Witham corridor via a clear span bridge. The grasslands between Greetwell Wood and the River Witham contain at least 21 scattered ponds (TN16/18), created after 2004 as part of the farmer's Countryside Stewardship Scheme agreement. In addition, a

number of drains that experience seasonal inundation from the River Witham traverse these grasslands, running parallel to the field boundaries.

10.4.10 The River Witham corridor (TN19) incorporates three main watercourses; North Delph, River Witham and South Delph (see Figure 11.1). A Sustrans cycleway lined with dense scrub and semi mature trees separates the River Witham from the South Delph (TN19). Typically these watercourses are artificial or modified channels that are linear and deep to maximise their drainage potential. A description of each watercourse is included in the habitat descriptions in Appendix 10C.

10.4.11 South of the River Witham, the scheme crosses an area of semi improved grassland (TN22) and passes under the Lincoln to Spalding railway line, before meeting Washingborough Road.

10.4.12 Between Washingborough Road and the end of the scheme at Sleaford Road, the landscape is dominated by arable farmland. The fields in this section are generally large and enclosed by species poor, defunct hedgerows. Between Washingborough Road and Heighington Road, the scheme is in a cutting as it climbs the Lincoln Edge.

10.4.13 Between Lincoln Road (B1188) and Sleaford Road, the scheme passes to the west of Ashfield House and Westfield Farm. Both these properties have ponds/lakes associated with them (TN42 – 45). A description of each feature is provided in Appendix 10C.

Habitats

10.4.14 Habitat surveys were carried out in March and July 2008. The surveys followed the methodology recommended by the Institute of Environmental Assessment (IEA 1995), 'Guidelines for Baseline Ecological Assessment', and the guidance set out in 'The Handbook for Phase 1 Habitat Survey' (JNCC 2003), recording information on habitats present.

10.4.15 The following habitat types were recorded within the study area:

- Broadleaved woodland
- Broadleaved plantation;
- Mixed plantation;
- Species-poor hedgerows
- Species-rich hedgerows;
- Species-rich, semi-improved grassland;
- Marshy grassland;
- Standing water;
- Dense continuous scrub;
- Improved grassland; and
- Arable.

10.4.16 Each habitat type is summarised in Appendix 10C. A list of plant species recorded during the Phase 1 Habitat survey is included in Appendix 10D. Figure 10.2 illustrates the habitats present in the study area. Target notes have been used to identify specific areas of habitat of nature conservation importance, such as ponds or areas of woodland.

10.4.17 The habitats recorded in the study area during the Phase 1 Habitat Survey are listed in the table below, with an assessment of their value for nature conservation. An

indication of conservation status of each habitat is given in terms of UK or Local BAP "Priority Habitats".

Table 10.3: Habitats Summary

Habitat	UK BAP	Local BAP	Receptor Value	Permanent Landtake
Broadleaved woodland	✓	✓	County	0.42 ha
Broadleaved plantation	-	✓	Local	
Mixed plantation	-	-	Local	
Species-poor hedgerows	-	✓	Local	7km
Species-rich hedgerows	✓	✓	Local	
Neutral, semi-improved grassland	✓	✓	Local	1.8 ha
Running water	✓	✓	County	
Standing water	✓	✓	Local	113 square metres
Dense scrub	-	-	Local	
Improved grassland	-	-	Local	1 ha
Arable	✓ (field margins only)	✓ (field margins only)	Local	43 ha
Amenity Grassland	-	✓	Local	
Marshy Grassland	-	✓	Local	0.07 ha
Tall Ruderal	-	-	Local	
Bare Ground	-	-	*	

* The bare ground in this case is Greetwell Quarry SSSI, and is of value as a designated site – see paragraph 10.4.2

Hedgerows

10.4.18 Hedgerows bisected by the alignment were surveyed using the methodology defined by the Hedgerows Evaluation Grading Scheme (HEGS). The aim of this assessment was to determine if any hedgerows directly impacted by the scheme met the ecological criteria for an 'important hedgerow' under the Hedgerow Regulations 1997.

10.4.19 The Hedgerow Regulations 1997 define the criteria used to identify ecologically important hedgerows, whereby a hedgerow needs to contain five woody species and meet four out of nine specified criteria.

10.4.20 Although none of the hedgerows surveyed met the required criteria for an 'important hedgerow' under the Hedgerow Regulations, the following hedgerows were nevertheless considered to be of notable ecological value (hedgerows are identified via grid references for the crossing point of the scheme):

- **TF005 733 (adjacent to A15)** - The moderately high ecological value is attained through a high structural score: the hedge contains a high proportion of small even-aged standard trees integrated into a dense and entire hawthorn hedge. It should be noted however, that the hedge is probably of recent origin, dating from the construction of the northern bypass in the late 1980s;
- **TF007712 (southern boundary of Greetwell Wood SNCI)** - Relatively species-poor, being dominated like all hedgerows in the study area, by hawthorn (Crataegus monogyna). Its ecological value is derived from its well-developed structure, connections with the woodland and the presence of a deep ditch along its course;
- **TF005 711 (TN13)** - Similarly structured hedge to the above, following a ditch across a field of improved grassland, but lacking connection with woodland; and
- **TF003 708** - Occurs along a narrow piece of land between the River Witham and the South Delph that was once a railway line and is now occupied by a cycleway. This is the most species-rich hedge in the survey corridor, but attains most of its ecological value from its structure (tall, wide and dense) and relatively high density of medium and small standard trees.

10.4.21 A relatively well structured and species-rich hedgerow occurs at Target Note 27 (SK 997 699). This hedgerow is not directly affected by the scheme.

Protected Species

Amphibians

10.4.22 This section presents the findings of amphibian surveys conducted at ponds described in the Phase 1 Habitat Survey (see Appendix C for details). These surveys were carried out between March and May 2008. Since that time, newly created ponds were discovered north of the River Witham. As these ponds were discovered after the suitable period for amphibian surveys, these additional ponds will be surveyed in 2009, and the results presented as an addendum to this assessment.

Consultation

10.4.23 Information from the National Biodiversity Network (www.nbn.org.uk) reveal that great crested newts (*Triturus cristatus*) have been recorded in Bracebridge and Branston (both south of the River Witham) and in North Greetwell (north of the River Witham); therefore it was assumed that all areas of open water within the study area have the potential to support great crested newt populations.

Field Surveys

10.4.24 Amphibian surveys were conducted following the standards set out in the great crested newt mitigation guidelines (Natural England, 2001), for a presence/absence survey for great crested newts.

10.4.25 Survey locations are shown on Figure 10.7. Appendix 10F contains a summary of the locations of ponds surveyed and the species recorded.

10.4.26 In brief, three species of amphibian were recorded in the study area with varying degrees of frequency. Common toad (*Bufo bufo)* and common frog (*Rana temporaria)* were recorded in ponds throughout the study area, with smooth newt (*Lissotriton vulgaris)* recorded in less abundance and in fewer ponds.

10.4.27 No great crested newts were recorded in the study area.

Identification of Key Attributes for Amphibians

10.4.28 Terrestrial habitat around ponds provides feeding and sheltering places for amphibians when they are out of the water. The type of habitat around a pond will influence the movement of amphibians and their long distance dispersal. The most common land-use within the survey area is arable, where amphibian movement is restricted to suitable field margins, hedgerows or drains that form the field boundaries. As such, these are likely to restrict amphibians' potential dispersal distance.

10.4.29 The key feature of the arable farmland in the study area is that the ponds are generally in clusters with large distances of sub-optimal terrestrial habitat (arable) between them. Therefore although there are suitable breeding ponds in the study area the surrounding terrestrial habitat is of low value to amphibians.

10.4.30 The newly created ponds north of the River Witham occur in an area of semi improved grassland close to Greetwell Wood SNCI and the Lincoln to Market Rasen railway line. These habitat features potentially provide suitable breeding sites and terrestrial habitat, as such this area must be considered of value to amphibians.

Bats

Consultation Data

10.4.31 There are seventeen species of bat known to be resident in the British Isles, 11 of which have been recorded within Lincolnshire in recent times (Richardson, 2000). These are:

- Common pipistrelle *(Pipistrellus pipistrellus)*;
- Soprano pipistrelle *(Pipistrellus pygmaeus)*;
- Brown long-eared *(Plecotus auritus)*;
- Brandt's *(Myotis brandtii)*;
- Whiskered *(Myotis mystacinus)*;
- Noctule *(Nyctalus noctula)*;
- Daubenton's *(Myotis daubentonii)*;
- Natterer's *(Myotis nattereri)*;
- Leisler's *(Noctula leisleri)*;
- Barbastelle *(Barbastella barbastellus)*; and
- Nathusius' pipistrelle *(Pipistrellus nathusii)*.

10.4.32 The conservation status and estimated UK population size of the eleven species of bat known to occur in Lincolnshire is shown in Table 10.4 below (the population estimates of common and soprano pipistrelle are combined).

Table 10.4: British Bat Species and Status (Source: Highways Agency 2001; Altringham 2003)

Species	UK Population Estimate	Status
Common pipistrelle	2,000,000	Common
Soprano pipistrelle		

Species	UK Population Estimate	Status
Brown long-eared	200,000	Common
Brandt's	30,000	Local
Whiskered	40,000	Local
Noctule	50,000	Uncommon
Daubenton's	150,000	Fairly Common
Natterer's	100,000	Fairly Common
Leisler's	10,000	Scarce
Barbastelle	5,000	Scarce
Nathusius' pipistrelle	16,000	Scarce

10.4.33 Specific bat records received from Lincolnshire Biodiversity Partnership are included in Appendix 10A. In brief the consultation data revealed that common and soprano pipistrelles were commonly recorded throughout the study area, especially in the Canwick and Greetwell areas, and foraging along the River Witham corridor. A single record of a common pipistrelle roost was identified near Canwick at Manor Farm (SK999 699).

10.4.34 Records (undated) for brown long-eared bats occur at Greetwell Quarry SSSI (TF003 725) and at Greetwell Hall TF013 715. At the grid reference for the brown long eared roost in Greetwell Quarry SSSI, the site is bare ground with no structures or trees that could be used as roosting sites. Therefore it is thought that former quarrying activities have removed any potential roosting sites.

Roost Sites

10.4.35 Bat surveys were carried out following the guidance set out in:

- Bat Conservation Trust: Bat Survey Good Practice Guidelines (2007);
- DMRB Vol.10. Section 4 - Nature Conservation Advice in Relation to Bats; and
- DMRB Interim Advice Note 116/08 - Nature Conservation Advice in Relation to Bats *(this updates DMRB Volume 10 Section 4).*

10.4.36 Bat surveys in the study area consisted of three elements:

- Identification and assessment of potential bat roosts along the entire scheme – January 2008;
- General activity (transect surveys) – June to August 2008; and
- Dusk emergence/dawn swarming survey at potential roost sites – June to August 2008.

10.4.37 Where bat roosts were identified through consultation, confirmation surveys were carried out to determine their current status.

10.4.38 Nine potential tree roost sites were identified, all within or adjacent to Greetwell Wood SNCI (see Figure 10.4). Location of potential roost trees was determined using a handheld GPS.

10.4.39 Table 10.5 below provides details of potential roost sites and an assessment of their potential to support bats (high, medium or low) using criteria adapted from the Bat Conservation Trust's Guidelines. These assessment criteria are defined in the detailed methodologies section (Appendix B).

Table 10.5: Potential Bat Tree Roost Summary (All Trees are Within Greetwell Wood SNCI)

Target Note	Description	Roost Potential
1	Sycamore. Two rot holes on approximately east facing side of tree. No evidence of bats (droppings or staining).	Medium
2	Sycamore. Rot hole on trunk. No evidence of bats (droppings or staining).	Medium
3	Sycamore. Two woodpecker holes on the west side of the tree. Possible staining around one hole.	Medium
4	Sycamore. Various rot holes. No visible evidence of bats.	Medium
5	Sycamore. Split in trunk on west side of the tree.	Medium
6	Sycamore. Three rot holes in dead tree trunk.	Medium
7	Ash. Woodpecker hole in north side of tree.	Medium
8	Sycamore. Rot hole on east side of tree.	Medium
9	Ash with many splits and rot holes.	Medium

10.4.40 Dusk emergence and dawn returning surveys were conducted on three occasions in July and August 2008 at all of these potential roost trees. No bats were observed emerging at dusk or returning at dawn.

10.4.41 The roosts previously identified at Manor Farm and Greetwell were subject to dusk emergence/dawn swarming surveys on three occasions between July and August 2008. Presence of roosting brown long-eared bats at Greetwell Hall and common pipistrelles at Manor Farm was confirmed. These locations are shown on Figure 10.3

General Bat Activity

10.4.42 Data on general bat activity in the study area was gathered via set transects covering the entire study area. Transects incorporated features bats would use for commuting or suitable bat foraging habitats. In line with Bat Conservation Trust (BCT) guidance, surveys were carried out in June, July and August 2008.

10.4.43 Bat activity is shown on Figures 10.3a – 10.3c. Individual bats recorded are identified via target notes and general direction of flight is identified. Behaviour at the time of recording is listed in Appendix 10E. In total, five bat species were recorded in the study area:

- Common pipistrelle;
- Soprano pipistrelle;

- Brown long-eared;
- Noctule; and
- Daubenton's.

Identification of Key Attributes for Bats

10.4.44 There a number of features of value to bats within the 500m survey area and these include building roosts, foraging areas and commuting routes. Activity surveys revealed important areas of foraging and commuting habitat throughout the survey corridor, with bats observed flying along hedgerows, in and around woodland, and along the River Witham corridor. Target notes are included in Appendix 10E and are referenced on Figure 10.3a to 10.3c The scheme has been split into three general areas to discuss these features and their key attributes below.

Northern Section (From Wragby Road to Greetwell Wood)

10.4.45 This area consists mainly of housing and large arable fields, with smaller areas of pasture, and woodland (Greetwell Wood SNCI and Fox Covert) around Greetwell House. The Lincoln to Market Rasen railway line traverses this section of the study area. A number of medium potential bat roosting trees were identified within Greetwell Wood SNCI, some of which were in close proximity or directly under the footprint of the proposed scheme. Surveys of these trees revealed no bat roosts; however a brown long-eared bat roost was identified in Greetwell Church, within the grounds of Greetwell Hall.

10.4.46 Foraging activity in the area was mainly focused on the areas around Greetwell (including Greetwell Wood, and Lincoln to Market Rasen railway line). Species foraging in this area include pipistrelles, noctule and brown long-eared bats. The mosaic of grasslands/mature woodland and strong linear features (hedgerows and the railway line) around Greetwell make this area a valuable foraging resource for bat species within the area. A few records of foraging pipistrelles were also recorded along hedgerows and the housing estate north of Greetwell Road.

10.4.47 Bats were commonly recorded commuting along hedgerows forming boundaries to arable fields in the study area. Pipistrelle species bats were the most common species recorded. They were commuting along hedgerows, the railway line and along the edge of Greetwell Wood SNCI.

10.4.48 Hedgerows, railway lines and woodland edges throughout the study area are utilised as bat commuting routes, as such all these features within the study area must be considered valuable to bats.

River Witham Corridor and Associated Floodplain

10.4.49 This area is characterised by the River Witham corridor, the associated semi-improved grassland habitats that form its floodplain, and hedgerows.

10.4.50 There was a high concentration of foraging records from the activity surveys undertaken in the riparian zones and surrounding habitats associated with the River Witham, indicating the significance of these features for bat foraging. Species recorded included common pipistrelle, soprano pipistrelle, and Daubenton's bats. Foraging bats were recorded feeding over the River Witham, South Delph and North Delph. Common pipistrelles were recorded foraging along the corridor that is formed by the cyclepath and hedgerows separating the River Witham from the South Delph.

10.4.51 Commuting routes utilised by bat species within the area consist mainly of hedgerows and the River Witham corridor. The River Witham is likely to be a feature of significant importance, as it provides both a significant foraging resource and a commuting corridor which connects areas of suitable bat foraging and roosting habitat. As such, all these features within the study area must be considered as being valuable to bats. The proposed road could potentially impact upon the bats significantly if their commuting lines are disrupted.

Southern Section (Washingborough Road to Sleaford Road)

10.4.52 As with the northern section, the southern section is dominated by arable fields bounded by a combination of intact and gappy species-poor hedgerows. The main foraging activity in this area appears to be limited to field margins along hedgerows, with both common and soprano pipistrelles being recorded. Foraging also occurs along a heavily vegetated track leading to Canwick Manor.

10.4.53 Bats were commonly recorded commuting along hedgerows forming boundaries to arable fields in the study area. Pipistrelle species were the most common bats recorded. These were commuting along hedgerows.

10.4.54 Hedgerows throughout the area are utilised as bat commuting routes, as such hedgerows within the study area must be considered as being valuable to bats.

Badger

10.4.55 Badger (*Meles meles*) are subject to illegal persecution throughout the UK, therefore the location and details of setts must be kept out of the public domain, to protect them from harm. Taking this into consideration a full confidential badger report has been produced in conjunction with this chapter, detailing results of field surveys, providing an assessment of the impacts of the scheme on badgers, and outlining a strategy to mitigate those impacts.

10.4.56 The following text summarises this report in the absence of detailed locations of badger setts.

Consultation

10.4.57 The Lincolnshire Environmental Records Centre returned one recent record of a badger sett near Greetwell. No records for badger road traffic accidents (RTAs) were identified through the data search, and therefore no current RTA “black spots” have been identified where badger mortality is occurring on the existing road network in the study area.

Field Surveys

10.4.58 All areas within 500m of the scheme were searched for signs of badgers including setts, established pathways attributable to badgers (through the presence of paw prints and guard hairs stuck on barb wire fences), and latrine sites.

10.4.59 Particular attention was paid to linear features, such as field boundaries and woodland edges, as a high proportion of setts and other field signs are likely to be associated with these. Additionally, dense scrub and other linear features that may form boundaries between territories were searched for the presence of field signs.

10.4.60 Four badger setts were recorded in the study area, two of which were categorised as main setts, indicating that at least two social groups utilise the study area.

Identification of Key Attributes for Badger

10.4.61 The badger survey identified areas of potential badger foraging and sett building habitat. Badgers are found in a wide variety of habitats, although it is generally accepted that they prefer certain characteristics (Neal & Cheeseman, 1996). Therefore, suitable badger foraging habitat was identified where the landscape provided adequate year-round food resources and where it included areas of arable, agricultural grassland and woodland. Sett forming habitat in the study area was identified where the landscape offered:

- Well drained soil (e.g. on a slope) that is easy to dig, but firm enough to prevent collapse;
- Sufficient cover (i.e. woodland or scrub); and
- Low disturbance levels from humans and domestic animals.

10.4.62 The study area provides suitable sett building habitat and a mosaic of foraging habitat, offering varied resources that badgers can utilise at different times of year, depending on seasonal abundance of food items. As badger territories are large it should be assumed that badgers utilise most habitats within the study area, unless there is some barrier to movement. As such, the entire study area should be considered of value to badgers.

Breeding Birds

Consultation

10.4.63 Data received from Lincolnshire Biodiversity Partnership indicate that c.20 species of bird have been recorded within 2km of the scheme. Notably this includes two bird species specifically listed on Schedule 1 (Part1) of the Wildlife and Countryside Act 1981. Schedule 1 lists 80 rare, endangered, declining or vulnerable bird species which are protected by special penalties at all times and receive additional protection from disturbance at the nest. The Schedule 1 birds recorded with 2km of the study area are:

- Kingfisher *(Alcedo atthis)* – nesting in the banks of the North Delph and River Witham; and
- Barn Owl *(Tyto alba)* – hunting near Washingborough.

10.4.64 Barn owls are of specific concern when considering the impacts of any new road as direct mortality occurs regularly on roads. Therefore baseline data and impact assessment for barn owls is presented in a separate section.

Field Surveys

10.4.65 Field surveys for breeding birds were based on the Breeding Bird Survey (BBS) methodology developed by the British Trust for Ornithology, Royal Society for the Protection of Birds and Joint Nature Conservation Committee (BTO 1998). This survey methodology was used as it is more suitable for larger areas than the Common Bird Census methodology, in that it provides a sample rather than being a comprehensive census of bird numbers present and the activity they are engaged in. In brief, the method involved recording birds on the site whilst walking a set transect that encompassed the different habitat types in the study area, to get a representation of the range of birds present. A number of surveys were carried out during the summer of 2008.

10.4.66 A full list of breeding bird species recorded in the study area is included in Appendix 10G. Figure 10.6 illustrates the numbers of birds recorded and their locations in relation to the scheme.

10.4.67 In total, 34 bird species were recorded within and immediately adjacent to the proposed scheme, of which 13 were key bird species (key bird species are those which are listed under: Wildlife and Countryside Act 1981 (Schedule 1 Part 1) (WCA1i), Joint Nature Conservation Committee Red List Species (JNCC Red list), Joint Nature Conservation Committee Amber List Species (JNCC Amber list), United Kingdom Biodiversity Action Plan (UK BAP) and Lincolnshire LBAP.

Identification of Key Attributes for Breeding Birds

10.4.68 The dominant habitat type in the study area is arable, with grassland and woodland habitats being restricted to areas adjacent to the River Witham.

10.4.69 Arable fields provide a resource for key species of ground nesting birds of open ground such as skylark (*Alauda arvensis*) and lapwing (*Vanellus vanellus*). Skylark were common throughout the study area and were recorded mostly in arable fields. Arable field margins and hedgerow bottoms provide a valuable nesting and foraging resource for birds such as grey partridge (*Perdix perdix*).

10.4.70 Consequently, all arable fields in the study area should be considered of value for ground nesting birds.

10.4.71 The grasslands either side of the River Witham corridor provide a valuable foraging/nesting resource for key species of breeding birds such as reed bunting (*Emberiza schoeniclus*) and barn owl.

10.4.72 Kingfisher have been observed hunting along the River Witham and associated watercourses. The close association of kingfisher with riparian habitats for nesting and hunting indicate that the River Witham corridor is a key resource for this species.

10.4.73 Woodland in the study area is restricted to two areas at Greetwell that are a valuable nesting resource for common species of passerine birds.

Wintering Birds

Consultation

10.4.74 A summary of consultation bird data is provided in the breeding bird section. A full list of birds recorded in the study area, provided by Lincolnshire Biodiversity Partnership, is included in Appendix H.

Field Surveys

10.4.75 For comparability, wintering bird surveys were based on the transect methodology used for the breeding birds surveys. In brief, the method involved recording birds on the site whilst walking a set transect that encompassed the different habitat types in the study area to get a representation of the range of birds present.

10.4.76 Wintering bird surveys were carried out in November and December 2008.

10.4.77 A full list of wintering bird species recorded in the study area is included in Appendix 10H. Figure 10.6 illustrates the numbers of birds recorded and their locations in relation to the scheme.

10.4.78 In total, 43 bird species were recorded within and immediately adjacent to the proposed scheme, of which 22 were key bird species (as defined in paragraph 10.4.67).

Identification of Key Attributes for Wintering Birds

10.4.79 The study area is composed of a mosaic of habitats including arable, improved and semi-improved grassland, marshy grassland, semi-natural broad-leaved woodland and the riparian habitats associated with the River Witham.

10.4.80 Arable is the dominant habitat type in the study area and is a valuable resource for key bird species such as lapwing that over-winter in this habitat. Hedgerows throughout the study area provide a valuable winter foraging resource for over-wintering bird species such as redwing (*Turdus iliacus*) and fieldfare (*Turdus pilaris*).

Barn Owl

Consultation

10.4.81 Records for barn owls were received from Lincolnshire Biodiversity Partnership, and from Wildlife Conservation Partnership (WCP) who monitor barn owl activity along the River Witham, as part of a species recovery project for the area that is focussed on the River Witham and Till corridors.

10.4.82 To protect barn owl nest sites from persecution, specific locations of breeding/nesting sites are not revealed in this chapter. Data received from WCP, revealed barn owl breeding sites either side of the scheme's crossing point of the River Witham. The nearest such site was 100m to the west of the scheme. In total 22 confirmed or possible breeding sites were identified within 5km of the scheme, of which at least 16 were along the River Witham corridor.

Field Surveys

10.4.83 Figure 10.8 illustrates general barn owl activity in the study area. In general, the focus of barn owl activity was around the River Witham and the grasslands to the north and south of this corridor. Occasional sightings of individuals were observed flying low over arable fields south of Heighington Road and adjacent to Greetwell Quarry SSSI, but no hunting behaviour was observed.

10.4.84 In addition to those sites identified from consultee records, a further five possible breeding sites were identified within 2km of the scheme, the nearest such site being approximately 200m to the east of the scheme, where the alignment is in cutting. No confirmed or potential breeding sites were identified directly under the footprint of the road.

Identification of Key Attributes for Barn Owl

10.4.85 During the breeding season, the majority of barn owl foraging takes place within a 1km radius of the nest, extending up to a 3 to 5km radius outside of the breeding season (The Barn Owl Trust 2005). In a mixed landscape, it is estimated that in the breeding season a pair of barn owls require the equivalent of 17 to 26ha of suitable foraging habitat, to rear their young successfully. These habitats include rough grassland and arable field margins, similar to that found within the study area, which can support a good population of field voles (the main prey item for barn owls).

10.4.86 The River Witham corridor is considered a key attribute for barn owls as it supports multiple breeding sites, and the grassland habitats adjacent to the Witham are likely to support a higher number of small mammal prey when compared to the arable landscape that dominates the remainder of the study area.

Otter

Consultation

10.4.87 The Lincolnshire Environmental Records Centre returned one record of otter from the River Witham in 1977 near Washingborough. No records for otter RTAs were identified through the data search, therefore no current RTA "black spots" have been identified where otter mortality is occurring on the existing road network in the study area.

Field Surveys

10.4.88 Field surveys were undertaken in April 2008 and September 2008. In accordance with guidance contained within the DMRB Volume 10, the study area extended up to 2km from the nearest extent of the scheme.

10.4.89 The following watercourses were surveyed for the presence of otters:

- North Delph;
- River Witham;
- South Delph;
- Canwick Fen Drain; and
- Tributary of Branston Brook.

10.4.90 No evidence of otters was recorded at any of the sites surveyed in the study area.

Identification of Key Attributes for Otter

10.4.91 The otter was once widespread throughout Britain. Between the 1950s and 1970s populations declined rapidly, largely due to the pollution of watercourses, especially by organochlorines such as dieldrin (Jefferies 1989). Habitat loss, often due to flood defence and drainage works is also considered a factor in otter decline, largely due to the subsequent reduction in fish populations (Liles 2003).

10.4.92 The decline now appears to have halted as a result of national and international legislation to protect otters, as well as positive conservation management (Environment Agency 1999).

10.4.93 The corridor formed by the River Witham and associated watercourses provides a feature in the landscape that otters could potentially use for commuting and foraging. Adjacent habitats, such as reedbeds and woodlands at Greetwell, provide potentially suitable laying up/holt sites. An otter survey of Lincolnshire (Environment Agency, 2003) recorded otters in the River Witham about 30 km downstream of the study area, but there were no records within the study area. As otter populations are thought to be expanding their range throughout the UK, the Witham catchment could be further utilised at some time in the future by otters.

10.4.94 As no otter field signs where recorded in the study area, there are no records of otter in the study area more recently than 1977 and the nearest recent record is located 30km away, potential impacts on otters will not be considered further in this assessment.

Reptiles

Consultation

10.4.95 No records for reptiles were received from the consultees; however, a search on the National Biodiversity Network website did reveal a record of grass snake in the 10km grid squares that the scheme passes through.

Field Surveys

10.4.96 Reptile surveys were undertaken in September/October 2008. The methodology used followed guidance set out in The Herpetofauna Workers' Manual (JNCC, 2003) and the DMRB guidance on Reptiles and Roads (Highways Agency, 2001).

10.4.97 Suitable reptile habitat in the study area is confined to the grassland and riparian habitat associated with the River Witham corridor. Therefore reptile surveys focused on these features to determine the presence of reptiles.

10.4.98 Because many of the areas surveyed for reptiles have public access, the laying down of artificial refugia was considered inappropriate as they were likely to get moved or stolen, with any reptiles using them at risk of killing or injury. Instead visual searches were made of natural features suitable for basking reptiles, or reptiles seeking refuge under logs or stones.

10.4.99 Grass snake *(Natrix natrix*) was the only reptile recorded in the study area during the surveys. Grass snake occurred commonly along the River Witham corridor and around the ponds north of the river, in sufficient numbers (a maximum count of five), to indicate a good population.

Identification of Key Attributes for Reptiles

10.4.100 Suitable reptile habitat is generally characterised by a complex vegetation structure that supplies suitable basking areas, refugia and supports a range of prey species. The River Witham and associated habitats are a key resource in the study area, providing a complex structure that incorporates basking/egg laying sites, refugia and suitable foraging opportunities. The suitable habitat along the River Witham will act as a key commuting corridor linking with areas of suitable reptile habitat in the wider landscape.

Water vole

Consultation

10.4.101 The Lincolnshire Environmental Records Centre returned one record of water vole from the River Witham, east of Lincoln city centre near Washingborough.

Field Surveys

10.4.102 Field surveys followed methodologies set out in the Water Vole Conservation Handbook (Strachan 2006). Detailed field survey methodologies are included in Appendix C. Each water feature was evaluated, and assigned either a High, Medium or Low value of suitability for water vole using the following characteristics:

- High – Suitable vegetation and suitable bank substrate with a water depth of at least 0.3 m or slow flowing/static water;
- Medium – Suitable vegetation and suitable bank substrate with water depth less than 0.3 m or a moderate to fast flow; and

- Low – Unsuitable vegetation or unsuitable bank substrate regardless of other landscape factors.

10.4.103 Suitability of vegetation and bank structure were given greater weight when assessing the overall suitability of habitat than flow rate and channel depth.

10.4.104 Mink are a major predator of water voles; therefore their presence on a watercourse will reduce its suitability for water voles. Signs of mink were searched for, including footprints, scats and actual mink sightings. For each water body, mink populations were assessed as being either present, likely to be present or unlikely to be present.

10.4.105 Table 10.6 summarises the areas surveyed for water voles, habitat assessment scores and the biodiversity value of the feature/site as a whole for water vole.

Table 10.6: Water Vole Survey Results

Water Feature	Habitat Suitability Assessment	Presence of Water Voles	Presence of Mink
North Delph	High	Feeding stations, latrines and burrows recorded.	No field signs recorded
Drains linked to North Delph.	Medium	No field signs recorded	No field signs recorded
River Witham	High	Feeding stations, latrines and burrows recorded.	No field signs recorded
South Delph	High	Feeding stations, latrines and burrows recorded.	No field signs recorded
Canwick Fen Drain	High	Feeding stations, latrines and burrows recorded.	No field signs recorded
Tributary of Branston Brook	Low	No field signs recorded	No field signs recorded

Identification of Key Attributes for Water Vole

10.4.106 The River Witham corridor provides features that support high numbers of water vole. In general the watercourses that constitute this corridor are highly modified, and in some cases man-made, linear features with earth banks. The tall emergent vegetation on the banks of these watercourses provides suitable refuge and foraging resources for water vole. The River Witham corridor is likely to be the key feature water voles use for dispersal, and the key link to water vole colonies outside the study area but within the same catchment. As such, this corridor should be considered to be of value for water vole.

10.4.107 The drains connected to the North Delph were dry at the time of survey and no water vole field signs could be identified; however it is assumed that as water levels fluctuate with flooding, that at times, these drains provide a refuge for displaced water voles. As such, these drains should be considered to be of value for water voles.

Invertebrates

Consultation

10.4.108 No invertebrate records were received from external consultees. A search on the National Biodiversity Network website indicated that over 130 species of invertebrate have been recorded in the 10km grid squares the scheme passes through.

Field Surveys

10.4.109 Information on invertebrates was gathered via incidental sightings whilst on site. In the case of aquatic invertebrates, incidental captures whilst carrying out amphibian surveys were also recorded.

10.4.110 Incidental sightings within the study area were made of the following invertebrate species:

- Emperor Dragonfly *(Anax imperator)*;
- Common Darter *(Sympetrum striolatum)*;
- Black -tailed Skimmer *(Orthetrum cancellatum)*;
- Cinnabar Moth *(Tyria jacobaeae)*;
- Common Blue Damselfly *(Enallagma cyathigerum)*;
- Orange Tip Butterfly *(Anthrocharis cardamines)*;
- Ringlet *(Aphantopus hyperantus)*;
- Meadow Brown Butterfly *(Maniola jurtina)*;
- Great Diving Beetle *(Dytiscus marginalis)*;
- Lesser water boatman *(Coraxia spp.)*;
- Greater water boatman *(Notonectia spp.)*;
- Common Whirligig beetle *(Gyrinus substriatus)*; and
- Common Pond Skater *(Gerris lacustris)*.

Identification of Key Attributes of the Feature

10.4.111 Invertebrates are one of the most successful groups in the animal kingdom and colonise almost every type of habitat. Within the study area there are several habitats that host the more important and most diverse range of species, these were:

- Dead wood habitats (Greetwell Wood);
- Veteran trees (Greetwell Wood);
- River Witham corridor;
- Semi-improved grasslands associated with the River Witham;
- Hedgerows; and
- Scrubby watersides.

10.5 LEVEL OF IMPORTANCE OF THE FEATURE/LEGAL PROTECTION OFFERED TO THE FEATURE

10.5.1 The table below summarises the level of importance (IEEM guidelines 2006) of each of the ecological features in the study area as defined by the conservation status at a UK and local level, as well as whether and to what extent each feature is legally protected in the UK.

Table 10.7: Level of Importance/Legal Protection of Features

Receptor	Key Attributes	Legal Protection
Designated Sites	Greetwell Quarry SSSI. This site is considered of **National** value for its geological interest.	Wildlife and Countryside Act 1981 (as amended) Natural Environment and Rural Communities Act (NERC) Act 2006.
	Greetwell Wood SNCI. This site is considered to be of **County** importance.	SNCI are not afforded any legal protection, however policy instruments in Regional and Local Plans relate directly to the protection of locally designated sites.
Bats	The bat species recorded roosting and foraging within the study area are all common and widespread through out the UK. The study area is therefore considered generally of value to bats on a **County** scale	All species of bat and their roosts are fully protected under the Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) and the Wildlife and Countryside Act 1981 (as amended).
Amphibians	Species of amphibian recorded during surveys are widespread and common throughout the UK. Common toads are listed as UK BAP priority species. The study area is therefore considered generally of value to amphibians on a **local** scale	No legal protection is afforded any of the species recorded in this survey.
Breeding Birds	The study area supports birds that are on the JNCC Red and Amber lists, as well as both UK and Local Biodiversity Action Plans. Many of these birds are considered to be widespread in the types of habitat recorded, therefore the area is considered to be of importance for breeding birds at a **local** level.	All wild birds, their nests and eggs are protected under the Wildlife and Countryside Act 1981 (as amended). The kingfisher and barn owl are fully protected under Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)
Wintering Birds	The study area supports birds that are on the JNCC Red and Amber lists, as well as both UK and Local Biodiversity Action Plans. Many of these birds are considered to be widespread in the types of habitat recorded, therefore the area is considered to be of importance at a **Local** level.	All wild birds are protected under the Wildlife and Countryside Act 1981 (as amended). The kingfisher and barn owl are fully protected under Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)
Barn Owl	The River Witham corridor supports multiple breeding sites for barn owls and forms part of an overall Species Recovery Project for the species, therefore the area is considered to be of importance at a **County** level.	Barn owls are fully protected under Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)
Otters	No specific otter activity was recorded during the field surveys however records indicate that otter were once present within the Witham catchment. Therefore the study area is considered to be of **Local** importance.	Otters are fully protected under the Conservation (Natural Habitats, & c.) Regulations 1994 (as amended) and the Wildlife and Countryside Act 1981 (as amended).
Water Vole	Water vole have been recorded in moderate numbers along the River Witham and associated watercourses. The water vole is found throughout Britain but is confined mainly to lowland areas near water. Once common and widespread, this species has suffered a significant decline in its numbers and distribution. As such they are considered of **County i**mportance.	Water vole are fully protected under the Wildlife and Countryside Act 1981 (as amended).

Receptor	Key Attributes	Legal Protection
Reptiles	The River Witham and associated habitats are a key resource in the study area that provides a complex structure that incorporates basking/egg laying sites, refugia and suitable foraging opportunities. The suitable habitat along the River Witham will act as a key commuting corridor that links areas of suitable reptile habitat in the wider landscape. As such they are considered of **Local** importance	Grass snakes are partially protected under the Wildlife and Countryside Act 198, (part of sub-section 9(1) and part of sub-section 9(5)) (as amended) which prohibits the intentional killing and injuring of this species.
Invertebrates	Based on the habitats present, the terrestrial invertebrate population in the study area is assessed as being of importance at a **Local** scale.	No legal protection is afforded any of the species recorded in this survey.

10.6 IDENTIFICATION OF POTENTIAL IMPACTS ON THE ECOLOGICAL FEATURES

10.6.1 The approach taken to the identification of activities that could impact on ecological features is outlined in the methodology section above.

10.6.2 Potential impacts on habitat features such as hedgerows and ponds are assessed in terms of their potential to support protected, or notable, species unless that receptor has a specific nature conservation designation.

10.6.3 For the purposes of this assessment it is assumed that the design of the scheme takes into account current industry best practice in terms of water quality making impacts due to sedimentation or chemical pollution unlikely (see chapter 11 for specific details on water quality).

10.6.4 Tables 10.8 – 10.16 in Appendix 10J detail the potential impacts of the scheme on each ecological feature and the legal implications of the impact, in line with the IEEM guidelines. Summaries of Tables 10.8 – 10.16 are presented below.

10.6.5 Temporary impacts associated with the construction and use of site compounds and other temporary structures, for example, access tracks, bridges or storage areas, are not specifically assessed in this section, as the location/s of such features are currently unknown at this stage and impacts would vary dependant on the size and location/s. However generic measures are included in the mitigation section that would need to be considered when determining the location of temporary compounds and structures. The same approach is taken to the sites for flood compensation areas.

10.6.6 Impacts are broken down to Construction and Operational impacts.

Table 10.8: Impacts on Designated Sites (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Greetwell Quarry SSSI Nationally important	Landtake	South east corner of the SSSI would be severed (0.5 ha of landtake within SSSI). Currently improved grassland and exposed quarry face (certain)	Negative impact - significant at a **Local** scale. Natural England consent required.
Greetwell Wood SNCI County importance	Landtake	Loss of 0.42 ha of broadleaf woodland, including 9 mature Ash and Sycamore trees, associated ground flora and scrub (certain).	Negative impact - significant at a **County** scale.
	Disturbance	During construction there is the potential to disturb habitats in the remaining part of the wood, adding to the impact on the SNCI (near certain).	Negative impact - significant at a **Local** scale.
River Witham LWS County importance	Landtake	Loss of scrub and some broadleaved trees (certain).	Negative impact - significant at a **County** scale.
	Disturbance	Potential disturbance of habitats adjacent to the scheme during construction, adding to the impact on the LWS (near certain).	Negative impact - significant at a **County** scale.
	Changes to hydrology and pollution	During construction there is potential for the hydrology of wetland habitats associated with the River Witham to be disrupted leading to drying out or waterlogging. There is also potential for site run-off to pollute the River Witham (unlikely).	Negative impact - significant at a **Local** scale.
Operational Impacts			
Greetwell Quarry SSSI Nationally important	Disturbance	The road would directly abut the SSSI boundary potentially causing disturbance through traffic noise/vibrations from traffic and lighting.	Negative impact - significant at a **Local** scale. Natural England consent required.
Greetwell Wood SNCI County importance	Disturbance	During operation of the proposed scheme there is the potential for disturbance of habitats in the remaining part of the wood as a result of traffic noise and headlights, adding to the construction-phase impact on the SNCI.	Negative impact - significant at a **Local** scale.
River Witham LWS County importance	Disturbance	Potential for disturbance from heavy road traffic, adding to the impact on the LWS.	Negative impact - significant at a **Local** scale.
	Changes to hydrology	Potential for road run-off to pollute the River Witham (unlikely).	Negative impact - significant at a **Local/Less than Local** scale.

Table 10.9: Impacts on Amphibians (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Ponds with submerged and emergent plants combined with terrestrial habitat such as woodland, scrub and hedgerows Locally important	Landtake	One pond supporting a small population of smooth newts would be directly impacted by the scheme (TN3) resulting in the loss of 113m^2 of suitable amphibian breeding habitat (certain). Severance of terrestrial habitat within 1km of a pond used by common toads (certain). Loss of one recently created pond north of the River Witham. The status of amphibians in these ponds is currently unknown as surveys on these ponds will commence in March 2009 (certain).	Negative impact - significant at a **Local** scale. No Natural England licences required (pending results of 2009 amphibian surveys)
	Direct mortality	Potential for direct mortality of common toads during the vegetation removal for the scheme (probable).	Negative impact - significant at a **Local** scale.
	Changes to hydrology	The pond directly affected at TN3 is connected to a ditch feature that could be a pathway for sediments or chemical pollution during construction, affecting any amphibian population. This ditch also connects to a second pond at TN5 (unlikely).	Negative impact - significant at a **Local** scale.
Operational Impacts			
Ponds with submerged and emergent plants combined with terrestrial habitat such as woodland, scrub and hedgerows Locally important	Direct mortality	Possible direct mortality through RTAs during mass migration of common toads from terrestrial habitat to breeding ponds (Probable).	Negative impact - significant at a **Local** scale.
	Changes to hydrology	Ponds adjacent to the road could be affected by sedimentation or chemical pollution from road run-off during the scheme's operation (unlikely).	Negative impact - significant at a **Local** scale.

Table 10.10: Impacts on Badgers (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Badger habitat (mix of agricultural grassland and woodland) Locally important	Landtake	One outlier sett would be destroyed during construction of the scheme (near certain).	Negative impact - significant at a **Local** scale. Natural England consent required.
	Direct mortality	Potential for mortality during destruction of outlier sett (unlikely). Potential for accidental death as a result of becoming trapped on the construction site or during night working (unlikely).	Negative impact - significant at a **Local** scale.
	Disturbance	Disturbance of badgers using 3 main setts located approximately 100m west of the scheme as a result of construction works. Such disturbance could potentially lead to abandonment of the setts. Additional disturbance of badgers in vicinity of these setts or in other parts of their territory through increased noise and light, potentially affecting foraging activity. (Certain)	Negative impact - significant at a **Local** scale.
Operational Impacts			
Badger habitat (mix of agricultural grassland and woodland) Locally important	Landtake	Severance of existing badger territories and pathways, isolation from key resources and increased traffic flows on Greetwell Road could lead to increased badger deaths caused by RTAs as they cross the road (near certain). Severance of existing territories could increase social conflict between badger groups, leading to increased fighting that can result in fatal injuries (near certain).	Negative impact - significant at a **Local** scale.
	Disturbance	Increased noise and light in vicinity of setts 1, 2 and 4 and in other parts of badger territories (certain).	Negative impact - significant at a **Local** scale.

Table 10.11: Impacts on Bats (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Potential Bat Roost Sites County importance	Felling of trees / direct mortality	No known bat roost would be lost as a result of the proposed scheme. The landtake for the proposed scheme would result in the loss of nine 'medium' potential tree roosting sites in Greetwell Wood SNCI (certain). Felling of such trees could result in direct mortality of bats (possible).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Conservation (Natural Habitats &c.) Regulations 1994 as amended and under the Wildlife and Countryside Act 1981 (as amended).
	Disturbance	Potential for abandonment of roosts (including the two known roosts, in Greetwell Church and Manor Farm) or of reduced access to roosts and/or foraging sites as a result of disturbance associated with road construction (noise, vibration and lighting). However, all roosts are likely to be habituated to such disturbance.	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Conservation (Natural Habitats &c.) Regulations 1994 as amended and under the Wildlife and Countryside Act 1981 (as amended).
Bat foraging habitat and connections between foraging and roosting habitat. County importance.	Changes to hydrology and water quality	Potential damage to foraging habitat through changes in hydrology or water pollution (loss of wet pasture or wet woodland) (unlikely).	Negative impact - significant at a **Local** scale.
	Landtake	Direct loss of foraging habitat through loss of 0.42ha of Greetwell Wood SNCI, woodland edge, loss of hedgerows, scrub and grasslands (certain).	Negative impact - significant at a **Local** scale.
	Severance	Potential restriction of bat access to foraging habitat or roosts, through severance of commuting routes, loss of woodland (0.42ha), woodland edge and approx. 7km of hedgerows. This could prevent bats from crossing the scheme during construction and therefore losing some foraging grounds (certain).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Conservation (Natural Habitats &c.) Regulations 1994 as amended.
Operational Impacts			
Potential Bat Roost Sites County importance	Disturbance	Potential disturbance of bats roosting in Greetwell Church and Manor Farm as a result of operational noise and lighting has the potential to result in roost abandonment, or reduced access to the roost. However, all of these roosts are already close to existing minor roads, and therefore are likely to be habituated to traffic noise (unlikely).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Conservation (Natural Habitats &c.) Regulations 1994 as amended.

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Bat foraging habitat and connections between foraging and roosting habitat. County importance.	Severance	Severance of commuting routes could restrict bat access to areas of foraging habitat or roosts (near certain).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Conservation (Natural Habitats &c.) Regulations 1994 as amended.
	Disturbance	Operational noise and lighting could cause the loss of foraging habitat adjacent to the scheme as some species of bat are light sensitive and prefer not to forage in brightly lit areas (probable).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Conservation (Natural Habitats &c.) Regulations 1994 as amended and under the Wildlife and Countryside Act 1981 (as amended).
	Direct mortality	The severance of commuting routes could lead to an increase in the frequency of bats crossing the operational scheme. This could lead to an increased incidence of bat mortality through RTAs (probable).	Negative impact - significant at a **Local** scale.

Table 10.12: Impacts on Birds (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Habitats of greatest importance to breeding birds within the overall study area include broad-leaved semi-natural woodland, hedgerows, marshy grassland, arable, and riparian banks along the River Witham.	Landtake	Loss of 0.42ha of woodland habitat and 7km of hedgerows that provide a key resource for breeding and over wintering birds. 43ha of arable habitat would be lost through construction of the scheme that provides a resource for breeding skylark/grey partridge and over wintering habitat for lapwing (certain).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Wildlife and Countryside Act 1981 (as amended).
	Changes in hydrology	This is likely to be limited to areas of marshy grassland and floodplain either side of the River Witham. These areas are an important food resource for many bird species as they are generally associated with high insect biomass (unlikely).	Negative impact - significant at a **Local** scale.

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Key Overwintering habitats; arable and hedgerows winter food resources. Locally important	Water quality/ pollution	Any pollution of the watercourses or marshy grassland crossed by the proposed scheme has the potential to impact on habitat used by birds for foraging, particularly birds such as the kingfisher that are reliant on the watercourses as a food resource (extremely unlikely).	No impact
	Disturbance	During construction of the proposed scheme, there is the potential to disturb birds in the habitats that have been bisected. This is only likely to be a significant impact during construction after which it seems highly likely that the birds would habituate to it (certain).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Wildlife and Countryside Act 1981 (as amended).
Operational Impacts			
Habitats as above Locally important	Disturbance	Disturbance as a result of operational noise and light in habitats that have been bisected. It is likely that the birds would habituate to this disturbance (the species recorded are generally more common species that adapt well to noise and disturbance). Evidence suggests that the noise associated with road schemes can have a negative impact on breeding success (certain).	Negative impact - significant at a **Local** scale. Risk of committing an offence under the Wildlife and Countryside Act 1981 (as amended).
	Direct mortality	During operation of the proposed scheme there is likely to be an increase in bird vehicle strike rate (near certain).	Negative impact - significant at a **Less than Local** scale.
	Water quality/ pollution	Any pollution of the watercourses or marshy grassland as a result of routine run-off or accidental spillages has the potential to impact on habitat used by birds for foraging, particularly birds such as the kingfisher that are reliant on the watercourses as a food resource (extremely unlikely).	No impact.

Table 10.13: Impacts on Barn Owls (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Barn owl habitat - mix of agricultural grassland, woodland and arable. County importance	Landtake	Direct loss of hunting habitat likely to be used by a number of breeding pairs. However, this loss of suitable barn owl habitat is likely to represent a fairly small proportion of the available resource for each breeding pair affected (certain).	Negative impact - significant at a **Local** scale.
	Direct mortality	The most common cause of direct mortality during construction is destruction/damage to a roost or breeding site. No such sites have been identified within the footprint of the scheme (unlikely).	No impact.
	Severance	Severance of flightlines such as hedgerows and woodland edge (Greetwell Wood SNCI), reducing access to suitable habitats either side of the scheme and inhibiting the distribution and dispersal of young after the breeding season (certain).	Negative impact - significant at a **County** scale.
	Disturbance	Construction noise, vibration and lighting could lead to reduced suitability of habitat either side of the construction zone and could lead to abandonment of nesting and/or roosting sites (probable).	Negative impact - significant at a **Local** scale.
Operational Impacts			
Barn owl habitat as above. County importance	Direct mortality	Barn owl deaths due to collision with vehicles in operational traffic (near certain).	Negative impact - significant at a **County** scale.
	Disturbance	Operational noise, vibration and lighting during operation could lead to reduced suitability of habitat either side, and could lead to abandonment of nesting and/or roosting sites (certain).	Negative impact - significant at a **Local** scale.

Table 10.14: Impacts on Reptiles (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Only grass snakes have been recorded within the study area. Locally important	Severance	Severance of existing grass-snake populations into two or more sub-populations, reducing their viability. However, open-span bridge would maintain connectivity (probable).	Negative impact - significant at a **Less than Local** scale.
	Landtake	Accidental deaths during clearance of suitable habitat areas (probable).	Negative impact - significant at a **Local** scale Risk of committing an offence under the Wildlife and Countryside Act 1981 (as amended).
	Water quality/ pollution	Damage to habitat following pollution of the watercourses or marshy grassland (extremely unlikely).	No impact
Operational Impacts			
Only grass snakes have been recorded within the study area. Locally important	Direct mortality	Accidental death during maintenance activities (e.g. verge mowing) (probable).	Negative impact - significant at a **Local** scale Risk of committing an offence under the Wildlife and Countryside Act 1981 (as amended).
	Water quality/ pollution	Any pollution of watercourses/marshy grassland through road run-off has the potential to impact on habitat used by grass snakes for foraging, as they are reliant on the watercourses as a foraging resource (extremely unlikely).	No impact

Table 10.15: Impacts on Water Voles (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Water Vole habitat - Riparian habitat along the River Witham County importance	All	Possible short term disturbance in the initial vegetation clearance phase of the scheme (probable).	Negative impact - significant at a **Less than Local** scale. Risk of committing an offence under the Wildlife and Countryside Act 1981 (as amended).

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Operational Impacts			
Water Vole habitat as above	All	No operational impacts	No impact

Table 10.16: Impacts on Invertebrates (Summary)

Ecological Feature and Level of Importance	Proposed Activity	Characterisation of Unmitigated Impact	Impact Significance Without Mitigation
Construction Impacts			
Invertebrates- habitat mosaic usually required to complete life cycle which varies between species. Local Importance	Landtake	Direct loss of habitat including approximately: • 1.8 ha of semi-improved grassland; • 1 ha of improved grassland habitat; • 0.42 ha of woodland habitat; • 0.07ha of marshy grassland; and • 0.01ha of standing water (certain).	Negative impact - significant at a **Local** scale.
	Severance	Severance of suitable habitats for invertebrates (especially saproxylic invertebrates) (probable).	Negative impact - significant at a **Local** scale.
	Direct mortality	Site clearance would result in the death of invertebrates (certain).	Negative impact - significant at a **Local** scale.
	Changes in hydrology	Direct loss of approximately 0.07ha ha of marshy grassland (probable).	Negative impact - significant at a **Local** scale.
Operational Impacts			
Invertebrates- habitat mosaic usually required to complete life cycle which varies between species. Local Importance	Changes in hydrology	Possible changes in hydrology of habitat suitable for invertebrates, especially wet grassland and the River Witham corridor (probable).	Negative impact - significant at a **Local** scale.

10.7 MITIGATION PROPOSALS

10.7.1 An overall package of mitigation has been set out to deliver the needs of all ecological features identified in the Ecological Impact Assessment report. This holistic approach was used as a number of features could have the same requirements in terms of habitat creation, connectivity and juxtaposition of different habitats. This is as important to nature conservation as the extent of individual habitats.

10.7.2 As Greetwell Quarry is of National importance for its geological interest mitigation for impacts associated with Greetwell Quarry SSSI is detailed with in the Soils and Geology chapter.

Habitat Creation

10.7.3 Four areas are proposed to be included in the CPO boundary for the scheme for the purposes of habitat creation. These areas are identified on the landscape and ecology masterplan (Appendix 9E) (Labelled A-D). Table 10.17 below gives outline habitat creation proposals for these areas. The proposals for these areas are intended to offset the landtake of the scheme from areas of ecological value and to provide areas that would be specifically managed for biodiversity purposes.

Table 10.17: Ecological Enhancement Areas

Area	Size (ha.)	Location	Proposals
A	0.7	West of Greetwell Fields, east of bypass. Arable land.	• Pond creation to compensate for the loss of the pond at TN3 • Planting of wildflower grassland and scrub/tree planting
B	0.4	Improved grassland adjacent to Greetwell Wood and opposite side of carriageway on embankments, on northern slopes of Witham valley.	• Woodland and Tree and shrub planting ajacent to Greetwell Wood and extending north / south on road embankments
C	1	Arable land on the western side of scheme, adjacent to Lincoln Edge cutting	• The creation of wildflower grassland • Tree and shrub planting around junction (foot of edge slope) planting
D	0.8	Arable land south of Lincoln Road	• Pond creation to compensate for the loss of the pond at TN3 • Planting of wildflower grassland and tree planting

10.7.4 Six balancing ponds would be created, as shown on the Environmental Masterplan (Appendix 9E)

10.7.5 Although the primary function of balancing ponds is for drainage, the areas of open water habitat and associated landscape planting of these areas is likely to have a secondary biodiversity function, and is likely to provide a resource for amphibians and waterfowl. As such, balancing pond features are not considered as mitigation proposals but recognised for their secondary ecological function. The landscape proposals for these areas have been developed in consultation with Jacobs' ecologists and are shown in Appendix 9E.

Amphibians

10.7.6 No legally protected amphibians (great crested newt) species were recorded during the amphibian surveys. However common toads have been recorded in several ponds in the study area. This species is listed as a '*Priority Species*' of conservation concern in the UK BAP. No specific species action plan (SAP) has been issued for common toad; therefore for the purposes of this assessment, it is assumed that targets for this species would be broadly analogous to targets set for great crested newt, as a similar widespread amphibian in the UK. In summary, conservation targets for common toad in the UK are assumed to be:

- Maintain the geographical range of common toads; and
- Maintain the viability of existing common toad populations.

10.7.7 Taking these targets in to consideration, the habitats to be created as part of the scheme (detailed in the previous section), include aquatic and terrestrial habitats that are likely to be of benefit to the local amphibian population. As such, with the full implementation of habitat creation areas, and the secondary benefit from balancing ponds, the favourable conservation status of common toad at a local level is likely to be maintained.

Birds

10.7.8 Table 10.18 identifies the best practice measures that should be undertaken to mitigate for the presence of birds.

Table 10.18: Bird Mitigation

Mitigation/Enhancement Measures
• Pre-Construction: Clearly demarcate vegetation to be retained/lost (including trees and hedgerows) with marking system agreed with contractor.
• Pre-Construction: All vegetation and hedgerow removal, and topsoil stripping should be carried out between September and February (inclusive) to avoid the bird breeding and nesting season.
• Post-Construction: Landscape planting for the scheme should include species of local provenance that provide suitable nesting areas, or a source of food at different times of year such as hawthorn, bramble, blackthorn and teasel.
• Post-Construction: The erection of various types of bird boxes in existing areas of scrub and woodland should be considered as an enhancement measure. The following areas should be considered for enhancement: Greetwell Wood SNCI and the River Witham corridor.

Badgers

10.7.9 A full description of the mitigation measures in relation to badgers is supplied in a separate confidential report. Table 10.19 below provides a summary of these measures.

Table 10.19: Badger Mitigation

Mitigation/Enhancement Measures
• Pre-construction surveys to ensure that new setts have not become established along the scheme.
• Pre-Construction: An ecologist will be consulted regarding the locations of work compounds and storage areas to avoid badger setts and the higher quality badger habitat areas.
• An outlier sett would be destroyed during construction. Pre-construction surveys and monitoring will be undertaken to determine whether it is in use or not. If it is active then a Natural England licence will be required to close the sett before it can be destroyed. The licence would permit works between July and November inclusive only.

Mitigation/Enhancement Measures
• During Construction: No steep-sided, deep and/or water-filled excavations would be left unguarded overnight as badgers could fall in and become trapped. Any major excavations that need to be left unguarded overnight would have their slopes battered to a slope no steeper than 50o. If it is necessary to leave small deep, steep-sided or water-filled excavations open overnight they would be fenced with suitable badger-proof fencing. • During Construction: No night-time working or traffic movements (other than light vehicles) would be allowed on the site at night where badger setts were within 100 m of the works area to prevent badgers being injured or killed by machinery. • End of Construction: Badger fencing installed to the standards set out in DMRB Volume 10 to guide badgers to safe crossing points.

Bats

10.7.10 Table 10.20 below identifies the best practice mitigation measures that should be undertaken for bats.

Table 10.20: Bat Mitigation Measures

Mitigation/Enhancement Measures
Pre-Construction: • Prior to construction, trees within Greetwell Wood SNCI identified as having medium potential to support bat roosts should be inspected and resurveyed to identify any change to the baseline reported. This inspection would identify any trees with features that offer roosting potential for bats, such as dense ivy, loose/raised bark, rot holes, cracks and splits. Inspection surveys are is best carried out during winter as tree features would not be obscured by leaves. Any such tree may require dedicated night time bat detector surveys to ascertain if they are used as a roost site. • As a general precaution, tree felling should only be undertaken in autumn, between late August and October/early November. At this time bats do not have dependent young and are not hibernating, and should therefore be active enough to escape harm if proper precautions are taken. • Any tree found to be used by bats is a legally protected roost site. To enable the demolition of a bat roost a licence must be obtained from the Natural England, which will detail the strict methodology and mitigation measures to be followed. • Where possible existing hedgerows should be safeguarded and retained within the development, and newly planted native hedgerows would be integrated in to the development of each phase to adjust flightlines to safe crossing points eg. the open span bridge across the River Witham. During Construction: • Where temporary severance of important bat commuting routes cannot be avoided when creating construction access routes, temporary fencing such as 'Heras' fencing can be placed across the gap overnight with either hedge material or camouflage netting used to create a more natural appearance. This should restore the functional connectivity of the commuting route during the construction phase. An experienced ecologist can advise on this procedure further as required. • Lighting during the construction and operational phase of the scheme should follow 'The Institute of Lighting Engineers – Guidance Notes for the Reduction of Obtrusive Light' to minimise the adverse impacts of lighting across the site and to peripheral habitats. • Night working should be avoided where possible. If it cannot be avoided, it should be restricted in the vicinity of known commuting routes and valuable areas of foraging habitat i.e. commuting hedgerows should not be illuminated nor have generators placed next to them. • Site compounds and plant should be stored away from known commuting routes and valuable areas of foraging habitat. • The erection of bat boxes in existing areas of scrub and woodland should be considered as an enhancement measure. The following areas should be considered for enhancement: Greetwell Wood SNCI and the River Witham Corridor. Bax boxes should be erected in advance of construction to increase the chances of them being used.

Mitigation/Enhancement Measures
Post-Construction: • Standard trees should be allowed to grow up (or be planted) along newly planted hedgerows in order to provide additional foraging and potential future roosting habitat. • Planted hedgerows should be cut on rotation, and not more frequently than once every two or three years. A minimum height of 2m should be attained and preferably a range of different heights encouraged. • Linear planting is proposed in the landscape design of the scheme in key areas of bat activity to channel them to safe crossing points such as the River Witham bridge. • The creation of balancing ponds would provide a secondary biodiversity benefit for bats in terms of foraging habitat.

Barn Owl

10.7.11 Table 10.21 below identifies the best practice mitigation measures that should be undertaken for barn owls.

Table 10.21: Barn Owl Mitigation Measures

Mitigation/Enhancement Measures
During Construction: • Lighting during the construction and operational phase of the scheme should follow 'The Institute of Lighting Engineers – Guidance Notes for the Reduction of Obtrusive Light' to minimise the adverse impacts of lighting across the site and to peripheral habitats. • Night working should be avoided where possible. If it cannot be avoided, it should be restricted in the vicinity of known commuting routes and valuable areas of foraging habitat. i.e. commuting hedgerows should not be illuminated nor have generators placed next to them. • Site compounds and plant should be stored away from known commuting routes and valuable areas of foraging habitat • The landscape and ecology master plan (Appendix 9E) identifies planting that is designed to deter barn owls from hunting on the road embankment to reduce the occurrence of direct mortality through chance encounters with the scheme. This includes dense tree and scrub planting from Greetwell Road to Washingborough Road. • Where possible, existing hedgerows are safeguarded and retained within the development and newly planted native hedgerows would be integrated into the development of each phase to maintain flightline features to safe crossing points e.g. the open span bridge across the River Witham. • Linear planting along the scheme is proposed in the landscape design in key areas of barn owl activity to channel them to new safe crossing points such as the River Witham bridge. Post-Construction • Planted hedgerows should be cut on rotation, and not more frequently than once every 2-3 years. A minimum height of 2 metres should be attained and preferably a range of different heights encouraged.

10.7.12 In addition to the above measures, consultation with the Environment Agency, in conjunction with Wildlife Conservation Partnership, should be conducted to discuss ways the scheme could contribute to the barn owl species recovery programme

Water Vole

10.7.13 No direct impacts on water voles are considered likely to occur during the construction or operation of the scheme, therefore no specific mitigation or enhancement measures are proposed. However indirect impacts through disturbance or degradation of water quality may occur. To avoid these impacts the following best practice measures would be adopted:

- A buffer zone of 5m from the top of the banks should be maintained where construction works are close to the River Witham corridor;
- The buffer zone would be clearly demarcated with high visibility fencing during the construction period;
- Throughout the construction period, regular monitoring of the water vole population would take place to determine the need for remedial action; and
- The scheme would be constructed to current best practice in terms of the prevention of water pollution, therefore reducing the risk of accidental spills/run-off during construction and operation.

Reptiles

10.7.14 Grass snakes are the only reptile to be recorded within the study area. Surveys were confined to the riparian zones associated with the River Witham and the flood plain to the north, as these were the only areas within the study area deemed to provide suitable habitat. The following measures in Table 10.22 below outline the best practice approach to be adopted during vegetation clearance in this area to avoid impacts on grass snakes during construction and operation of the scheme.

Table 10.22: Reptile Mitigation Measures

Mitigation/Enhancement Measures
Pre-Construction: • Pre-construction surveys would be undertaken by a suitably qualified ecologist to identify areas of high risk reptile habitat. • All natural/artificial refugia should be removed from this area by hand to deter grass snakes from seeking refuge within the construction zone. • This area should then be sequentially mown over 2 days (at any time between April and September); firstly to a height of 600mm, left overnight then mown to ground level. It is considered that grass snakes are sufficiently mobile that they would have left the construction area after the first cut thus avoiding any offences under the Wildlife and Countryside Act when mown to ground level in the second cut. During-Construction: • All debris from site clearance should be used to create habitat piles in habitat creation areas and on road embankments. This material should also be used to create reptile refugia on the banks of the River Witham, South Delph and North Delph by agreement. The above methodology should be agreed with the local authority ecologist before being implemented.

Invertebrates

10.7.15 Table 10.23 below identifies the best practice mitigation measures that should be undertaken for invertebrates.

Table 10.23: Invertebrate Mitigation Measures

Mitigation/Enhancement Measures
Pre-Construction • Clearly demarcate vegetation to be retained/lost (including trees and hedgerows) with marking system agreed with contractor. During Construction • Where removal of dead standing and fallen timber is necessary, the material would be relocated into areas of existing dead wood habitats and in areas of new woodland planting, to enhance

Mitigation/Enhancement Measures
invertebrate habitat. Relocated deadwood would be placed in areas of partial shade. • Piles of brash and smaller material would be placed in tightly packed, large litter piles in a range of aspects. • Replacement habitat would be created through planting of hedgerows, woodland, species rich grassland, and the creation of new marsh/wetland in some of the attenuation areas; with particular emphasis on the UK and Lincolnshire BAP habitats. All planting would use native species of local provenance. • Part of the new woodland planting would be adjacent to existing woodland areas to both aid colonisation of the new woodland and enhance the retained woodland habitat. • Within new woodland planting, open areas would be created including scalloped and coppiced rides. Post-Construction • Management plans would be produced to ensure the woodland condition is maintained and developed.

10.8 MONITORING PROPOSALS

10.8.1 The aim of the monitoring proposals put forward here, is to determine whether further protected species have moved into the study area prior to construction and to determine the success of the mitigation measures post construction. The monitoring/ aftercare period should extend a minimum of 3 years post construction.

Table 10.24: Proposed Monitoring Programme

Monitoring Proposal	Timing
Habitat Creation Areas Aim – Monitor the success of the planting schemes, pond creation and the establishment of marshy habitats associated with the attenuation ponds. The monitoring programme would be agreed with all stakeholders, in particular to decide what the indicators of success would be. This could include the successful establishment of certain species, or % cover of certain species. The monitoring programme would also include actions to resolve any failures in the mitigation.	• Post construction – continue annually until end of aftercare period
Badger Aim – To monitor badger activity during construction and success of mitigation measures. The exact nature of this monitoring needs to be discussed and agreed with all stakeholders but could comprise any or some of the following: • Checking for new setts that would pose a constraint to construction activities. • Collation of RTA data along the scheme. This would include follow up work to determine key factors in RTAs and further remedial actions required.	• During and Post construction – continue until end of aftercare

Monitoring Proposal	Timing
Barn Owl Aim – to monitor the success of mitigation put in place to reduce the effects of the scheme on barn owl. The exact nature of this monitoring needs to be discussed and agreed with all stakeholders but could comprise any or some of the following: • Monitor barn owl activity during construction. • Monitor the usage of bridges and underpasses to determine the efficacy of mitigation measures employed. • Record any barn owl RTA data and take remedial action.	• Construction – regularly according to an agreed programme. • During/Post construction – continue until end of aftercare period
Bats Aim – to monitor the success of mitigation put in place to reduce the effects of the scheme on bats. The exact nature of this monitoring needs to be discussed and agreed with all stakeholders but could comprise any or some of the following: • Roost exit counts at nearby confirmed roost sites • Surveys of the bat boxes erected as part of mitigation to determine use in the post construction period The programme would also include actions to resolve any failures in the mitigation.	• Construction – regularly according to an agreed programme • Post construction – continue at longer intervals until end the aftercare period

10.9 ASSESSMENT OF POTENTIAL RESIDUAL IMPACTS OF THE PROPOSALS

10.9.1 All assessments of residual potential impacts are based on, and dependent upon, adoption of the mitigation measures outlined in previous sections. Assessment of significance is defined as 'the geographical scale at which the impact is considered to be of a material matter for decision makers in terms of maintaining the nature conservation status of the feature resource'. An impact can therefore be significant at Local, County, Regional, National or International levels. Professional judgement was used by experienced ecologists to make this assessment.

10.9.2 Appendix 9K contains the full tables showing the assessment of the residual ecological impacts. Summary tables are included below.

Designated Sites

Table 10.25: Residual Impacts on Designated Sites

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Greetwell Quarry SSSI Level of Importance: National	Landtake	negative impact of significance at a local scale.	N/A	negligible.
	Disturbance	N/A	negative impact of significance at a Local scale.	negligible
Greetwell Wood SNCI Level of Importance: County	Landtake	negative impact of significance at a County scale.	N/A	negligible
	Disturbance	negative impact of significance at a local scale.	negative impact of significance at a local scale.	negligible
River Witham LWS Level of Importance: County	Landtake	negative impact of significance at a County scale.	N/A	negative impact of significance at a local scale.
	Disturbance	negative impact of significance at a County scale.	negative impact of significance at a local scale.	negligible
	Changes to hydrology and pollution	negative impact of significance at a local scale.	If any wetland areas were reduced or lost, this would constitute a negative impact of significance at a local scale, however, due to the likelihood of occurrence, it is considered negligible.	Negligible

Amphibians

Table 10.26: Amphibians Residual Impacts

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Level of Importance: Local Common Toads are UK "Priority Species"	Landtake	negative impact of significance at a local scale	N/A	short term negative impact of significance at a local scale; however once these areas establish the residual impact is considered to be negligible.
	Direct Mortality	negative impact of significance at a local scale	negative impact of significance at a local scale.	negligible.
	Changes to Hydrology	negative impact of significance at a local scale.	negative impact of significance at a local scale.	negligible.

Badger

Table 10.27: Badgers Residual Impacts

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Badger Level of Importance	Landtake	negative impact of significance at a local scale.	N/A	negligible.

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Local	Direct Mortality	negative impact of significance at a local scale	negative impact of significance at a local scale.	negligible.
	Disturbance	negative impact of significance at a local scale.	negative impact of significance at a local scale.	negligible
	Severance	N/A	negative impact of significance at a local scale.	negligible

Bats

Table 10.28: Bats Residual Impacts

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Bats **Roosting habitat** Level of Importance County UK, HA and LBAP *"Priority Species"*.	Landtake/ Direct mortality	negative impact of significance at a local scale	No Impact	negligible
	Disturbance	**negative impact of significance at a local scale.**	**negative impact of significance at a local scale.**	**negative impact of significance at a local scale.**

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Bats **Foraging habitat/ Connectivity to foraging areas and roosting sites** Level of Importance County	Landtake	**significant negative at a local scale** for bat species.	N/A	**short term negative impact of significance at a local scale**; however once these areas establish the residual impact is considered to be **negligible.**
	Changes to hydrology and water quality;	If any wetland areas were reduced or lost, this would constitute a negative impact of significance at a local scale, however, due to the likelihood of occurrence, it is considered negligible.	If any wetland areas were reduced or lost, this would constitute a negative impact of significance at a local scale, however, due to the likelihood of occurrence, it is considered negligible.	negligible.
	Severance	a negative impact of significance at a local scale	negative impact of significance at a local scale,	negative impact on a local scale in the short term, and negligible in the long term.

Birds

Table 10.29: Birds Residual Impacts

Construction

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Birds Level of Importance	Landtake	negative impact of significance at a local scale.	N/A	In the short term the residual impact would remain a negative impact of significance at a local

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Local				scale, however in the long term once the planting has become established which contains a mix of habitats including hedgerows and woodland the residual impact is considered negligible.
	Changes in hydrology	negative impact of significance at a local scale.	no impact	negligible.
	Water Quality/ pollution	no impact	no impact	
	Disturbance	a negative impact of significance at a local scale.	a negative impact of significance at a local scale.	negligible
	Direct Mortality	a negative impact of significance at a local scale.	negative impact of significance at a less than local scale.	negligible.

Barn Owl

Table 10.30: Barn Owl Residual Impacts

Construction

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Barn Owl Level of Importance	Landtake	negative impact significant at a local scale.	N/A	negative impact of significance at a local scale.

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
County	Direct Mortality	no impact	negative impact of significance at a county scale.	negative impact of significance at a local scale in the long term
	Severance	negative impact significant at a county scale.	negative impact significant at a county scale.	In the short term the residual impact would be negative of significance at a local scale, however in the long term once the planting has become established which contains a mix of habitats including hedgerows, grassland and woodland the residual impact is considered negligible.
	Disturbance	negative impact significant at a local scale	negative impact significant at a local scale	In the short term the residual impact would remain a negative impact of significance at a local scale, however in the long term once the planting has become established which contains a mix of habitats including hedgerows, grassland and woodland the residual impact is considered negligible.

Reptiles

Table 10.31: Reptiles Residual Impacts

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Reptiles Level of Importance Local value	Severance	negative significant at a less than local scale	As for construction.	In the short term the residual impact would remain a negative impact of significance significant at a local scale, however in the long term once the planting has become established which contains a mix of habitats including hedgerows, grassland and woodland the residual impact is considered negligible.
	Landtake and direct mortality	significant at a local scale	negative impact of significance at a local scale	In the short term the residual landtake impact would remain a negative impact of significance at a local scale, however in the long term once the planting has become established which contains a mix of habitats including hedgerows, grassland and woodland the residual impact is considered negligible.
	Water Quality/ pollution	no impact	As for construction.	negligible

Water Vole

Table 10.32: Water Vole Residual Impacts

Construction

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Water Vole Level of Importance County	All	negative impact of significance at a less than local scale	negative impact of significance at a less than local scale	negligible

Invertebrates

Table 10.33: Invertebrate Residual Impacts

Ecological feature, key attributes, legal framework and level of importance	Proposed Activity	Impact significance without mitigation (Construction)	Impact significance without mitigation (Operation)	Residual Impact
Invertebrates Level of Importance Local Importance	Landtake	negative impact of significance at the local level	N/A	In the short term the residual landtake impact would remain a negative impact significant at a local scale, however in the long term once the planting has become established which contains a mix of habitats including hedgerows, marshy grassland and woodland, and dead wood habitats the residual impact is considered negligible.
	Severance	negative impact of significance at the local scale	As for construction.	In the short term the residual landtake impact would remain a negative impact significant at a local scale, however in the long term once the planting has become established which contains a mix of habitats including hedgerows, marshy grassland and woodland, and dead wood habitats the residual impact is considered negligible.
	Direct Mortality	negative impact of significance at the local scale	N/A	negligible
	Changes in hydrology	negative impact of significance at the local scale.	As for construction	negligible

11 ROAD DRAINAGE AND THE WATER ENVIRONMENT

11.1 INTRODUCTION

11.1.1 Both the availability of sufficient water resources and the quality of water are vital for society, the economy and the support of ecosystems. Water can also be destructive to society, for example during flood events.

11.1.2 Surface run-off can transport pollutants from a wide area and concentrate it in water bodies, which are therefore vulnerable to pollution.

11.1.3 The rate of run-off is a key factor in determining the likelihood of flooding, and is itself influenced by changes in the nature of the land surface, for example by the creation of impermeable road surfaces.

11.1.4 This chapter assesses the potential effects of the proposed road on the water environment under the following sub-headings:

- Hydrology and Water Quality;
- Groundwater; and
- Flood Risk.

11.1.5 The chapter provides an assessment of the likely impacts of the proposed road on the key receptors in the water environment, and provides details of the mitigation measures proposed to counter any potential adverse impacts.

11.2 POLICY AND LEGAL CONTEXT

11.2.1 National policy and legislation relevant to the proposed scheme includes:

- The Water Resources (Water Framework Directive) Regulations 2003;
- Water Resources Act 1991;
- Planning Policy Statement 23: Planning and Pollution Control; and
- Planning Policy Statement 25: Development and Flood Risk.

11.2.2 Relevant regional and local policies relating to the water environment are set out in:

- East Midlands Plan Regional Spatial Strategy, 2009;
- Lincoln City Council Local Plan, 1998;
- North Kesteven Adopted Local Plan, 2007; and
- West Lindsey Local Plan First Review, 2006.

11.2.3 The assessment has been developed in light of the requirements of these policy and legislative documents, and in particular the following key themes:

- Protecting water quality;
- Protecting water resources; and
- Avoiding inappropriate development in flood risk areas.

11.3 APPROACH AND METHODS

Hydrology and Surface Water Quality

11.3.1 Baseline data has been collected by means of a desk study using a search area of approximately 500 metres around the proposed bypass. Information was obtained from the following sources:

- The Environment Agency;
- The Environment Agency's website (www.environment-agency.gov.uk);
- Ordnance Survey mapping;
- An Envirocheck Report (Landmark Information Group, November 2007);
- The MAGIC website (www.magic.gov.uk);
- Witham 1st District Internal Drainage Board website (www.witham-1st-idb.co.uk); and
- Witham 3rd District Internal Drainage Board website (www.witham-3rd-idb.co.uk).

11.3.2 In addition, a site walkover was carried out on 15th November 2007.

11.3.3 Specific data for the receiving watercourses, upstream of the study area, is required for the assessment process. This includes:

- Q_{95} river flows (river flow that would be exceeded 95% of the time);
- Upstream dissolved copper and total zinc;
- Average water hardness;
- River Ecosystem Classification; and
- Location and nature of fisheries.

11.3.4 The Environment Agency does not have any gauging stations within or close to the study area. Therefore, the Q_{95} figures were calculated using the catchment characteristics available in the Centre for Ecology and Hydrology's Flood Estimation Handbook.

11.3.5 Water quality information was obtained from the Environment Agency's website.

11.3.6 The assessment also requires data about the volume and composition of traffic. This was obtained from traffic forecasting studies carried out by Jacobs.

Groundwater

11.3.7 Baseline data was gathered from the following sources:

- British Geological Survey, 1967, Hydrological Map of North and East Lincoln;
- National Rivers Authority Groundwater Vulnerability Map, Sheet 19, Lincolnshire, 1:100 000 (1995);
- The Environment Agency's website; and
- Environment Agency, 2004, Witham CAMS.

Flood Risk

11.3.8 The Environment Agency's Flood Zone maps show that the route of the proposed bypass crosses the flood plain of the River Witham. The floodplain in this area is divided into two classifications, moderate and low, according to the risk of flooding. A moderate flood risk area has a flood return period of between 1 in 75 and 1 in 200

years, and a low flood risk area has a flood return period of more than less than 1 in 200 years.

11.3.9 Data was gathered from the following organisations:

- Environment Agency, Lincoln Office;
- Anglian Water, Huntington;
- City of Lincoln Council, Lincoln;
- Witham First and Third District Internal Drainage Board, Washingborough;
- Upper Witham Internal Drainage Board, Lincoln;
- Lincolnshire County Council, Lincoln;
- North Kesteven District Council, Sleaford; and
- West Lindsey Borough Council, Gainsborough.

11.3.10 Information was also taken from existing studies, as follows:

- Lincoln Eastern Bypass Environmental Statement, (Babtie 2003);
- River Witham Catchment Flood Management Plan (CFMP) Environment Agency 2008;
- Witham Catchment Flood Map Improvements, Upper Witham Hydraulic Modelling Report, (Faber Maunsell 2007);
- Lincoln Integrated Urban Drainage Pilot – SLD2309 (Faber Maunsell 2008a);
- Lincoln Water Cycle Study (Faber Maunsell 2008b);
- Lincoln Policy Area – Strategic Flood Risk Assessment (JBA 2004); and
- Lincoln Eastern Bypass Stage 2 Environmental Assessment Report (Jacobs 2008a).

11.4 ASSESSMENT METHODOLOGY

11.4.1 Potential effects on the water environment were identified and assessed in accordance with the guidance set out in DMRB and in Chapter 4 of this Environmental Statement. The significance of predicted impacts is considered as a function of the sensitivity of the relevant receptor and the likely magnitude of the impact.

11.4.2 The sensitivity of the water-related environmental receptors within the study area has been defined in relation to their 'importance' on a four-point scale (Very High, High, Medium and Low), as shown in Table 11.1.

Table 11.1: Estimating the Importance of Water Environment Attributes (Reproduced from DMRB Volume 11, Section 3, Part 10, Table 5.3)

Importance	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on regional or national scale	**Surface Water:** EC Salmonid/Cyprinid fishery; RQO River Ecosystem Class RE1 Site protected under EU or UK wildlife legislation (SAC, SPA, SSSI, Ramsar Site) **Groundwater:** Major aquifer providing a regionally important resource or supporting site protected under wildlife legislation; SPZ I **Flood Risk:** Flood Plain or defence protecting more than 100 residential properties from flooding
High	Attribute has a high quality and rarity on local scale	**Surface Water:** RQO River Ecosystem Class RE2; Major Cyprinid Fishery; Species protected under EU or UK wildlife legislation **Groundwater:** Major aquifer providing locally important resource or supporting river ecosystem; SPZ II **Flood Risk:** Flood plain or defence protecting between 1 and 100 residential properties or industrial premises from flooding
Medium	Attribute has a medium quality and rarity on local scale	**Surface Water:** RQO River Ecosystem Class RE3 or RE4 **Groundwater:** Aquifer providing water for agricultural or industrial use with limited connection to surface water; SPZ III **Flood Risk:** Flood plain or defence protecting 10 or fewer industrial properties from flooding
Low	Attribute has a low quality and rarity on local scale	**Surface Water:** RQO River Ecosystem Class RE5 **Groundwater:** Non-aquifer **Flood Risk:** Floodplain with limited constraints and a low probability of flooding of residential and industrial properties

11.4.3 Magnitude of impact is measured on a scale based on the predicted level of change regarding an individual receptor's integrity, use or quality, as shown in Table 11.2. Impacts may be adverse or beneficial.

Table 11.2: Criteria for Determining Magnitude of Impact (based on DMRB, Volume 11, Section 3, Part 10, Table 5.4)

Magnitude	Criteria	Example
Major Adverse	Loss of attribute and/or quality and integrity of attribute	High risk of surface water pollution and potential failure of total zinc and dissolved copper, extensive change to a fishery or nature conservation site, loss of an aquifer or high risk of groundwater pollution, 100mm increase in flood peak level (1% annual probability)

Magnitude	Criteria	Example
Moderate Adverse	Effect on integrity of attribute or loss of part of attribute	High risk of surface water pollution and potential failure of either total zinc or dissolved copper, partial loss in productivity of a fishery, partial loss or change to an aquifer, medium risk of groundwater pollution, greater than 50mm increase in flood peak level (1% annual probability)
Minor Adverse	Measurable change in attribute's quality or integrity	High risk of surface water pollution but no change in total zinc and dissolved copper, low risk of pollution to groundwater, greater than 10mm increase in flood peak level (1% annual probability)
Negligible	Effects of insufficient magnitude to affect the attribute's use or integrity	Unlikely to affect the integrity of the water environment
No Change		
Minor Beneficial	Some beneficial effect or reduced risk of negative effect	Reduction in spillage risk by 50% or more (where existing risk is less than 1% per annum), greater than 10mm reduction in flood peak level (1% annual probability)
Moderate Beneficial	Moderate improvement to attribute quality	Reduction in spillage risk by 50% or more (where existing risk is greater than 1% per annum), greater than 50mm reduction in flood peak level (1% annual probability)
Major Beneficial	Major improvement to attribute quality	Removal of existing polluting discharge or of existing potential polluting discharge, recharge of an aquifer, greater than 100mm reduction in flood peak level (1% annual probability)

11.4.4 The significance of the predicted impact, whether beneficial or adverse, is based on the matrix in Table 11.3, which compares the sensitivity of the receptor with the predicted magnitude of impact.

Table 11.3: Matrix for Estimating the Significance of Effects on the Water Environment (based on DMRB, Volume 11, Section 3, Part 10, Table 5.5)

	Magnitude				
Sensitivity	**No change**	**Negligible**	**Minor**	**Moderate**	**Major**
Very High	Neutral	Neutral	Moderate / Large	Large / Very Large	Very Large
High	Neutral	Neutral	Slight / Moderate	Moderate / Large	Large / Very Large
Medium	Neutral	Neutral	Slight	Moderate	Large
Low	Neutral	Neutral	Neutral	Slight	Slight / Moderate

Hydrology and Surface Water Quality

11.4.5 The key risks to water quality in sensitive water-related receptors include pollution from contaminants contained in routine rainwater run-off, and pollution from accidental spillages (for instance after road accidents). For aquatic life, the risk of harm is related to the concentration of pollutants within the receiving water.

11.4.6 A quantitative risk assessment has been carried out to calculate the risks of pollution from routine run-off to surface waters using methods A and B in Volume 11, Section 3, Part 10 of DMRB. Method A is a simple assessment used to identify whether the routine run-off is likely to have an impact on surface watercourses. If Method A shows that an impact is possible, further assessment is required using Method B, which goes in to more detail.

11.4.7 The information required to carry out the routine run-off risk assessment includes:

- The predicted daily volume of traffic ('annual average daily traffic' or AADT);
- The sensitivity of the receiving watercourse;
- Water quality data for locations upstream of proposed discharge locations;
- The flow exceeded in the watercourse 95% of the time;
- Average rainfall data; and
- Area of road to be drained.

11.4.8 Traffic information was obtained from a traffic model for 2031 (the design year for the bypass) which has been prepared for the proposed bypass.

11.4.9 Spillage risk relates to the likelihood that polluting materials may be accidentally spilled onto the road, as a result for example of road accidents. A spillage risk assessment has been carried out in accordance with Method D in Volume 11, Section 3, Part 10 of DMRB.

11.4.10 The information required to carry out the spillage risk assessment includes:

- The predicted daily volume of traffic ('annual average daily traffic' or AADT);
- The percentage of predicted traffic with HGV classification;
- The length of the relevant section of road;
- The type of junction;
- The sensitivity of the receiving watercourse; and
- The time it would take the emergency services to respond to a serious pollution risk.

Groundwater

11.4.11 An assessment of pollution impacts from routine run-off on groundwater was carried out by a hydrogeologist, using the Environment Agency's ConSim v2.02 software, which is a predictive model used to assess the predicted impact on receptors. Further information on the approach is provided in Section 1.4 of the Controlled Waters Risk Assessment report, included as Appendix 11B.

Flood Risk

11.4.12 A Flood Risk Assessment (FRA) has been undertaken in accordance with Planning Policy Statement 25: Development and Flood Risk. Further information on the approach is provided in the Flood Risk Assessment report, included as Appendix 11C.

11.5 BASELINE CONDITIONS

11.5.1 The following features have been identified as key receptors in terms of the water environment, and are illustrated in Figures 11.1, 11.2 and 11.3. These features have

been identified on the basis of their proximity to the road corridor and their sensitivity to changes in water quality and run-off volumes.

Hydrology and Surface Water Quality

Watercourses

11.5.2 The River Witham flows northwards along the foot of the Lincoln Edge escarpment before turning slowly eastwards through the Lincoln Gap at an elevation of below 5m AOD. Downstream of Lincoln, the river gradually turns southwards and flows through Boston before discharging to the sea. The River Witham is a main river with a substantial floodplain, upon which most of the southern part of Lincoln lies. All of the waterways surrounding Lincoln have a long history of modification, indicated by the almost straight path of the Witham from Lincoln to Bardney.

11.5.3 The South Delph, or Sincil Dyke, is a man-made channel on the south side of the River Witham, and is classed as a main river. It originates to the south of Lincoln at the point where the Catchwater Drain meets the River Witham at NGR SK 969 695. At this point, the watercourse is known as the Sincil Dyke. It branches off to the east, before flowing north and then east again at New Boultham, where it becomes the South Delph. The watercourse then runs approximately 50 metres south of and parallel to the River Witham until Bardney Lock.

11.5.4 To the south of the South Delph is Canwick Fen Drain (also known as Soak Dyke), which is administered by the Witham First Internal Drainage Board. This drain becomes Longstrongs Delph approximately 1km east of the proposed bypass before discharging into the South Delph via a pumping station at NGR TF 042 714.

11.5.5 The North Delph is a large drain administered by the Witham Third District Internal Drainage Board. It originates near works at NGR SK 990 711 and runs parallel to the River Witham until Bardney.

11.5.6 Reepham Beck is located with 100m of the roundabout of the A158, and crosses under Wragby Road. This watercourse has a combination of straight, man-made and naturally meandering sections.

11.5.7 Two streams dissect the southern limestone plateau and lie in the vicinity of the route. These both flow eastwards and form part of a series of streams draining off the plateau and into a network of channels and ditches in the fens area further east. The most northerly of the streams is a tributary of Branston Brook which arises near Canwick Heath Farm close to the Lincoln Road. The more southerly stream, Ashfield Beck, arises south west of Westfield Farm.

Water Quality Grading

11.5.8 The Environment Agency uses water quality monitoring results to classify the quality of any given watercourse based on chemistry and biology. Table 11.4 sets out this classification system.

Table 11.4: The Environment Agency's River Water Quality Grading System

Grade	Chemistry	Biology
A Very Good	All abstractions. Very good salmonid fisheries. Cyprinid fisheries. Natural ecosystems.	Biology similar to that expected for an unpolluted river
B Good	All abstractions. Very good salmonid fisheries. Cyprinid fisheries. Ecosystems at or close to natural.	Biology is a little short of an unpolluted river

Grade	Chemistry	Biology
C Fairly Good	Potable supply after advanced treatment. Other abstractions. Good cyprinid fisheries. Natural ecosystems, or those corresponding to good cyprinid fisheries.	Biology worse than expected for unpolluted river
D Fair	Potable supply after advanced treatment. Other abstractions. Fair cyprinid fisheries. Impacted ecosystems.	A range of pollution tolerant species present
E Poor	Low grade abstraction for industry. Fish absent or sporadically present, vulnerable to pollution **. Impoverished ecosystems **	Biology restricted to pollution tolerant species
F Bad	Very polluted rivers which may cause nuisance. Severely restricted ecosystems	Biology limited to a small number of species very tolerant of pollution
*providing other standards are met **where the grade is caused by discharges of organic pollution		

11.5.9 The River Witham is sampled by the Environment Agency for chemical and biological quality upstream of the proposed bypass, at Brayford Pool. The most recent published results are for 2001, and show that the River Witham at this point is graded A for biology and B for chemistry.

11.5.10 Sincil Dyke (South Delph) is sampled by the Environment Agency for chemical and biological quality immediately upstream of the proposed bypass, at Canwick Sewage Treatment Works. The most recent results are for 2007, and show that Sincil Dyke at this location is graded A for biology and C for chemistry.

11.5.11 It is assumed that the chemical and biological quality of Canwick Fen Drain is comparable to Sincil Dyke (South Delph).

11.5.12 The North Delph is not a main river and therefore chemical and biological water quality data is not available from the Environment Agency website. However, consultation with the Environment Agency has provided fishery information which indicates that the watercourse supports a cyprinid fish population.

11.5.13 There is no water quality data available for the smaller drains and streams. For the purposes of assessment, it must be assumed that the water quality of these watercourses is comparable to the larger watercourses in the area.

Nutrient Levels in Watercourses

11.5.14 The Environment Agency also samples for nutrients (nitrates and phosphates), and grades the levels on six point scales. Excess levels of nutrients can have a significant effect on water quality. The grading is shown in Table 11.5 below.

Table 11.5: Nutrient Level Grading System

Classification	Grade limit (mg/l) average	Description
Phosphate		
1	0.02	Very low
2	0.06	Low
3	0.1	Moderate

Classification	Grade limit (mg/l) average	Description
4	0.2	High
5	1	Very high
6	>1	Excessively high
Nitrate		
1	5	Very low
2	10	Low
3	20	Moderately low
4	30	Moderate
5	40	High
6	>40	Very high

11.5.15 Environment Agency records for both the River Witham and Sincil Dyke show that Nitrate and Phosphate levels are both of Grade 5.

River Ecosystem Classification

11.5.16 The Environment Agency applies targets from its River Ecosystem (RE) Classification to each stretch of main river. The RE Classifications are as follows:

- RE1: very good quality (suitable for all fish species);
- RE2: good quality (suitable for all fish species);
- RE3: fairly good quality (suitable for high-class coarse fisheries);
- RE4: fair quality (suitable for coarse fisheries); and
- RE5: poor quality (likely to limit fish populations).

11.5.17 The two main rivers in the study area are the River Witham and South Delph. Both the River Witham at Brayford Pool and South Delph (Sincil Dyke) at Canwick STW are classified as RE3.

Fisheries

11.5.18 The River Witham is a designated Salmonid fishery from Colsterworth to Marston, and a designated Cyprinid fishery from Marston to North Hykeham, under the Freshwater Fisheries Directive (78/659/EEC). Both of these stretches are upstream of the study area. The River Witham and South Delph are important resources for anglers, with significant populations of Roach, Common Bream and Pike. Spined Loach are abundant in the River Witham. These are nationally rare species that are restricted to slow-flowing, East Midlands rivers. Consequently, these watercourses should be considered to be of high importance for fisheries.

Abstractions and Discharges

11.5.19 Within 1km of the route of the proposed bypass, there are three licensed abstractions from groundwater and five from surface water. Most of these abstractions are for agricultural and domestic uses, with just one abstraction for industrial purposes. Whilst these abstractions may be sensitive to changes in water quality, the most

sensitive types of abstractions are those for public water supply, of which there are none within 1km of the proposed bypass.

11.5.20 Within 1km of the route there are five licensed discharges. Two of these are agricultural discharges to land, one is a treated sewage effluent discharge to the South Delph, one is a storm water sewage discharge to the South Delph, and the final one is an industrial discharge to the North Delph.

Pollution Incidents to Controlled Waters

11.5.21 The Envirocheck Report shows past pollution incidents to watercourses within 1km of the proposed bypass. The information shows that the watercourses in the study area have been affected by pollution arising from industrial and agricultural activities. Category 1 incidents are the most serious, category 2 incidents are significant but less severe, and Category three incidents are minor.

11.5.22 Two category 2 (significant) incidents have been recorded in the area. One involved oil pollution to Greetwell Beck, and the other involved unknown pollutants to Sincil Dyke. As category two incidents, these would have had a significant effect on water quality and caused significant damage to the ecosystem.

11.5.23 Fourteen category 3 (minor) incidents have been recorded in the area. These were two oil pollution incidents to the River Witham, two oil pollution incidents to tributaries of the North Delph, one oil pollution incident to the North Delph, four oil pollution incidents to Greetwell Beck, one incident of organic chemical pollution to Greetwell Beck, one incident of suspended solids pollution to Greetwell Beck, two undefined pollution incidents to the River Witham, and one undefined pollution incident to Sincil Dyke.

Sensitivity of Watercourses

11.5.24 The sensitivity of a watercourse to potential impacts, measured in terms of its importance, is defined principally by reference to its RE classification. The watercourses in the study area have RE classifications of 3, and hence are of medium importance

Groundwater

Groundwater Vulnerability and Source Protection Zones

11.5.25 The hydrogeology of the area is shown on the Environment Agency Groundwater Vulnerability Map, reproduced as Figure 11.2

11.5.26 The Lincolnshire Limestone is classified as a major aquifer. The Northampton Sand and Ironstone is classified as a minor aquifer. The Upper Lias Clay is classified as a non aquifer. As the Lincolnshire Limestone is part of a succession of aquifers and non aquifers, there is a complex relationship between groundwater within the aquifers and surface waters. Hydrogeology is discussed in greater detail in Chapter 12.

11.5.27 Environment Agency records show that the study area lies within the outer zone and total catchment of a source protection zone, as shown on Figure 11.3.

Landfill and Contamination

11.5.28 Landfill sites have the potential to cause to water pollution, particularly if leachate is able to escape from an un-lined landfill site and into the groundwater. Twelve landfill sites are recorded within the study area. Two of these are active landfill sites – Smith Clayton Forge and Canwick Sewage Treatment Works – and the remainder are

historic. None of the landfill sites are within the footprint of the proposed bypass. More information is provided in Chapter 12.

Sensitivity of Groundwater

11.5.29 The groundwater in the study area is considered to be of high importance.

Flood Risk

11.5.30 The Environment Agency's Flood Zone maps show that the proposed bypass crosses the floodplain of the River Witham.

11.5.31 Fluvial flooding is currently well managed in the River Witham catchment, meaning there is a limited number of people and properties at flood risk. Consultation with the Environment Agency indicated that the "National Flood and Coastal Defence Database (NFCDD) asset inspection report show that the raised defences are in good condition. The fluvial defences protecting this site consist of earth embankments and upstream flood storage reservoirs. They are in good condition and provide protection against a flood event with a 1% chance of occurring in any year (1 in 100 year)".

11.5.32 However, when taking climate change into account, flood defences might provide less protection. The main findings of the Environment Agency broad scale modelling in the River Witham catchment area are: very little flooding expected for the 1 in 10 year event (no flooding was predicted for this event in current conditions) and an increase in the 1 in 100 year flood extent.

Sensitivity of Flood Plain

11.5.33 The flood plain in the study area is considered to be of high importance.

11.6 PREDICTION OF IMPACTS DURING THE CONSTRUCTION PERIOD WITHOUT MITIGATION

Impacts on Surface Water Receptors

11.6.1 Highway construction works have the potential to cause accidental damage to surrounding water bodies, as a result of spills, leaks and sedimentation.

11.6.2 Water quality in rivers and streams can be damaged by sedimentation from construction sites. In particular, suspended solids found in construction site run-off can lower the chemical or biological water quality of the river and have adverse effects on in-stream flora and fauna. The effects of sedimentation can be felt at various locations along a river. Larger particles would be deposited on the stream bed closer to the source of pollution than would finer particles, which are likely to travel further and affect distant, downstream sections.

11.6.3 Run-off from construction sites may also contain toxic elements, which can have adverse effects on in-stream flora and fauna. Such toxic elements may build up on the stream bed and remain *in situ* for some time before they are degraded or disturbed.

11.6.4 Leaks or spills of fuels (hydrocarbons), oils and chemicals can potentially enter watercourses and cause acute pollution incidents. For example, oils can cause thin films over surface water and can bind to sediments, strata, flora and fauna. Even at low concentrations, fuel and chemical spills and leaks can make the water toxic and therefore unfit for aquatic life and/or human consumption. Cement spills can decrease the pH of watercourses, which can adversely affect aquatic flora and fauna.

11.6.5 The disturbance of contaminated land may cause contaminants to be mobilised. If they reach surface watercourses, they may have adverse effects on in-stream flora

and fauna. Potential sources of contamination are limited, as there has been limited industrial land use along the route of the proposed bypass. More details are provided in Chapter 12.

11.6.6 The effects of spillage events associated with construction events are likely to be temporary. By definition, any such occurrence would be accidental, and its precise nature and scale could not be precisely predicted. It is therefore not possible to assess accurately the significance of impacts.

Impacts on Groundwater

11.6.7 The nature of construction works and the plant used in such works mean that there is always the potential for spills of fuel, oil or other potentially polluting materials. Such spilt materials can seep into underlying groundwater, particularly in areas where a 'pathway' has been created by disturbance of the ground.

11.6.8 Impacts on groundwater can last for a much longer period than those on surface waters, due to the slow movement of water and slow rates of diffusion. Any such impact could cause long-term adverse effects on groundwater abstractions.

11.6.9 During construction and operational phases of the scheme, there is the potential for changes to occur to groundwater flow, due to the interception of natural pathways. Hard surfacing can present a barrier to rainwater reaching underground strata, preventing recharge of the underlying aquifers. Foundations taken down into natural strata can also influence groundwater flow regimes.

11.6.10 The cuttings required for the proposed bypass have been assessed as having a negligible impact on groundwater flows.

11.6.11 The area of impermeable carriageway would intercept rainwater and prevent it from reaching groundwater. However, the volumes involved mean that this impact has been assessed as insignificant.

11.6.12 None of the structures to be built as part of the bypass scheme would have a significant portion of their structure below the water table. Therefore, the risk of changes to groundwater levels has been assessed as negligible.

Impacts on Flood Risk During Construction

11.6.13 All Impacts on flood risk would arise from the construction of the bypass, and would continue during its operation. There would be no additional impacts on flood risk that would begin during the operational phase.

11.6.14 The impacts identified through the flood risk assessment are as follows:

- There is no increase on fluvial flood risk from the river system with the bypass;
- The peak water levels in the River Witham and South Delph vary between 4.7 to 4.9m AOD for the 100 year event with climate change. The deck level of the bypass bridge is over 9.0m AOD therefore the deck level would not constrict the flow;
- Minor compensation event storage may be required on the floodplain totalling 1110 m^3;
- The breach analysis has been completed to the EA requirements on flooding to examine the impact of the development proposals on the flooding experienced in the unlikely event of flood embankment failure. The breach locations assumed are just upstream of the proposed bypass location with peak velocities of 6.4 m/s and 3.9m/s occur at the North Breach location and the South Breach location respectively. The results also illustrated that flooding does not occur in the urban areas, only in the rural floodplain; and

11.7 PREDICTION OF IMPACTS DURING THE OPERATION OF THE PROPOSED BYPASS WITHOUT MITIGATION

Proposed Highway Drainage

11.7.1 Highway drainage systems are designed to remove surface run-off from the carriageway as rapidly and as freely as possible, leading to short, shock run-off events. This means that a significant volume of run-off water can be removed rapidly, carrying with it any contaminants that have accumulated on the road surface between rainfall events. These contaminants can include:

- Fuel and other oil deposits that have leaded onto the road surface;
- Hydrocarbons from exhaust deposits;
- Lead, copper, zinc and cadmium deposits from exhaust emissions and tyre wear;
- Synthetic rubber deposits from tyre wear;
- Chemicals used in windscreen washes such as detergents or de-icer;
- De-icing agents such as salt, but also potentially including trace amounts of impurities such as cyanide, metals and clays;
- Herbicides from road-side verge maintenance; and
- Chemicals or oils that result from spillage and leakage after traffic accidents.

11.7.2 The rapid introduction of large volumes of run-off containing such pollutants can have adverse effects on the receiving waters, in terms of their capacity, morphology and water quality.

11.7.3 The quantity of water forming the run-off is dependent largely on the area of impermeable surfaces on the highway. The quantity of contaminants depends both on the area of impermeable surface and on the volume and composition of the traffic using the road. The degree to which the contaminants are diluted by water can therefore vary, influenced by both the volume of traffic and the amount of water in the receiving watercourse.

11.7.4 Run-off from the LEB would be drained to a number of attenuation ponds, before being discharged to surface watercourses. The receiving watercourses would be the North Delph, Canwick Fen Drain and a tributary of Branston Brook. There would be no discharges to groundwater. The road areas draining to each point are shown on Figure 11.4.

Hydrology and Surface Water Quality

11.7.5 The LEB would involve the creation of approximately 25 hectares of impermeable surface area.

Pollution Risk from Routine Run-off

11.7.6 The pollution impact from routine run-off was assessed using Method A of Volume 11, Section 3, Part 10 of DMRB. The results showed that the dilution of pollutants in the run-off from the new road may be lower than is acceptable for a RE3 river. As a result, detailed calculations were carried out using Method B from Volume 11, Section 3, Part 10 of DMRB.

11.7.7 The results of the Method B assessment showed that concentrations of copper and zinc in two of the receiving watercourses, North Delph and the tributary of Branston Brook, would be within the relevant Environmental Quality Standards. In the third receiving watercourse, Canwick Fen Drain, the calculated concentration of copper downstream of the proposed discharge would be just above the required quality

standard, at 114 µg/l compared with an EQS of 112µg/l, meaning that further mitigation measures would be required.

11.7.8 The calculations are shown in Appendix 11A.

Pollution Risk from Spillages

11.7.9 A spillage risk assessment has been undertaken for the proposed LEB. The results have been compared with the threshold of a 1% probability of a pollution incident occurring in any given year (or a 1 in 100 year return period). The spillage risks calculated were 0.05% (once in 2,228 years) for the North Delph, 0.02% (once in 5,136 years) for Canwick Fen Drain, and 0.04% (once in 2,898 years) for the tributary of Branston Brook. This means that the risks would be well within acceptable limits and no additional mitigation measures would be required.

Groundwater

11.7.10 The Controlled Waters Risk Assessment (Appendix 11B) shows that the impacts on groundwater flow, caused by the cuttings required for the scheme, would be negligible.

11.7.11 The Controlled Waters Risk Assessment shows that the impact of the scheme on the volume of groundwater resources in the Lincolnshire Limestone would not be significant.

11.7.12 The Controlled Waters Risk Assessment shows that the risk of structures within the proposed scheme having an impact on groundwater levels is negligible.

11.7.13 The Controlled Waters Risk Assessment states that, without mitigation, the use of a SUDS drainage system would have significant impacts on the quality of the groundwater resource. Mitigation measures would therefore be required in the form of impermeable linings for all the primary drainage systems and SUDS.

11.7.14 The Controlled Waters Risk Assessment found that discharging the highways run-off from the scheme to groundwater via soakaways would be acceptable in terms of water quality, provided that mitigation was put in place and that the modelled conditions matched the actual conditions. However, conditions on site showed that the unsaturated zone was insufficient, and that discharges to groundwater should therefore not be used. For this reason, the scheme has been designed to discharge all run-off from the new road to surface waters.

Flood Risk

11.7.15 The impacts on flood risk would be as described for the construction phase above. No additional impacts would arise as a result of the bypass being open to traffic.

11.8 MITIGATION

Mitigation during Construction

11.8.1 Appropriate measures to control the risk of pollution during construction works would be implemented through a Construction Environmental Management Plan. In general, contractors would be expected to operate in accordance with Environment Agency Pollution Prevention Guidelines (PPGs). PPGs of particular relevance to the proposed bypass include:

- PPG2: Above ground oil storage tanks;
- PPG5: Works and maintenance in or near water;
- PPG6: Working at construction and demolition sites;

- PPG18: Managing fire water and major spillages;
- PPG21: Pollution incident response planning;
- PPG22: Dealing with spillages on highways; and
- PPG26: Storage and handling of drums and intermediate bulk containers.

11.8.2 Site drainage would be programmed early in the construction sequence for the scheme, to ensure that any run-off from the site could be controlled.

11.8.3 In order to mitigate potential impacts from the use and storage of cement, standard precautions would be implemented as outlined in PPG5 and PPG6. The use and storage of cement close to any watercourse or drain would be carefully controlled to minimise the risk of any material entering the water.

11.8.4 All appropriate measures would be taken to avoid discharge of any substance into controlled waters as set out in PPG5. This would prevent a linkage between contaminants and ground and surface water. Any contaminated waters produced (for example from dewatering and excavations) would require off-site disposal at an appropriate facility in accordance with the Environmental Permitting (England and Wales) Regulations, 2007.

11.8.5 All fuel, oil and chemicals would be stored in accordance with the requirements of the Control of Pollution (Oil Storage) Regulations, 2001. Construction plant would be refuelled in a designated area with an impermeable surface, away from drains and watercourses. An emergency spill plan would be formulated and spill kits would be placed on site at appropriate locations.

11.8.6 A site waste management plan would be developed for the construction site in order to minimise waste and to maximise re-use and recycling. Any construction materials to be disposed of would be removed from site by registered waste carriers, and taken to a regulated facility.

11.8.7 In terms of flood risk during construction, temporary works must be arranged so that they do not adversely affect flood conveyance or flood water levels on the River Witham and South Delph. The contractor would need an agreement with the Environment Agency following best practice including containing sediment run-off and temporary bunding along the works.

11.8.8 The proposed road surface water drainage design for the scheme is to be designed so that there is no increase in flooding in a 100 year design storm plus 30% increase in rainfall intensity for a possible climate change event. The surface water scheme reduces the potential flood risk since the proposed bypass catchment is effectively removed from catchment run-off since it discharges into attenuation ponds which have a reduced and controlled outflow.

11.8.9 The five watercourses that are to be culverted as part of the LEB scheme are to be designed with a sufficient capacity to pass the 1 in 100 year design event with climate change flows.

11.8.10 The risk of embankment breach of the River Witham or South Delph with scheme is in the same order of magnitude as the existing condition, therefore as long as the embankment is protected from the anticipated velocities, the residual flood risk is minimal.

Mitigation during Operation

11.8.11 Attenuation ponds have been included in the drainage design in order to capture road run-off, and then to discharge the water to the receiving surface water bodies at

the greenfield run-off rate, meaning that there would be no increase in discharge rates as a result of the scheme.

11.8.12 The attenuation ponds would retain, and to a certain extent treat, sediments and pollutants associated with the sediment fraction of drainage run-off. In particular, ponds are particularly effective at allowing metals present as contaminants in the run-off water to settle out before the water is released. In addition, reed beds (wetlands) would be provided to filter and treat the water flowing into each of the attenuation ponds.

11.8.13 To prevent contaminants in the highway drainage migrating downwards into the groundwater all the Primary Drainage Systems and SUDS would be lined with impermeable materials.

11.8.14 Two areas of flood compensation would be provided. The largest of these would have a capacity of 1044m^3, and would be situated on the southern floodplain, approximately 750 metres upstream of the bypass. The second flood compensation area would have a capacity of 66m^3, and would be situated on the southern floodplain, immediately upstream of the bypass.

11.9 RESIDUAL IMPACTS

11.9.1 Table 11.7 provides a summary of the impact assessment.

Residual Construction Impacts

11.9.2 The implementation of the Construction Environmental Management Plan and adherence to the Environment Agency's Pollution Prevention Guidance would neutralise the risk of pollution to groundwater and surface water as a result of sedimentation, leaks and spills during construction.

11.9.3 Early construction of the drainage system would mean that flood risk and water quality would be managed to meet the requirements of the Environment Agency.

Residual Operational Impacts

11.9.4 With mitigation in place, the impacts of routine run-off and spillage risk on surface water quality would be reduced to slight adverse.

11.9.5 The residual impact on groundwater is assessed as a Neutral impact.

11.9.6 The flood risk assessment found that the proposed bypass would not increase flood risk in the area.

Table 11.7: Water Environment Impact Assessment Summary Table

Description of Study Area / Summary of Potential Impacts	Feature	Attributes / Services	Quality	Importance	Magnitude of Impact before Mitigation	Magnitude of Impact after Mitigation	Residual Impact
Construction Phase							
Impacts on surface waters and abstractions as a result of construction activities, such as risk of spillage and sedimentation from construction run-off	North Delph	Water quality, aesthetics, conveyance of flows	River Ecosystem Class RE3 (based on River Witham and South Delph)	Medium	Unknown	Negligible	Neutral
	Canwick Fen Drain	Water quality, aesthetics, conveyance of flows	River Ecosystem Class RE3 (based on River Witham and South Delph)	Medium	Unknown	Negligible	Neutral
	Tributary of Branston Brook	Water quality, aesthetics, conveyance of flows, abstractions for agricultural irrigation	River Ecosystem Class RE3 (based on River Witham and South Delph)	Medium	Unknown	Negligible	Neutral
Impacts on groundwater and abstractions as a result of construction activities such as risk of spillage and sedimentation from construction run-off	Major and Minor Aquifers	Base flows to watercourses and abstractions for agricultural, domestic and industrial use, and for public water supply	Outer zone and total catchment of groundwater source protection zone	High	Moderate	Negligible	Neutral
Increased risk of flooding associated with new development within the floodplain.	River Witham Floodplain	Flood storage	Flood plain and flood defences	High	Minor	Negligible	Neutral

Description of Study Area / Summary of Potential Impacts	Feature	Attributes / Services	Quality	Importance	Magnitude of Impact before Mitigation	Magnitude of Impact after Mitigation	Residual Impact
Operational Phase							
Impacts on surface waters and abstractions as a result of the operation of the bypass, such as through accidental spillages	North Delph	Water quality, aesthetics, conveyance of flows	River Ecosystem Class RE3 (based on River Witham and South Delph)	Medium	Moderate	Minor	Slight Adverse
	Canwick Fen Drain	Water quality, aesthetics, conveyance of flows	River Ecosystem Class RE3 (based on River Witham and South Delph)	Medium	Moderate	Minor	Slight Adverse
	Tributary of Branston Brook	Water quality, aesthetics, conveyance of flows, abstractions for agricultural irrigation	River Ecosystem Class RE3 (based on River Witham and South Delph)	Medium	Moderate	Minor	Slight Adverse
Impacts on groundwater and abstractions as a result of the operation of the bypass, such as through accidental spillages	Major and Minor Aquifers	Base flows to watercourses and abstractions for agricultural, domestic and industrial use, and for public water supply	Outer zone and total catchment of groundwater source protection zone	High	Negligible	Negligible	Neutral
Increased risk of flooding associated with new development within the floodplain.	River Witham Floodplain	Flood storage	Flood plain and flood defences	High	Minor	Negligible	Neutral

12 SOILS AND GEOLOGY

12.1 INTRODUCTION

Scope of Topic

12.1.1 Soils and geology are an important factor in determining the environmental character and quality of any given geographical area. Underlying rocks are a key determinant of landform, while the physical and chemical properties of the rocks and the overlying soils influence the type and variety of vegetation that will grow, agricultural quality, flood risk and water storage capacity. In some cases historic land uses have resulted in changes to the soils and geology, for instance by introducing contaminants or in old mining areas.

12.1.2 Highway construction can have a significant effect on soil and geological resources, while the nature and condition of the soils and the underlying rocks can be a key constraint on scheme design.

12.1.3 The purpose of this section is to identify the approach to be adopted in assessing the impact of the scheme on the soils and geology of the study area. A summary of the extent of available data is given and gaps in the baseline information are highlighted. A brief summary of the potential receptors and significant impacts on soil and geology are given. Details of the scope and method of assessment are provided and possible mitigation methods suggested. Residual impacts (impacts remaining after implementation of mitigation measures) are assessed.

Legislative Background

12.1.4 The Mines and Quarries Act (1954) (as amended) sets out requirements relating to abandoned and disused mines and quarries. PPG14 explains briefly the effects of land instability on development and land use. The responsibilities of the various parties to any development are considered and the need for instability to be taken into account in the planning process is emphasised.

12.1.5 With particular reference to City of Lincoln Local Plan, policy 44A (Sites of Special Scientific Interest and Other Critical Natural Assets) notes that 'the Local Planning Authority will not grant planning permission for any development which will diminish, or in any other way adversely affect, the interest and importance of a Site of Special Scientific Interest (SSSI)'.

12.2 APPROACH AND METHODS

Data Sources

12.2.1 The description of baseline conditions draws on information gained from the following sources.

12.2.2 The following geotechnical and geo environmental data have been obtained:

- Landmark Information Group, Envirocheck Report (2007);
- National Rivers Authority Groundwater Vulnerability Map, Sheet 19, Lincolnshire, 1:100 000 (1995);
- Soil Survey of England and Wales, Sheet 3, 1:250 000 (1983);
- The Geology of Lincolnshire, Swinnerton. H and Kent, P. (1981);
- British Geological Survey, Sheet 114, Lincoln, 1:50 000 (1973);

- Department of Scientific and Industrial Research, Geological Survey of Great Britain. The Mesozoic Ironstones of England, The Northampton Sand Ironstone Stratigraphy, Structure and Reserves. (1950); and
- Site Inspections by Jacobs staff.

12.2.3 Previous Geotechnical and Hydrogeological studies:

- Jacobs. Lincoln Eastern Bypass Geotechnical Report. In progress. (2009);
- Jacobs. Supplementary Interpretative Geotechnical Report for the Proposed Lincoln Eastern Bypass – North East Quadrant. (2008);
- Jacobs. Greetwell Link Road. Geotechnical Report. (2008);
- Lincs Laboratory. Factual Ground Investigation Report for Proposed Alignments A & B Lincoln Eastern Bypass. (2006);
- Jacobs Babtie (now Jacobs). Lincoln Eastern Bypass Alternative Routes for Jesus College. Geotechnical Report. (2006);
- Babtie Group (now Jacobs). Interpretative Report on the Supplementary Ground Investigation for the Proposed Lincoln Eastern Bypass. (2003);
- Babtie Group (now Jacobs). Groundwater Risk Assessment Report Lincoln Eastern Bypass. (2003);
- Babtie Group (now Jacobs). Lincoln Eastern Bypass -Preliminary Sources Study Report (PSSR). (2002);
- Lincs Laboratory. Report on the Ground Investigation for the Proposed Eastern Bypass, Volume 1 – Factual Report and Volume 2- Interpretative Report. (1998); and
- Roger Bowles in association with JMP Consultants Ltd. Geotechnical Desk Study. (1992).

Impact Assessment

12.2.4 Impacts and soil and geology are not certain to occur. Such impacts can therefore be identified through a risk assessment process, which defines their likelihood of occurrence.

12.2.5 Currently there is no guidance on the assessment of predicted impacts in relation to soils and geology. A method has therefore been devised to assess the significance of impacts. In line with the generic framework set out in Chapter 4, this method is based on the principle that the significance of impact is a function of the sensitivity of the receptor and the magnitude (i.e. scale) of the impact.

12.2.6 For the purposes of this assessment, the sensitivity of receptors to geological (geotechnical and earthworks) impacts within the study area has been defined according to the criteria summarised in Table 12.1. Note that further information on sensitivity of environmental receptors relating to groundwater and surface water can be found in Chapter 11 (Road Drainage and the Water Environment).

Table 12.1: Sensitivity Criteria

Sensitivity	Description	Examples of Receptors
Very High	Very high sensitivity receptors, including areas of high population density, major aquifers and designated areas considered to be of international interest.	Significant residential / industrial development. Strategic sites e.g. hospital, park. Public water supply abstractions. Surface Water: EC Designated Salmonid/Cyprinid fishery RQO River Ecosystem Class RE1. Site protected under EU or UK wildlife legislation (SAC, SPA, SSSI, Ramsar site). Groundwater: Major aquifer providing a regionally important resource or supporting site protected under wildlife legislation. SPZ I High quality agricultural land.
High	High sensitivity receptors, including areas of high population density, major aquifers and designated areas considered to be of national interest.	Sites of Special Scientific Interest (SSSIs). Significant transport links e.g. railway, airport. Significant utilities. Surface Water: RQO River Ecosystem Class RE2. Major Cyprinid fishery. Species protected under EU or UK wildlife legislation. Groundwater: Major aquifer providing a locally important resource or supporting river ecosystem. SPZ II. High quality agricultural land.
Medium	Medium sensitivity receptors, including areas of moderate population density, major aquifers and designated areas considered to be of regional interest.	Regionally Important Geological Sites (RIGS). Surface Water: RQO River Ecosystem Class RE3 or RE4 . Groundwater: Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ III. Medium quality agricultural land.
Low	Receptors not currently protected but that may require specific protection in the future.	Minor residential / industrial development . Surface Water: RQO River Ecosystem Class RE5. Groundwater: Non-aquifer. Low quality agricultural land.
Negligible	Receptors not currently protected and unlikely to require specific protection in the future.	No residential / industrial development. Low quality agricultural land.

12.2.7 The magnitude of predicted impacts on soil and geology has been assessed on a five-point scale, in accordance with the definitions summarised in Table 12.2.

Table 12.2: Magnitude Criteria

Magnitude	Description	Potential Impacts
Major	Where there would be partial (greater than 50%) or total loss of a receptor, or where there would be complete severance of a site such as to affect the value of the site, e.g. where contamination would be spread across 50% or greater of the site, or where a significant proportion of contaminated material would be remediated / removed.	• Disturbance of groundwater flow paths • Disturbance of potentially contaminated land • Remobilisation of residual pollutants • Creation of new pollution pathways • Soil deterioration • Soil consolidation • Creation of dust and airborne • contaminants • Earthworks balance • Spillages • Contamination from road run-off • Siltation of watercourses • Mineral extraction or sterilisation • Land slips
Moderate	Where there would be loss of part (between approximately 15% to 50%) of a receptor, major severance, major effects to the setting, or disturbance such that the value of the receptor would be affected, but not to a major degree, eg where contamination would be spread across 15% to 50% or greater of the site, or where a moderate proportion of contaminated material would be remediated / removed.	
Minor	Where there would be a minimal effect on a receptor (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the receptor would not be affected, eg where contamination would be spread across up to 15% or less of the site or where a minor proportion of contaminated material would be remediated / removed.	
Negligible	Very slight change from baseline condition.	
No Change	Change hardly discernible, approximating to 'no change' conditions.	

12.2.8 Assessment of risk in relation to geotechnics and earthworks is covered by the geotechnical reporting, investigation, assessment and certification procedures carried out in accordance with HD22/08. The risk assessment will generally determine relevant aspects of the engineering design. In most cases, these engineering design solutions represent the relevant mitigation measures (e.g. requirements for treatment of contaminated land or treatment of voiding caused by mineral extraction).

12.2.9 Additionally, there is much overlap, particularly in terms of potentially contaminated land, with other disciplines. For example, contaminated material has the potential to leach (soak) into surface water or groundwater, or to become airborne as dust particles.

12.2.10 Following the assessment of the magnitude of an impact, taking account of any appropriate risk assessment as discussed above, the significance of impacts are determined by the use of a matrix (Table 4.1), with the magnitude of impact on one axis and the sensitivity of the receptor on the other.

12.3 BASELINE CONDITIONS

Geology and Pedology

12.3.1 The geological survey sheet covering the area, included as Figure 12.1, shows Jurassic strata to underlie the entire site. Table 12.3 summarises the solid succession in descending order from youngest to oldest.

Table 12.3: Solid Geology

	Horizon Name and Description (descending order)
Jurassic	**Blisworth Clay** – Lower horizons consist of black or green clays with some oyster shells, whilst upper horizons are dark blue clays and shales.
	Great Oolite Limestone – Buff coloured and well bedded and of moderate hardness. Usually laminated with marls and clays. Variation to be expected. Rubbly when weathered.
	Upper Estuarine Beds – Clays with thin limestones in upper parts.
	Upper Lincolnshire Limestone - Oolitic limestone with clays. In the partially weathered state it comprises limestone boulders in a matrix of silty sand with limestone fragments and a dark brown sandy clay. Reddish brown silty clayey sand when completely weathered.
	Crossi Beds - Oolitic limestone with clays.
	Lower Lincolnshire Limestone Very thinly bedded closely jointed strong limestone with some thin bands of clay. In the partially weathered state it comprises limestone boulders in a matrix of silty sand with limestone fragments and a dark brown sandy clay. Reddish brown silty clayey sand when completely weathered.
	Northampton Sand and Ironstone -Ferruginous sandstones and limestones.
	Lias Clay In the lower part: black shales with lenticular nodules of mudstone, bands of shelly material and thin limestones with fish and insect remains. In the upper part: blue clays.

12.3.2 North of the Lincoln to Market Rasen railway line drift deposits are absent and the route passes over surface outcrops representing the full succession, with the exception of Lias Clay. In this area the strata are cross cut by a number of faults which has created a complex distribution of strata at the surface.

12.3.3 Drift deposits associated with the River Witham are present in the central part of the site between the Lincoln to Market Rasen railway line and Washingborough Road. These deposits comprise river terrace sands and gravels and alluvial clays and peat.

12.3.4 South of Washingborough Road the route crosses outcrops of Lias Clay, Northampton Sands and Ironstone and Lincolnshire Limestone. In the vicinity of the route, the strata are essentially horizontal, or with a very gentle dip of a few degrees to the east. Generally, drift deposits are absent in this section of the route although limited extents of alluvium may be present associated with Branston Brook.

12.3.5 The Soil Survey map identifies several soil types and these are:

- Elmton 1 soils: described as shallow, well drained, brashy, calcareous, fine loamy soils over limestone. Some similar deeper soils and some non-calcareous and calcareous, clayey soils have also been noted. These soils are derived from Jurassic Limestone and cover the majority of the route, outside the river valley;
- Blackwood soils: these are described as deep, permeable, sandy and coarse loamy soils derived from glacio fluvial drift deposits. Groundwater in these soils is

commonly controlled by ditches. These soils are present between Lincoln to Market Rasen railway line and Washingborough Road; and

- Wickham 2 soils: these soils are derived from Jurassic clays and mudstones and are described as slowly permeable, seasonally water logged fine loamy, fine silty and clayey soils. These soils are present along the scarp face of Lincoln Edge south of Washingborough Road.

Designated Sites

12.3.6 Greetwell Quarry Site of Special Scientific Interest (SSSI) is located just north of Greetwell Road as shown on Figure 12.2. Formerly a limestone quarry, the quarry is classified as a SSSI due to the Lincolnshire Limestone exposed in the quarry face. The designation relates to the presence of rare ammonites (a type of fossil) in the Lincolnshire Limestone and a thin attenuated sequence of Lower Lincolnshire Limestone present in the quarry face. This has geological importance as it has yielded fossils enabling the correlation of the Jurassic limestones of the region with those in other parts of the country – notably the south of England.

12.3.7 During the site walkover, the attenuated band of limestone was not visible in the proposed location of the route as it was masked by spoil (quarry waste material), possibly placed as part of earlier restoration works. However, the band is visible in the outcrop supporting the pylon.

Hydrology and Hydrogeology

12.3.8 The River Witham and its tributaries drain the Lias and Upper Jurassic plain. The river rises near South Witham and flows northwards constrained by Lincoln Edge to Lincoln, from where it flows eastwards through the Lincoln Gap and then discharges into The Wash. Springs rise along Lincoln Edge and discharge into the river system. Artificial drainage works and earth river embankments are present in the lower areas.

12.3.9 Greetwell Beck rises to the north of Greetwell Link Road and flows directly south to join the River Witham some 300m to the south.

12.3.10 Lincolnshire Limestone is classified as a major aquifer. Major aquifers are regionally important and support large potable water supplies.

12.3.11 Northampton Sand and Ironstone and Great Oolitic Limestone are classified as a minor aquifer. Minor aquifers are usually only of local importance for supporting abstractions or providing base flow to rivers.

12.3.12 The major and minor aquifers are generally overlain by soils of high leaching potential. Due to their shallow nature and susceptibility to by pass flow, these soils have little ability to attenuate (decrease in quantity or strength) pollutants.

12.3.13 Lias Clay, Upper Estuarine Beds and Blisworth Clay are classified as a non aquifer. Non aquifers usually do not support any abstractions or provide significant base flow to rivers.

Mining and Mineral Extraction

12.3.14 Ironstone mining, both by underground and surface techniques, is known to have occurred in the scheme area, notably around Greetwell Road. Available records show underground extraction by the pillar and stall technique to have taken place around Greetwell Hollow and in the area to the west. Subsequently, surface mining has extracted the remaining pillars to the north of Greetwell Road and to the west of Greetwell Beck leaving a void in the ground (see section on designated sites). This void has been backfilled in part with waste (see section on potential sources of contamination).

12.3.15 Historical maps from 1887 show the presence of two old quarries situated south of the sewage works (on Washingborough Road) and immediately north of Wheeler Lane. An additional quarry is located adjacent to Branston Heath Farm and a stone pit immediately south of Heighington Road to the west of the route.

12.3.16 According to the Law Society's Guidance Notes and Directory for Coal Mining Searches (1998 sections 3.3) the scheme area is not affected by coal mining activity.

Potential Sources of Contamination

12.3.17 Greetwell Landfill is located on the south side of Greetwell Road to the east of Allenby Industrial Estate. The landfill is a backfilled former ironstone quarry (see section on mining and mineral extraction). Ground investigations encountered evidence of tipped material (brick rubble, plastic, metal waste (fridge)) and diesel odours within the landfill area.

12.3.18 Elsewhere, available information indicates that there has been limited industrial land use within the route corridor. The potential contamination sources are therefore limited. They are summarised below:

12.3.19 At Sheep Wash Grange there has been a sheep wash in existence since 1889. There is a possibility of the presence of organophosphate and synthetic pyrethroids from this use.

12.3.20 Canwick Sewage Works lies to the west of the route at Canwick and has been active since 1898. Typical contaminants associated with sewage works include heavy metals, oils and petroleum hydrocarbons, chlorinated hydrocarbons, polychlorinated biphenyls (PCB's), nitrates and sulphates.

12.3.21 There is the potential for contamination associated with general agricultural use. Potential contaminants include heavy metals from the application of sewage sludge; cadmium and fluorides from inorganic fertilizers; dredged material from drainage ditches; oil spills and hydrocarbons from farm machinery and vehicles and small scale historic burial or deposition of materials on farmland.

12.3.22 There may also be a potential for contamination of near surface soils from aerial deposition of contaminants from roads, quarries and other nearby industrial sources.

12.3.23 A large area to the south of the River Witham in the Canwick area is classed as Nitrate sensitive. This is not considered a constraint on the scheme but imported material should be carefully selected to ensure there would be no nitrate contamination of the underlying aquifers.

Earthworks Balance

12.3.24 The proposed scheme requires the excavation of significant quantities of material, particularly in the deep cutting between Washingborough Road and Heighington Road. It is anticipated that those materials removed from the cuttings would be used in the construction of road embankments elsewhere on the scheme, particularly the high embankments required across the River Witham Valley.

Landslip Potential

12.3.25 There are no landslips shown on the Ordnance Survey or geological maps. However, the local geology guide reports that the Lias Clays forming the steeper slopes of Lincoln Edge are commonly covered with materials slipped from above. Exploratory holes sunk during the various phases of investigation encountered Head deposits (slipped materials) along the scarp face to the south of Washingborough Road.

Baseline Sensitivity

12.3.26 Sensitivity in relation to the items summarised in Table 12.1 includes significant overlap with other disciplines.

12.3.27 High or very high sensitivity receptors identified on the site include:

- Greetwell Quarry Site of Special Scientific Interest.

12.3.28 Medium sensitivity receptors include:

- Major aquifer;
- Agricultural land to the east and west of the route; and
- Surface watercourses.

12.3.29 Low to negligible sensitivity receptors include:

- Site geomorphology; and
- Minor aquifer.

12.4 IMPACT PREDICTION

12.4.1 Impacts on soils and geology are likely to be most significant during the construction phase. Construction and operational phase impacts have not been separated out for this assessment but have been considered together. Where a specific construction or operational impact is identified further details are given in the text. This section only considers the predicted impacts of the scheme, details of mitigation measures are covered in section 12.5.

Designated Sites

12.4.2 Construction of the scheme would impact significantly on the Site of Special Scientific Interest at Greetwell Quarry. Whilst the scheme would not destroy the limestone rocks, it would obscure them from view by placing an earth embankment across the quarry face. The magnitude of this impact is considered to be moderate as less than 50% of the designated site would be obscured by the proposed works. Therefore the resultant unmitigated impact is considered to be moderate or large.

Geology and Geomorphology

12.4.3 With the exception of the designated site noted above, the impact on the geology and geomorphology is considered to be negligible and the resulting impact neutral.

Disturbance of Landfill Sites and Potentially Contaminated Land

12.4.4 During construction, there is the potential to encounter contaminated material within in the ground. Construction activities have the potential to cause the following effects:

- Disturb potentially contaminated land;
- Remobilise residual pollutants (i.e. pollutants that are already present, but stable and inactive in their present condition);
- Create new pollution pathways (i.e. routes by which pollutants can reach environmental receptors that are vulnerable to their effects); and
- Remediate areas of existing contamination (i.e. a beneficial effect).

12.4.5 The ground investigation for this scheme has been designed to target potential sources of contamination identified from current and historical land uses. Therefore, the likelihood of encountering unknown contaminated material in the construction phase is considered low. However, there is the potential that ground contamination

not identified at the investigation stage could be encountered during the construction works.

12.4.6 Construction work can create new pathways for contaminants to migrate to sensitive receptors. For example, engineering options such as excavations, piling for bridge foundations and ground improvements all have the potential to create potential pollution pathways to groundwater and surface water.

12.4.7 Any potentially contaminated material identified during the course of the construction works would be assessed and, if appropriate, included in the works. Contaminated material not suitable for inclusion in the works should be appropriately disposed of off-site. As such, the construction works may have a beneficial impact in relation to potentially contaminated ground.

12.4.8 Operations during construction would lead to disturbance and exposure of the soils. This can increase erosion susceptibility. Increased run-off and erosion could result in increased sediment load transportation to surface watercourses. This could impact on the biological, physical and chemical characteristics of the soils.

12.4.9 The use of plant, equipment and machinery would require maintenance and refuelling. Potential contaminative substances (e.g. hydrocarbons and oils) would be required for operation. Accidental spillage of these substances, during storage or use, may lead to contamination of soils and watercourses.

12.4.10 The magnitude of any impact from potentially contaminated land and landfill sites has the potential to be moderate or major and the resulting unmitigated significance moderate or large adverse.

Mineral Extraction

12.4.11 Records indicate the presence of underground ironstone workings beneath the site along Greetwell Road. Investigations are on going as to the nature and extent of these workings. Treatment of these workings may be necessary to prevent collapse of the workings.

12.4.12 The magnitude of any impact from mineworkings is considered to be moderate and the resultant unmitigated impact is considered to be moderate adverse.

Earthworks Balance

12.4.13 There is an excess of fill material on the scheme, i.e. more material would be excavated than would be placed in embankments. Consideration should be given to the construction of bunds or use of shallower slope angles to allow as much use of material on site and minimise the need for off site disposal.

12.4.14 Disposal of material has the impact of creating excessive transport requirements for the scheme, including increased vehicle use and associated impact on the local highway network. The effects associated with the off site disposal of material could have an impact on the broader area outside the site and may impact on receptors other than those identified in section 12.3.

Changes to Surface and Groundwater

12.4.15 During the construction and operational phases there is the potential for contamination and sediment to reach surface water and groundwater receptors. Additionally, construction methods may influence the flow of groundwater. Construction operations and operational activities have the potential to:

- Disturb groundwater flow paths e.g. through excavations or the use of drainage measures or closely spaced piles;

- Cause disruption of water flow to existing springs, wetlands and ponds;
- Cause siltation of surface watercourses e.g. through run-off from exposed soils; and
- Cause potential contamination of water resources due to spillages during construction or road run-off during operation.

12.4.16 Further consideration of these impacts is given in Chapter 11.

Landslip Potential

12.4.17 The natural slopes between Heighington Road and Washingborough Road show evidence of historical slips in the form of Head deposits. A major cutting is proposed in this area. This may have the potential for reactivating existing slips.

12.4.18 The magnitude of landslips on soils and geology is considered to equate to no change or negligible and the resulting unmitigated impact is considered to be neutral.

Creation of Dust

12.4.19 Dust created by on site construction activities, particularly excavation and transportation of soil materials, can occur throughout the construction period, particularly during periods of dry weather. Whilst there may be no long term residual impact, it may represent a nuisance during construction. This issue is addressed in greater detail in Chapter 6 (Air Quality) and Chapter 16 (Disruption due to Construction).

Soil Deterioration and Consolidation

12.4.20 Consolidation of soils underlying the embankments would occur. Consolidation could lead to groundwater flow beneath the embankment being impaired, which in turn may lead to ponding of water at the toe of the embankment structure.

12.4.21 The magnitude of soil deterioration on soils and geology is considered to be negligible and the resulting unmitigated impact is considered to be neutral.

12.5 MITIGATION

12.5.1 This section outlines the possible mitigation measures that are proposed to minimise the effect of the potential impacts of the Lincoln Eastern Bypass, both during and after construction, on the surrounding environment.

Designated Sites

12.5.2 Whilst the proposed embankment obscures the strata in the south eastern part of the quarry, comparable exposures are present outside the scheme footprint.

12.5.3 Currently, the only readily accessible parts of the geological sequence are the rocks immediately above the quarry floor, i.e. within viewing height. It may be possible to provide safe access from the road embankment which would allow rocks higher up the stratigraphic sequence to be more readily accessed locally to the interface between the embankment and the quarry face.

Geology and Geomorphology

12.5.4 With the exception of the designated site noted above, no other special features in relation to geology or geomorphology have been identified in the study area.

Disturbance of Landfill Sites and Potentially Contaminated Land

12.5.5 Appropriate testing of Greetwell landfill will allow any potential risks that the landfill might pose to be determined. This will allow an appropriate engineered solution to be designed for the landfill which reduces the risk from the contaminated material on the surrounding ecosystems and site users to an acceptable level.

12.5.6 Otherwise, the potential sources of contamination are limited. Therefore, the probability of encountering contaminated material is low, although it can not be ruled out entirely. If contaminated material were to be encountered on site, it would be necessary to assess the risk to potentially sensitive receptors at the site, e.g. groundwater, surface water, human health and ecosystems. Should the material be determined to pose an unacceptable risk to the identified receptors and require excavation, the risk assessment should detail appropriate handling and disposal methods.

12.5.7 Good construction practice and proper disposal of any contaminated arisings should minimise the possibility of creating a pollution pathway. Additionally, the works can be designed to prevent a linkage between contaminants and ground and surface water.

Mineral Extraction

12.5.8 Appropriate investigation will allow risk assessment to be carried out to determine any potential risk that the underground workings pose to site users. This risk assessment will then be used to guide design of measures to deal with the mineworkings. This could include measures such as grouting of workings.

Earthworks Balance

12.5.9 The scheme has been designed to allow reuse of as much material as possible.

12.5.10 The design of the cuttings and embankments along the route, including environmental bunds, has aimed to create a balance between volumes of excavated materials generated from cuttings and volumes of fill required for embankments. This takes account of the potential slope instability issues arising from the formation of cuttings through Lias Clay, as outlined earlier.

Changes to Surface and Groundwater

12.5.11 Mitigation measures controlling surface and groundwater are covered in Chapter 11.

Landslip Potential

12.5.12 Cutting slopes are being designed to take account of the potential instability within the Lias Clay. Shallow slope angles of around 1 in 3.5 may be required to achieve an adequate factor of safety. Shallow slope angles would require a large landtake, and alternatively, remedial works e.g. steepening slopes with the use of soil nailing could be considered to reduce the landtake requirements. Consideration is being given to the engineering, environmental and economic implications of the slope design.

Creation of Dust

12.5.13 Dust control measures are covered in Chapter 16.

Soil Deterioration during Construction

12.5.14 For all areas the following mitigation measures could be adopted:

- Define access routes to all working areas;

- Restrict access to only these areas;
- Stripping, careful handling and storage of soils prior to construction, where necessary; and
- Careful soil replacement.

12.6 RESIDUAL IMPACT

12.6.1 The following residual impacts are based on the content in chapter 12.2 and Table 12.3.

Designated Sites

12.6.2 Following implementation of mitigation measures, i.e. improved access to parts of the quarry outside the road footprint, the magnitude is considered to be minor and the residual impact moderate adverse.

Geology and Geomorphology

12.6.3 With the exception of the designated site noted above, the magnitude is considered to be negligible and the residual impact is considered to be neutral.

Disturbance of Landfill and Potentially Contaminated Land

12.6.4 With mitigation measures in place, such as the testing of the landfill material and appropriate assessment, it would be possible to remediate or remove areas of contaminated land resulting in a moderate beneficial residual impact.

Mineral Extraction

12.6.5 Through appropriate investigation, assessment, design and treatment it would be possible to mitigate the impact posed by underground workings. Consequently this would result in a slight beneficial residual impact.

Earthworks Balance

12.6.6 The scheme has been designed to maximise use of material. Consequently the impact on the soils and geology at the site is likely to equate to 'no change' conditions and the resulting impact is considered to be neutral.

12.6.7 Should any material require off site disposal the residual impact would depend on the disposal method selected.

Changes to Surface and Groundwater

12.6.8 The residual impacts relating to surface and groundwater are covered in Chapter 11.

Landslip Potential

12.6.9 With appropriate design there should be no added risk of landslip potential. Therefore the magnitude is considered to be negligible and the residual impact is considered neutral.

Creation of Dust

12.6.10 The residual impacts relating to the creation of dust are covered in Chapter 16.

Soil Deterioration and Consolidation

12.6.11 Any effects on the quality and nature of the soils are likely to be local in extent, therefore the magnitude is considered to be negligible and the resulting impact neutral.

13 LAND USE

13.1 INTRODUCTION

13.1.1 This chapter assesses the potential impacts that the proposed scheme could have on existing or future land use, both directly on the proposed route and on land within the wider vicinity. This section also identifies possible mitigation measures that could be put in place to prevent, reduce or compensate, for any undesirable effects.

Definition/Scope of Work

13.1.2 In accordance with DMRB, for the purposes of this assessment 'land use' is assumed to comprise the following topic areas:

- Demolition of private property – That is the demolition of property or any associated loss of land which may result in the loss of facilities, quality of life, services or employment;
- Loss of land used by the community – This includes land used by the public that is common land, town or village green, a public park or land used for public and private recreation amenity, 'fuel or field garden allotments', or disused burial grounds;
- Effects on development land – That is future land-use changes that are likely to occur in the absence of the scheme, including land covered by land use planning designations and any planning proposals lodged with the planning authorities; and
- Effects on agricultural land – This includes agricultural land take, type of husbandry, severance of agricultural land and access.

13.1.3 For the purposes of the Stage 3 assessment, properties and land immediately adjacent or within 1km of the scheme were considered, and impacts on them assessed. A full agricultural assessment was also carried out which assessed the impacts on farmland and businesses operating within 1km of the proposed scheme.

Baseline Data Gathering

13.1.4 Existing private property, community land, development land and agricultural land were identified through site visits, a desk-based survey and information gathered at Stage 2. The desk based assessment used information from:

- Both the adopted and emerging Regional Spatial Strategy for the East Midlands;
- The Lincolnshire Structure Plan;
- The Local Plans for the City of Lincoln, West Lindsey and North Kesteven;
- The emerging LDF documents for all three authorities;
- The MAGIC website (www.magic.gov.uk);
- Agricultural Impact Assessment produced by Acorus;
- Planning Policy Statement 7: Sustainable Development in Rural areas , 2004 (PPS7);
- Lincolnshire County Council's Planning Application information.

13.1.5 The extent to which the proposed scheme will impact on land used by the community, has been assessed on the following information:

- Identification of the owners of all land directly on the proposed scheme route or in the close vicinity, through information provided by local authorities;
- Identification of key community facilities within the vicinity of the proposed scheme, including schools and sports clubs through a desk based survey; and
- A review of relevant Local Plan proposals maps for each local authority, to identify areas of Green Belt, Historic Parks and Gardens, and other areas of recreational or amenity use, such as sites of ecological interest (ponds, woods etc).

Policy Context

13.1.6 National policy context regarding land use can be found in Planning Policy Guidance Notes and Planning Policy Statements such as PPS1: Delivering Sustainable Development. These documents can be summarised under the following theme headings:

- Sustainable transport and accessibility (PPG 13 and PPS6);
- Biodiversity, archaeology, geology and open space (PPS9, PPG16, PPG15 and PPG17);
- A reduction of CO2 emissions and other forms of pollution (PPS23 and PPG24);
- The mitigation of flood risk and the promotion of sustainable drainage (PPS25).

13.1.7 The East Midlands Plan 2009 (the RSS for the East Midlands) forms the regional context for land use policy. Key themes include:

- Incorporating better design into new development to reduce CO2 emissions (policy 2);
- Conservation and enhancement of the natural and historic environment, biodiversity and landscape and recognition of their contribution to the region's quality of life (policies 26 and 27);
- A promotion of accessibility, improved air quality, reduced congestion and increased road safety throughout the region (policies 32, 36 and 43).

13.1.8 Local plan policy context considers the following themes in relation to land use, as identified within the City of Lincoln, West Lindsey and North Kesteven Local Plans:

- The preservation of best and most versatile Agricultural Land;
- Protection of residential amenity;
- Mitigation of flood risk;
- An overall reduction in pollution and CO2 emissions through development proposals;
- The promotion of safe, accessible, legible development to include adequate provision for Non-motorised users (NMUs);
- The protection of environmentally important sites such as Sites of Specific Scientific Interest (SSSIs), Local Nature Reserves (LNRs) and Ancient Woodland.

Site Visits

13.1.9 Site visits were carried out by Acorus in September 2008 to gather information about the potentially affected farm businesses. A walkover survey was also undertaken to assess the likely Agricultural Land Classification grading of the proposed scheme corridor and to identify any sustainable soil use issues to be considered in the assessment of the scheme.

Consultation

13.1.10 Lincolnshire County Council carried out a consultation on three possible routes for the Lincoln Eastern Bypass in early 2008. Relevant responses on agriculture and land quality were reviewed for this assessment.

13.1.11 Most of the agricultural land owners and occupiers potentially affected by the scheme were interviewed during the site visit in September 2008 and comments about the proposals noted. Where land take is likely to be very small or nil, agricultural occupiers were contacted by telephone.

13.1.12 For this Stage 3 assessment, telephone discussions were held with Natural England and the Government Office for the East Midlands regarding agricultural land quality within 1km of the proposed route corridor.

13.2 ASSESSMENT METHODOLOGY

13.2.1 No guidance is available specifically on the impacts on land use. An assessment methodology has therefore been designed in accordance with the generic framework defined in Chapter 4, which is based on DMRB and HA205/08. A matrix-based approach has been adopted, which assumes that the significance of any impact is a function of the sensitivity of the receptor and the magnitude (scale) of impact. The matrix used for these assessments is set out in Chapter 4 (see table 4.1).

13.2.2 For the purpose of this assessment of impacts on land-use, the sensitivity of receptors has been classified according to criteria described in Table 13.1 below. The magnitude of impact is defined according to the criteria described in Table 13.2.

Table 13.1: Description of sensitivity categories

Very High	Land that is of high importance and rarity and is important on an international/national scale in relation to the relevant topic area, with limited potential for substitution.
High	Land that is of high importance and rarity and is important at a regional scale in relation to the relevant topic area, with limited potential for substitution.
Medium	Land that is of high importance and rarity and is important on a local scale in relation to the relevant topic area, with limited potential for substitution.
Low	Land that is of low or medium importance and rarity and is important on a local scale in relation to the relevant topic area.
Negligible	Land that is of very low importance and rarity, and important only on a local scale.

Table13.2: Description of magnitude of impacts

Major	**Adverse** – Loss of land and/or quality and integrity; severe damage to key characteristics, features or elements and prevents use of land for intended purpose e.g. demolition of property.

	For assessing impact on agriculture, the viability of a farm may be jeopardised in a typical year under the current farming system and/or a major reorganisation of that holding would be required, with a large increase in demands on management. Typically this would involve land loss in excess of 10% of the holding's area. **Beneficial** – Large scale or major improvement of land use quality; extensive restoration or enhancement; major improvement of attribute quality.
Moderate	**Adverse** – Significant impact on the receptor, without reducing its integrity; partial loss or damage to land use. For assessing impact on agriculture, in a typical year the viability of a farm would not be jeopardised although it would suffer a significant impact. In years of adverse weather and/or market conditions viability may be jeopardised. Some changes would need to be made to the farming system, leading to a *moderate* increase in demands on management. Typically this would involve a land loss of between 5 and 10% of the holding's area. **Beneficial** – Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Minor	**Adverse** – Some measurable change in attributes quality or vulnerability; minor loss of land or property but unlikely to prohibit viability of use. For assessing impact on agriculture, the viability of the farm would not be jeopardised irrespective of adverse weather or market conditions. Only minor changes, if any, would need to be made to the farming system, with minimal effect of management. Typically this would involve the loss of between 1 and 5% of the holding's area. **Beneficial** – Minor benefit to or addition of one or more key characteristics, features or elements, some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	**Adverse** – Very minor loss or detrimental alteration on property/Land, causing little damage to land or property; ability to continue using land use for intended purpose. Very minor loss of holding area. Insignificant impact upon farm income. No changes necessary to the system of the farm, or effect on management. **Beneficial** – Very minor benefit to or positive addition to one or more property/land use feature.
No Change	No loss or alteration of property land use; no observable impact in either direction. No loss of holding area or alteration to farming system. No observable adverse or beneficial impact.

13.2.3 The application of the matrix (Table 4.1) leads to the definition of the significance of impact on a five-point scale (Very Large, Large, Moderate, Slight and Neutral). These terms can be interpreted in the context of Land-Use impacts using the criteria set out in Table 13.3.

Table 13.3: Description of significance of effects

Very Large	The proposed scheme will result in an adverse effect due to the damaging impact and loss of property/land use of international or national or regional importance or rarity. A serious change in a site or feature of district importance may also be included.
Large	These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important, but are not likely to be

	key decision making factors. The cumulative effects of such issues may become a decision making issue if leading to an increase in the overall adverse effect due to the loss of land uses of local importance.
Slight	The beneficial or adverse effects may be raised as local issues. They are unlikely to be critical in the decision making process, but are important in enhancing the subsequent design of the project.
Neutral	No effects or those that are beneath the levels of perception, within normal bounds of variation or within the margin of forecasting error.

13.2.4 Impacts can be further classified as 'direct' or 'indirect', as defined below:

- *Direct effect* – where the scheme will impinge directly upon the land or property in question (e.g. demolition, loss of some or all of the associated land etc).
- *Indirect effect* – where the scheme will pass in close proximity, or directly adjacent, to the land use receptors being considered, or the proposed scheme will encroach on land uses over a wider area, in such way as to have an adverse effect in its use.
- *No effect* – Scheme will not impact upon land or property.

13.2.5 Impacts on land use are likely to be most significant during the construction phase. Construction and operation phase impacts have not been separated out for this assessment but have been considered together. Where a specific consultation impact is identified, further details are given in the text.

13.3 BASELINE INFORMATION

Private Property

13.3.1 There are a number of residential dwellings located within the scheme study boundaries and these are located within the following villages; North Greetwell, Canwick, Washingborough, Branston, Cherry Willingham, Bracebridge Heath and the eastern edge of Lincoln. In addition there are a number of farm units distributed throughout the study area. The study area extends 1km from the proposed route alignment.

13.3.2 Other property in the study area includes RAF Waddington which is situated to the south of Bracebridge Heath on the southern edge of the study area. St Swithin's Cemetery and Washingborough Sewage Treatment Works are both situated just off the Washingborough Road in Washingborough. Greetwell Hollow Quarry, approximately 58Ha in size, is situated on the north eastern edge of Lincoln and is designated as a Site of Special Scientific Interest (SSSI).

Community Land

13.3.3 Land used by the community in the study area includes Canwick Park Golf Club, situated on the northern edge of Canwick on the western edge of the study area. Canwick Recreation Ground lies to the west of the extant route on the southern edge of Heighington Road and comprises a Bowling Green and tennis courts. Canwick Riding School is situated adjacent to Canwick Recreation Ground on its eastern boundary.

Land Allocated for Development

13.3.4 The route of the approved extant LEB is protected in the City of Lincoln Local Plan, North Kesteven Local Plan (and Revised Deposit Draft) and West Lindsey Local Plan (First Review). The remainder of the proposed scheme is located within the North Kesteven District Council (NKDC) area.

13.3.5 There are a number of sites allocated for development within the study area. These are shown on Figure 13.2 and are as follows:

- Land North of Greetwell Quarry is allocated for a District Mixed-Use Centre or Business use at the western edge of the site and Housing or Non-Residential Institutions on the remainder of the site as stated in Policy 92 of the City of Lincoln Local Plan.
- Land East of the Tower Works is allocated for industrial/business development with particular emphasis on developments which make use of the railway network and/or waterways as stated in Policy 102 of the City of Lincoln Local Plan.
- Land South of Hawthorn Road is allocated for a major residential proposal in the City of Lincoln Local Plan Policy 38E.
- Greetwell Quarry is allocated for the following uses once mineral extraction has been completed: Business and General Industrial Uses (within Class B1 and B2), Public Open Space, Storage and Distribution (Class B8) and a Park and Ride.

13.3.6 Greetwell Quarry is designated as a geological SSSI as highlighted in Policy 70: Greetwell Quarry in the City of Lincoln Local Plan.

13.3.7 A number of industrial estates exist between Greetwell Quarry and the Lincoln to Market Rasen Railway line. Development opportunities exist to extend this area as part of the Lincoln Eastern Growth Corridor (also known as the North East Quadrant). Opportunities include an extension of the existing employment land (particularly on the Land East of Tower Works), residential development, some recreational space and road access improvements connecting to the approved LEB. Existing Green Wedge land is also designated within these areas of opportunity.

13.3.8 Furthermore there are a number of sites in the area that currently have planning permission for development. These are shown on figure 13.2.

Agricultural Land

13.3.9 Most of the land affected by the Lincoln Eastern Bypass scheme would be arable farmland, with some grazing land alongside and north of the River Witham. The other major land use affected is a former quarry north of Greetwell Road (Plot 9B). The bulk of the affected farmland lies immediately along the proposed bypass route corridor. Smaller areas of farmland would be required for side road improvements (e.g. Greetwell Road improvement) and at seven locations for drainage balancing ponds, etc. Further areas are being identified for temporary uses during the construction period.

13.3.10 The quality and versatility of agricultural land is classified from Grade 1 to Grade 5, with Grade 3 subdivided into 3a and 3b. Land in Grades 1, 2 or 3a is defined in PPS7[30] as the 'best and most versatile land' (BMV land) and benefits from a higher degree of protection under national and local planning policy. The results of the agricultural desk-based assessment and walkover survey, noting a 2003 ALC study report[31] covering the wider route corridor, suggest that nearly all of the agricultural land in the vicinity of the proposed bypass scheme is likely to be Grades 2 and 3a. This falls within the 'best and most versatile' agricultural land category, and for the purposes of this assessment is considered to be of 'Medium' sensitivity to effects on the use of the land. A small area of Grade 4 land is identified in the River Witham flood plain.

[30] Planning Policy Statement 7: Sustainable Development in Rural Areas (Office of the Deputy Prime Minister, August 2004).
[31] Lincoln Eastern Bypass – Agricultural Land Classification Study (Acorus, April 2003)

13.3.11 Agricultural land in the bypass route corridor is mainly owned by institutions such as the Church (plot number 9) and an Oxford College (plot number 26). The land is let to the farmers on a mix of traditional agricultural tenancies and modern farm business tenancies. There are also some owner-occupied land areas (e.g. plots numbered 21, 29 and 42). The River Witham floodbanks are owned by the Environment Agency (plot number 13) and licensed for livestock grazing.

13.3.12 The agricultural land use in the bypass route corridor is mainly mixed arable, with some grazing livestock. Arable cropping is mainly cereals (wheat and barley) in rotation with potatoes and sugar beet. The potato crops are irrigated for crop yield and quality. There is a limited area of grassland, used as permanent or long-term pasture for grazing. No intensive beef cattle, dairy, pig or poultry enterprises lie within or in close proximity to the route corridor.

13.3.13 Nine farm businesses have been identified which would be affected by land-take for the proposed bypass. These are summarised in Table 13.3, while the known extent of land in each farm unit is shown on Figure 13.3.

Table 13.3: Agricultural land uses

Plot No.	Agricultural business	Approx total area of land farmed	Agricultural activity	Use of local road network?	Internal tracks?	Sensitivity to impact
2A/3A	Greetwell Lane Farm Nettleham	61 ha (150 acres)	Arable farming	Yes – access to fields adjacent to A158	No	High
9A	Manor Farm Reepham	N/A	Arable farming	Yes – access to fields adjacent to A158	No	High
9C/ 26B	Whitehall Farm Bracebridge Heath	668 ha (1650 acres)	Arable farming	Yes – B1131, B1188 and Heighington Road	Yes – Plot 26A	High
9D	Manor House Farm Bracebridge Heath	620 ha (1530 acres)	Arable farming incl sugar beet	Yes – A15 and Bloxholm Lane	No	High
9E/2 6E/2 9	Westfield Farm Branston incl land at Glebe Farm Canwick	485 ha (1200 acres) plus licensed cropping land	Arable farming incl irrigated potatoes on own/licensed land from reservoir at Westfield Farm	Yes – principally B1188 and Heighington Road for access to Glebe Farm (or via Plot 42)	Yes – access to Plots 26E and 29 (via Plot 42)	High
9F/ 9H/1 3A	Greetwell Hall Greetwell	405 ha (1000 acres)	60% arable, 40% grassland – beef suckler herd	Yes – Greetwell Road, Greetwell Fields Road and Hawthorn Road	Yes – Plot 9H	High

Plot No.	Agricultural business	Approx total area of land farmed	Agricultural activity	Use of local road network?	Internal tracks?	Sensitivity to impact
9G	Cottage Farm Washingborough	48 ha (118 acres)	Mixed – arable (incl potatoes) and grassland	Yes – B1190	Yes – bridge under railway	Low
21/ 42	Ashfield House Branston	380 ha (940 acres)	Arable farming incl potatoes; small area grassland	Yes – B1188 and Heighington Road (or via Plot 29)	Yes – Plot 42 and 21 link via Plot 29	High
26A	Lake Farm Washingborough	97 ha (225 acres)	Arable farming	Yes – B1188 for access to buildings at Heath Farm	No	High

13.3.14 It is understood that most of the farm holdings have entered the Natural England Entry Level Stewardship Scheme and Greetwell Hall Farm is in the Countryside Stewardship Scheme.

13.4 IMPACT ASSESSMENT

Demolition of Private Property

13.4.1 No residential properties, farmsteads or commercial properties will need to be demolished for the construction of the proposed scheme. The overall impact is no change.

Assessment of Impacts on Community Land

13.4.2 The potential effects of the proposed scheme on land used by the community are set out in table 13.4.

Table 13.4: Impact on Community Uses

Receptor	Type of property/ land use	Sensitivity	Magnitude of impact	Significance
Canwick Park Golf Course	Golf Course	Low	No Change	Neutral
Canwick Recreation Ground	Tennis Court and Bowling Green	Low	No Change	Neutral
Canwick Riding School	Riding School	Low	No Change	Neutral

13.4.3 The proposed development would not result in the loss of any land from any of the community land uses. A number of public rights of way would be affected by the proposed scheme and these are discussed in chapter 14.

Impact on Land Currently Allocated for Development

13.4.4 The northern section of the proposed route would traverse the south eastern corner of Greetwell Quarry with an estimated land take of approximately four hectares. The quarry has now been closed. This land take would impact upon the SSSI status of the site as discussed in chapter 12. It would not however, impact upon the land use allocation.

13.4.5 The proposed scheme would not have any impact on land currently allocated for development. Figure 13.2 highlights the fact that the proposed scheme would not affect any planned developments that have either not been started or that are currently under construction. However, future allocations are set out in the East Midlands Regional Plan. This includes the south east quadrant between Bracebridge Heath and Canwick where up to 3000 homes may be allocated until 2026 and 8000 homes beyond this. However, this precise land area will not be defined until new LDFs are adopted and as such has not been included in this study.

Table 13.5: Impact on Land Allocated for Development

Receptor	Type of property/ land use	Sensitivity	Magnitude of impact	Significance
Land North of Greetwell Quarry	Allocated for District Mixed Use Centre	Low	No Change	Neutral
Greetwell Quarry	Allocated for Business and General Industrial Uses (Within Class B1 and B2), Public Open Space, Storage and Distribution (Class B8) and a Park and Ride.	Low	No Change	Neutral
Land East of the Tower Works	Allocated for industrial/business development	Low	No Change	Neutral
Land South of Hawthorn Road	Allocated for a Major Residential Proposal	Low	No Change	Neutral

Agricultural Land Classification

13.4.6 Consideration of the Agricultural Land Classification of England and Wales indicates that the 65.6 ha of agricultural land which would be permanently taken for the proposed bypass scheme would be predominantly Grade 2 and 3a quality i.e. 'best and most versatile agricultural land' (BMV) as defined in PPS 7:

- 54.2 ha (82.6%) Grade 2
- 6.4 ha (9.8%) Grade 3a located in two areas, immediately south of the B1190 Washingborough Road and north of the B1188 Lincoln Road; and
- 5.0 ha (7.6%) Grade 4 located between the B1190 Washingborough Road and the north bank of the River Witham.

13.4.7 Following the 2008 public consultation on three alternative routes by Lincolnshire County Council and follow up discussions with Acorus regarding the preferred route, the potential loss of this land for the proposed scheme has not raised any policy objections from Natural England or the Government Office for the East Midlands.

Agricultural Land Take and Severance impacts

13.4.8 Nine farm businesses would be affected by permanent land-take for the proposed scheme (see Figure 13.3 and Table 13.6), taking between 0.1% (Plot 21/42) and 10.2% (Plot 9G) of the land area of each farm.

13.4.9 The retention of the local road network east of Lincoln, with five roundabout connections to the proposed bypass, would allow most farms with land on both sides of the scheme route to continue in agricultural use. However, five farms, comprising plots 9F/9H, 9G, 26A, 26B and 9E/26E/29, would lose access to some land, or would lose access routes that are currently available.

13.4.10 The scheme would isolate small pockets of land on the west side from Plots 9F/9H (future development land north of Greetwell Road) and on the east side from Plot 9D.

13.4.11 Cottage Farm (Plot 9G) would lose 10.2% of the farm area, comprising land for the new road construction including railway and river crossings, B1190 Washingborough Road roundabout junction and drainage balancing ponds. The existing private access bridge under the Lincoln to Spalding railway line would be lost and the two existing parcels of farmland would be split into two small parcels each, with no access for farm vehicles. As Plot 9G is held on a Farm Business Tenancy which is due to terminate in 2009, it is suggested that these areas of Grade 4 land could be taken out of agricultural use for low key agricultural and/or environmental enhancement use, e.g. stock grazing, without overall detriment to the farm business.

13.4.12 Greetwell Hall Farm (Plots 9F/9H/13A) would lose 5.3% of its rented farmland for road construction and drainage ponds, etc., together with loss of field access via the Greetwell Fields lane. Other land would subsequently be lost west of the bypass and north of the Lincoln to Market Rasen railway line to future proposed development.

13.4.13 Lake Farm (Plot 26A) would lose 4.9% of the rented farmland to the road construction. An area of farmland east of the bypass and north of a small stream would potentially be severed without access and there would be inconvenient access to farmland immediately west of the bypass.

13.4.14 Whitehall Farm (Plots 9C and 26B) would lose 2.3% of the rented farmland to the road construction, including the proposed balancing ponds off the B1188 Lincoln Road. Internal access within Plot 26B would be cut and irregular shaped fields created.

13.4.15 Westfield Farm (Plots 9E & 26E, rented, and Plots 29A-C, owned) would lose 2.2% of the total farmed land, mainly on Plots 26E and 29C. The proposed bypass would disrupt existing access routes on this farm: access to Plot 26E via a linking track; and access to Plot 29 (Glebe Farm land) via a track through Plot 42 from the B1188 Lincoln Road.

13.4.16 Westfield Farm utilises water from its winter surface water filled reservoir via a system of irrigation pipes to grow potatoes on Plot 26E and other holdings in the vicinity. The irrigation pipe system would be cut by the proposed bypass. There are understood to be plans for an irrigation reservoir on Plot 29, where siting and underground irrigation pipe routing would be affected by the proposed bypass.

13.4.17 Greetwell Lane Farm (Plots 2A and 3A) would lose 1.3% of the farm area. The proposed enlarged A158 roundabout at Wragby Road and watercourse diversion on plot 2A would eliminate the existing access to the field west of Reepham Beck.

13.4.18 Manor House Farm (Plot 9D) would lose 1.3% of the farm area, located near to the farmstead. Four small, awkwardly shaped enclosures would be created, by the bypass and Bloxholm Lane diversion to the Sleaford Road roundabout, one without access.

13.4.19 The other two farm units have small areas of land taken as noted in Table 13.6.

Table 13.6: Impacts on agricultural land

Plot No.	Receptor	Type of farm	Permanent Land-take	Comments
2A/3A	Greetwell Lane Farm	Arable	0.82 ha (1.3% of farm area)	Replace access off A158
9A	Manor Farm	N/A	0.17 ha	Retain access off A158
9C/26B	Whitehall Farm	Arable	15.34 ha (2.3% of combined farm area)	Internal access required within Plot 26B, land east of the bypass
9D	Manor House Farm	Arable including sugar beet	7.91 ha (1.3% of farm area)	Access required to field east of Bloxholm Lane
9E/26E/29	Westfield Farm	Arable including irrigated potatoes on Plots 26B and 26E	10.15 ha (2.1% of combined farm area)	Access required to severed areas on both sides of the bypass Irrigation distribution main cut by bypass route on Plot 26E
9F/9H/13A	Greetwell Hall Farm	Arable and grassland – beef cattle	21.40 ha (5.3% of farm area)	Access required to land east of Greetwell Fields Road
9G	Cottage Farm	Arable	4.88 ha (10.2% of farm area)	Potential loss of all farmland at Plot 9G (end of Farm Business Tenancy)
21/42	Ashfield House	Arable	0.22 ha (0.1% of farm area)	Loss of informal access route between these plots via Plot 29
26A	Lake Farm	Arable	4.75 ha (4.9% of farm area)	Access required to severed land north of stream on east side of the bypass

13.4.20 Although the area east of Lincoln is characterised as mainly relatively free draining soils, the construction works could disrupt existing land drainage systems, creating a risk of localised waterlogging. Additionally, the land-take for the scheme would produce a surplus of good quality topsoil stripped from the agricultural land.

Temporary Land Uses During Construction

13.4.21 The Environmental Masterplan included in Appendix 9E indicates areas which may be required during construction for contractor's compound sites, haul routes and temporary storage of topsoil. The additional 33 ha of agricultural land potentially affected comprises an estimated 26.8 ha (81%) of Grade 2, 3.9 ha (12%) of Grade 3a and 2.3 ha (7%) of Grade 4.

13.4.22 The areas affected by these temporary uses would be out of production during the construction period but would be returned to agriculture on completion of the works. Measures would be taken to ensure careful stewarding of the soil resources during the construction period, proper restoration of the land and subsequent aftercare. The long term significance of effect of these temporary uses of land is therefore categorised as Neutral.

MITIGATION

13.4.23 The locations of the proposed shared and farm-specific Private Means of Access (PMA) are shown on the Environmental Masterplan. This section considers the need and use of the proposed PMAs on the affected farms, working from north to south, and other proposed agricultural mitigation measures.

13.4.24 A new PMA would be provided from Greetwell Lane, within the Greetwell Lane Farm land on Plot 2A, alongside the A158 Wragby Road to an extended culvert to give farming access to the field west of Reepham Beck.

13.4.25 A new PMA would be provided east of the bypass from the Greetwell Fields lane to Hawthorn Road for the use of Plots 9F/9H, Greetwell Hall Farm, shared with a proposed bridleway and separate from the drainage pond access.

13.4.26 Near Greetwell Hall farmstead, an underpass link (shared with the Viking Way footpath) would be included on the south side of the Lincoln to Market Rasen railway line overbridge for year round access to the land to the west of the bypass and north of the River Witham.

13.4.27 Shared use of the maintenance access track from the B1190 Lincoln Road to the drainage ponds would allow grassland farming use access to the severed portions of Plot 9G, between the Lincoln to Spalding Railway and the Canwick Fen Drain.

13.4.28 Three PMAs would be provided, east and west of the bypass, north of the B1188 Lincoln Road, for the use of Westfield Farm and Lake Farm:

- On Plot 29, part Westfield Farm, a short link would connect the existing access track on Plot 42 to the severed land east of the bypass;
- On Plot 26A, Lake Farm, a short track and culvert over the stream would give access to a severed field east of the bypass;
- Also on Plot 26A, a shared track west of the bypass would provide access to the adjacent fields and also access to Plot 29 west by Westfield Farm;
- Finally, a PMA would be provided, east of the bypass south of the B1188 Lincoln Road, for the use of Whitehall Farm and Westfield Farm;
- On Plot 26B, part of Whitehall Farm, a shared track would provide access for the two Jesus College farms which would be severed (Plots 26B and 26E); and
- An extension southwards on Plot 26E would provide a linking access for Westfield Farm to Plots 9E, 26E and 29.

13.4.29 A sleeved pipe under the bypass, within Plot 26E, Canwick Manor Farm, would allow the land to the west of the proposed bypass to continue to benefit from the existing irrigation system arising at the reservoir at Westfield Farm (Plot 9E). Similar provision

could also be made within Plot 29 to allow for plans for an irrigation system on this land.

13.4.30 Maintaining access to farmed land during the works would be achieved within the construction management plan, to enable continued farming on all these holdings. However, this might involve extended journeys for some occupiers on public roads between blocks of land.

13.4.31 The potential disruption of land drainage systems would be mitigated through the provision of effective drainage outlets.

13.4.32 Livestock-proof fencing of the highway boundary would be provided where existing grassland is crossed on Plot 9H, Greetwell Hall Farm.

13.4.33 A scheme for sustainable use of soil resources within the scheme (a 'Soil Management Plan') would be devised. This would include the careful design, construction and restoration to agriculture, of any temporarily used agricultural land, and the sustainable use of any surplus topsoil produced by the construction process. The Plan would include details of soil types, stripping, storing and reinstatement requirements, any remedial works such as ripping or land drainage and crop establishment recommendations.

RESIDUAL IMPACTS

13.4.34 Eleven individual agricultural receptors have been considered within this section and impacts have been predicted for all these receptors: agricultural land quality, soil resources and nine farm businesses. For most agricultural receptors, the high degree of sensitivity, combined with major or moderate impacts, means that specific mitigation measures are necessary.

13.4.35 Mitigation measures are proposed in respect of five receptors. These include possible design measures to reduce impact, construction management measures designed to minimise disruption to farm businesses and soil resources, and the provision of new private means of access to replace those that would be lost.

13.4.36 Some mitigation measures would result in a reduction in the overall significance of impact. However, others address a specific issue (such as access to farmland) without reducing the main impact (such as loss of land). In these cases, the significance of impact remains unchanged.

13.4.37 The identification and assessment of impacts on agriculture of the proposed Lincoln Eastern Bypass, taking account of mitigation where appropriate, is summarised in Table 13.7.

Table 13.7: Summary and assessment of land-use impacts

Receptor	Receptor Type	Sensitivity	Magnitude of impact	Mitigation proposed?	Magnitude of impact (after mitigation)	Significance of impact
Grade 2 & 3a agricultural land	Finite resource	Medium	Moderate adverse	No	Moderate adverse	Moderate adverse

Receptor	Receptor Type	Sensitivity	Magnitude of impact	Mitigation proposed?	Magnitude of impact (after mitigation)	Significance of impact
Soil resources	Finite resource	Medium	Moderate adverse	Soil Management Plan	Minor adverse	Slight adverse
Greetwell Lane Farm	Farm	High	Minor adverse	PMA	Negligible adverse	Slight adverse
Manor Farm	Farm	High	Negligible adverse	No	Negligible adverse	Slight adverse
Whitehall Farm	Farm	High	Minor adverse	PMA	Minor adverse	Slight adverse
Manor House Farm	Farm	High	Moderate adverse	No	Moderate adverse	Slight adverse
Westfield Farm	Farm	High	Minor adverse	PMAs; design - irrigation pipes	Minor adverse	Slight adverse
Greetwell Hall Farm	Farm	High	Major adverse	PMA	Moderate adverse	Moderate adverse
Cottage Farm	Farm	Low	Moderate adverse	No	Moderate adverse	Slight adverse
Ashfield House Farm	Farm	High	Negligible adverse	No	Negligible	Slight adverse
Lake Farm	Farm	High	Moderate adverse	PMA	Moderate adverse	Moderate adverse

14 PEDESTRIANS, EQUESTRIANS, CYCLISTS AND COMMUNITY EFFECTS

14.1 INTRODUCTION

14.1.1 This chapter addresses two key aims:

- To assess the impact of the proposed scheme on the journeys that people make on foot, bicycle or on horses, using the public right of way network; and
- To determine the effects of the scheme on local communities, and in particular the ability of residents to access and use community facilities and services.

14.1.2 Public Rights of Way (PRoW) are minor public highways that exist for the benefit of the community at large, in much the same way as the public road network. PRoWs include:

- Footpaths – over which the right of way is on foot only;
- Bridleways – for pedestrians, horse riders and cyclists (who must give way to people on foot or horseback);
- Byways open to all traffic (BOATs) - carriageways over which there is a right of way for both non-motorised users (NMUs) and vehicular traffic, but which are used mainly by NMUs; and
- Restricted byways (formerly known as Roads Used as Public Paths, or RUPPs) carry rights for all types of traffic except motorised vehicles.

14.1.3 In determining whether residents would be separated from community facilities and services, the assessment takes account of the accessibility of the facilities and services as well as the pleasantness and length of the journey. Community facilities and services are considered to include schools and other educational institutions, nurseries, general practice surgeries, libraries, post offices and any other facilities that are designed for general community use at a local level.

14.2 POLICIES AND LEGAL CONTEXT

Introduction

14.2.1 This section provides the relevant planning policy context for the proposed Lincoln Eastern Bypass (LEB) scheme. This includes a review of the national, regional and local level planning policy and guidance documents relating to pedestrians, cyclists, equestrians and other non-motorised travellers.

National Planning Policies

14.2.2 Current national policy guidance relevant to the assessment of pedestrians, cyclists, equestrians and other non-motorised travellers is contained in the following documents:

- Transport White Paper: The Future of Transport - a Network For 2030 (Jul 2004);
- Encouraging Sustainable Travel – Highways Agency Strategic Plan For Accessibility;
- Planning Policy Statement 1: Delivering Sustainable Development (Jan 2005);
- Planning Policy Statement 7: Sustainable Development in Rural Areas (Aug 2004); and
- Planning Policy Guidance 13: Transport (Apr 2001).

Regional Planning Policies

14.2.3 Current regional planning policy and other regional guidance relevant to the assessment of the LEB proposal is contained in the following regional strategy:

- East Midlands Plan Regional Spatial Strategy:
  - Policy 28 Regional Priorities for Environmental and Green Infrastructure;
  - Policy 43 Regional Transport Objectives;
  - Policy 44 Sub-area Transport Objectives; and
  - Policy 45 Regional Approach to Traffic Growth Reduction.

Local Planning Policies

14.2.4 Current local planning policy guidance, relevant to the assessment of the LEB proposal is contained in the following local strategies and plans:

- Local Transport Plan for Lincolnshire County Council, 2006/07 to 2010/11 (March 2006);
- Lincoln City Council Local Plan (1998):
  - Policy 5 Strategic Network of Cycleways, Footpaths and Bridleways;
- West Lindsey District Council Local Plan First Review (June 2006):
  - Policy Sus 4 – Cycle and Pedestrian Routes in Development Proposals;
  - Policy CRT 9 – Public Rights of Way; and
- North Kesteven District Council Local Plan (Sept 2007):
  - Policy RST2 – Protection of Existing Public Rights of Way.

Summary of Policies

Pedestrians

14.2.5 The promotion of green and adequate transport infrastructure is outlined by National and Regional policies such as PPS1 and Policy 27 from the Draft East Midlands Plan. Overall, the policies outlined above encourage new development to promote a greater proportion of journeys to be made on foot through the development of high quality, safe and convenient routes, including a separation from existing vehicular access.

14.2.6 Local planning policy goes further, stating that suitable provision should be made for stretches of footpaths, to form networks and connect with other areas of development. In addition, Local policies also highlight the opportunity to reduce car dependency through multimodal improvements and through the maintenance of existing public rights of way.

Equestrians

14.2.7 Regional policy promotes the conservation of bridleways and green lanes. Local policy states that suitable provision will be made for stretches of bridleways to connect with or complete parts of the transport network in relation to development. Unless an alternative right of way or the diversion proposed would not be significantly detrimental to existing users and potential future users, the extinguishment or diversion of a public right of way will not be permitted.

Cyclists

14.2.8 National and Regional policies outline the need to reduce overall car dependency and to maximise the opportunity to use other modes of transport. In order to increase accessibility within and beyond the county, multimodal improvements are therefore promoted to widen travel choice.
The creation of cycleways as part of green transport infrastructure is promoted by the Draft East Midlands Plan. Local policy SUS4 states that the provision of safe cycle routes which run separately from vehicular access should be provided.

14.3 APPROACH AND METHODOLOGY

14.3.1 The approach and methodology has been developed in line with the 'Approach to Assessment' framework set out in the Chapter 4 of this Environmental Statement. Guidance has also been taken from the DMRB[32] and TAG[33]. Potential impacts on public rights of way, non-motorised users and communities have been assessed by identifying the effect on:

- Severance of routes and communities, including journey length and travel patterns;
- Amenity of public rights of way, cycle paths, and roads; and
- Physical fitness.

Baseline Information

14.3.2 Data on communities, community facilities and public rights of way was obtained through a desk-based assessment for an area extending to 1km in all directions. Data sources included:

- Local Transport Plan for Lincolnshire (LTP 2) – 2006/07 to 2010/11;
- Ordnance Survey Explorer Map 272 – Lincoln Area;
- Lincoln and surrounding area cycling map 2007; and
- Lincolnshire County Council public rights of way map.

14.3.3 A consultation meeting with the officers of Lincolnshire County Council and the representatives of key user group organisations was held in October 2007 to obtain information about the usage of various public rights of way, their importance and typical travel patterns. Further consultation letters were posted to the same groups in January 2009 for their comments on the proposed NMU facilities.

14.3.4 A site visit was also carried out by Jacobs in October 2007. This included the location of key community services and facilities and inspection of the condition of the public rights of way.

14.3.5 The information on the use of public rights of way was also obtained from the NMU Context Report[34]. This report drew on NMU surveys carried out in December 2004 and October 2007 at 26 different locations within the study area.

[32] Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3
[33] TAG Unit 3.3.12 'The Physical Fitness Sub-Objective and 3.6.2 'The Severance Sub-Objective'
[34] Lincolnshire County Council Lincoln Eastern Bypass: NMU Context Report (Jacobs, December 2007).

Impact Assessment

Communities, Community Facilities, Community Severance

14.3.6 Community severance is defined as the separation of residents from facilities and services in such a way as to make these services and facilities less accessible to them.

14.3.7 The methodology for assessment of impacts on communities and community severance has been developed from the guidance set out in the TAG unit 3.6.2 'The Severance Sub-Objective'. The TAG unit gives a comprehensive guidance and is in line with the assessment framework set out in Chapter 4.

14.3.8 Community severance has been classified according to the four broad levels presented in TAG. Table 14.1 illustrates this classification in the form of a matrix which is based on TAG. By comparing the level of severance for the do minimum and the do something scenario, the change in community severance that could occur can be estimated as presented in Table 14.2.

Table 14.1: Classification of Community Severance

Classification	Description
None	Little or no hindrance to pedestrian movement
Slight	All people wishing to make pedestrian movements will be able to do so, but there will probably be some hindrance to movement
Moderate	Some people, particularly children and old people, are likely to be dissuaded from making journeys on foot. For others, pedestrian journeys will be longer or less attractive
Severe	People are likely to be deterred from making pedestrian journeys to an extent sufficient to induce a reorganisation of their activities. In some cases, this could lead to a change in the location of centres of activity or to a permanent loss of access to certain facilities for a particular community. Those who do make journeys on foot will experience considerable hindrance

Table 14.2: Impact Assessment Framework for Community Severance

Do Something / Do Minimum	None	Slight	Moderate	Severe
None	None	Slight Negative	Moderate Negative	Large Negative
Slight	Slight Positive	None	Slight Negative	Moderate Negative
Moderate	Moderate Positive	Slight Positive	None	Slight Negative
Severe	Large Positive	Moderate Positive	Slight Positive	None

Non-Motorised Users

14.3.9 The assessment of the impacts on non-motorised users includes:

- Changes in access to the public rights of way network;
- Journey lengths and local travel patterns; and
- The 'amenity value' of each public right of way.

14.3.10 The term 'journey length' is used to describe both the distance travelled and the time taken for the journey. For the purposes of this assessment, it is assumed that pedestrians on average move at 5km/hr, equestrians at 10km/hr and cyclists at 20km/hr. Local travel patterns can be affected by journey length, and also by changes in the ease of access to the public right of way network.

14.3.11 The 'amenity' of a route is a measure of the relative pleasantness of a journey, based on the effects of people's exposure to traffic, the safety of the trip, noise levels and air quality, and landscape and visual quality.

14.3.12 Typical criteria used to determine the sensitivity of public rights of way and the magnitude of impacts are set out in Table 14.3 and Table 14.4.

Table 14.3: Assessment of the Sensitivity of Public Rights of Way

Sensitivity Classification	Description
Very High	1. Non-motorised user routes[35] that – • Are used for both recreational and utility[36] journeys, **and** • Are suitable for all types of NMU, are lit and are provided with all-weather surfaces 2. National strategic routes and long-distance trails (e.g. the Viking Way)
High	1. Non-motorised user routes that – • Are used for both recreational and utility journeys, **and** • Whose use at night or in bad weather is limited by the nature of the surface or lack of lighting, **or** • Which are not suitable for all types of NMU 2. Named and/or waymarked trails designated on a local or regional basis 3. Other routes whose use by NMUs is principally for recreational journeys, whose amenity value is enhanced by the quality of the landscape to which they provide access (including landscapes protected by designations at national, regional or local level)
Medium	1. Non-motorised user routes used principally for recreational journeys that - • Are provided with all-weather surfaces, and are not obstructed by stiles or other barriers that restrict the accessibility of the route, **or** • Act as 'feeder routes' to other non-motorised user routes of 'Very High' or 'High' sensitivity[37]
Low	1. Public rights of way whose accessibility is restricted by the nature of the surface or by barriers such as stiles, and which meet none of the other criteria detailed above
Negligible	1. Roads carrying little non-motorised traffic, or not suitable for non-motorised use[38] 2. Public rights of way shown on the Definitive Map, but already severed or permanently unusable

Table 14.4: Typical Criteria for Magnitude of Impacts on Public Rights of Way

Impact Magnitude	Criteria	
	Adverse impacts	**Beneficial impacts**

[35] including roads suitable for non-motorised use, public rights of way or any other route on which there is a right of way and that is suitable for use by any category of non-motorised users

[36] utility journeys are those that are made for non-recreational purposes, such as commuting, to access a community facility either within the same community or elsewhere, or to travel between communities

[37] feeder routes are those linking two other routes of greater sensitivity, or a community to a more sensitive route

[38] routes such as busy dual carriageways, where non-motorised use is not restricted by law but on which such use is rare or dangerous due to the volume and speed of traffic and where no dedicated facilities are provided

Impact Magnitude	Criteria	
	Adverse impacts	**Beneficial impacts**
Major	Permanent closure of a non-motorised user route Permanent severance of any non-motorised user route that prevents access between the parts	Provision of new surfaced non-motorised user route Provision of new linkage between communities that is shorter or safer for non-motorised users than existing links
Moderate	Temporary closure of any non-motorised user route for more than 1 month Increase in journey time of 10% or more Introduction of new intersection with a highway, with at-grade road crossing that is not controlled by signals Permanent severe loss of amenity on any public right of way	At least 10% shorter journey time on utility journeys Replacement of at-grade, uncontrolled crossing with signal-controlled or grade-separated facilities Two or more improvements in accessibility on a public right of way (removal of stiles or other barriers, improvements in surface, lighting, etc). Substantial improvements to amenity on any non-motorised user route
Minor	Temporary closure of any non-motorised user route for 1 month or less Increase in journey time of less than 10% Introduction of new intersection with a highway, with at-grade road crossing that is controlled by signals or a grade-separated crossing Minor permanent loss of amenity, or any temporary loss of amenity, on any non-motorised user route	Reduction in journey time of less than 10% for utility journeys Improved accessibility on a public right of way, through removal of stiles or other barriers or improvements in surface or provision of lighting etc. Minor improvements to the amenity of any non-motorised user route
Negligible	Temporary closure of any non-motorised user route for up to 1 day	
No change	Changes in the physical environment on a non-motorised user route that do not affect journey time, accessibility or amenity	No change

Physical Fitness

14.3.13 Impacts on physical fitness are identified through an assessment of changes in the opportunities for physical activity through cycling and walking. Providing increased opportunities for these activities can have additional benefits, such as improvements to the physical environment within communities and fostering well-being and community spirit, which also have health implications.

14.3.14 According to TAG, the available evidence indicates the minimum time of beneficial activity is 30 minutes, and assuming that the analysis can distinguish between trips which fall above and below this duration, there are four levels of benefit which can be considered:

- for new walk and cycle trips where journey times are below this threshold, there will be some minor health benefits;
- for new walk and cycle trips where journey times are above this threshold, there will be significant health benefits;
- for existing walk and cycle trips, where the journey time remains above the threshold, health benefits will be largely unchanged; and
- for existing walk and cycle trips, where the journey time falls below the threshold, there will be minor reductions in health benefits.

14.4 BASELINE CONDITIONS

Communities and Community Facilities

14.4.1 The communities that have been considered as a part of this assessment are:

- North Greetwell;
- Cherry Willingham;
- Washingborough;
- Heighington;
- Branston;
- Bracebridge Heath; and
- Strategic Development Areas: North East Quadrant (NEQ) and South East Quadrant (SEQ) – whilst these areas have not been developed yet, the influences of these proposals should be considered in these Baseline Conditions as the effects on NMU route usage could be significant.

14.4.2 The locations of these communities and community facilities are shown on Figure 14.1. Apart from Washingborough, the built up residential areas of these communities are located on the outer fringes of the study area. The communities are fairly self-contained, in that most of the necessary local community facilities are available within their own built-up areas.

14.4.3 The data from the 2001 census and the population profile of each community is shown in Table 14.5. National and regional comparisons are presented, to put the local figures in context.
The data suggests that the percentage of local people under 16 years of age is lower than the national average, and the percentage of people 60 years or over is greater than the national average. The percentage of local aged between 16 and 60 years correlates to the national average.
This data could suggest several scenarios and shape the way NMUs are represented in the local facilities. For example, as the number of young people is smaller, it could be considered that NMU route usage is low (for this demographic) as there are less young people walking, cycling and horse riding.
As the local populus aged 60 years or over is greater than the national average, this could be considered in two different usage patterns. Firstly, the NMU facility usage could be low as the elderly may not be mobile and hence keep walking, cycling and horse-riding figures depressed. Alternatively, as the over 60 age group may be considered to be keen walkers, cyclists and equestrians, the NMU usage may be raised by this section of people.

Table 14.5: Population Profile of Local Communities in National and Regional Context

Community	Total population	% under 16	% between 16 and 60	% 60 or over
North Greetwell	Unknown	Unknown	Unknown	Unknown
Cherry Willingham	3761	15.70	53.00	31.30
Washingborough & Heighington	6613	17.70	56.40	25.80
Branston	4667	19.40	55.30	25.30

Bracebridge Heath	8120	21.10	56.70	22.30
East Midlands	4,172,174	20.06	56.43	21.04
England	49,138,831	20.20	59.00	20.90

North Greetwell

14.4.4 This community is located to the east of the proposed Lincoln Eastern Bypass (LEB) route, along the southern side of A158 Wragby Road. This is the smallest community within the study area. As community facilities do not exist within North Greetwell, people either travel into Lincoln or into neighbouring Cherry Willingham to access facilities. Please refer to Figure 14.1 for locations.

Cherry Willingham

14.4.5 This community is located to the east of the proposed LEB route, north of the River Witham. Community facilities within Cherry Willingham include schools, post office, recreation grounds, and a library. It has the least population of the communities considered for this assessment but has the highest percentage of population that are over 60 years age. Please refer to Figure 14.1 for locations.

Washingborough & Heighington

14.4.6 The communities of Washingborough and Heighington are located to the east of the proposed LEB route, south of the River Witham. The two communities are located quite close to each other. The residential development to the west of the Washingborough is located at a close proximity to the bypass route. The community facilities within Washingborough and Heighington include schools, post offices, recreation grounds, a library, general practice surgeries, and a public house. Please refer to Figure 14.1 for locations.

Branston

14.4.7 This community is also located to the east of the proposed LEB route, south of the River Witham. Community facilities within Branston include a school, a college, a post office, a recreation ground, and a library. Please refer to Figure 14.1 for locations.

Bracebridge Heath and SEQ

14.4.8 This community is located to the west of the proposed LEB route. Community facilities within Bracebridge Heath include a school, post office, and a recreation ground. The strategic development area known as SEQ is to the north and east of Bracebridge Heath. The area has yet to be determined in terms of size, number of dwellings, commercial, schools, etc. However, it is likely to be a significant urban expansion of Lincoln. Please refer to Figure 14.1 for locations of the proposed developments. When completed, the development may provide an increase in NMU numbers as residents may commute as NMUs to Lincoln city centre and also undertake leisure activities on both sides of the proposed LEB. The SEQ may also have community facilities installed that may attract NMUs from outside of the development, thus increasing NMU route usage.

NEQ

14.4.9 As described in 14.4.1 and located on Figure 14.1, the NEQ strategic development area, situated to the west of the LEB, north of the River Witham and east of the current housing extents, may provide increased NMU route patronage as more NMUs are seeking to commute to Lincoln city centre and undertake leisure activities.

The NEQ may also have community facilities installed that may attract NMUs from outside of the NEQ development, thus increasing NMU route usage.

Community Facilities

14.4.10 Apart from the facilities identified within the local communities above, other facilities with the study area are identified as follows and shown in the Figure14.1.

14.4.11 A Sustrans cycle route and walking tracks along the banks of River Witham provide leisure facilities and access to the countryside east of Lincoln. These routes are also very popular among people trying to access attractions within Lincoln. There is a strong desire among the non-motorised user group and the LCC officers to maintain safe continuity of these routes.

14.4.12 Canwick Park golf club is located on the west of the LEB south of the River Witham. This facility is not affected by the LEB route.

Non-Motorised Users and Public Rights of Way

14.4.13 The public rights of way, cycle paths and roads within the study area of the proposed scheme are illustrated on Figure 14.2 and described below.

Public Footpaths and Pedestrian Routes

14.4.14 The public footpaths and pedestrian routes (routes that are not PRoW but used by pedestrians) within the study area include the following:

(PF = Public Footpath)

- PF 186/140/1 – runs between Wragby Road (50-60m east of the existing Wragby Road roundabout) and Hawthorn Road (opposite the Greetwell fields turning);
- PF 186/139/1 – runs from a point on a minor road south of Hawthorn Road and runs south east connecting to footpath 535/57/1;
- PF 535/57/1 – connects from PF 186/139/1 and runs south east before connecting into Greetwell Road;
- PF 535/58/2 – a short footpath connecting Greetwell Road to PF 535/59/4 to the east of the Allenby Road industrial estate;
- Viking Way – is a long walking route, a section of which passes through the LEB corridor. It runs along the northern bank of the River Witham between Greetwell Hall and Fiskerton. From a point southeast of Greetwell Hall along the river bank, it runs in the north direction towards the Lincoln to Market Rasen Railway track. Running along the southern side of this railway track, it becomes PF 535/59/4 as it crosses the railway line and travels into north west towards the Allenby Road industrial Estate and continues into Lincoln City;
- PF 535/26/1, PF 186/102/1 – it runs along the north bank of River Witham from Greetwell Hall towards Lincoln city and terminates close to Spa road;
- PF 186/102/2 – runs to the north of River Witham between 186/102/1 and the Viking Way;
- PF 186/136/1 – runs perpendicular to the River Witham in the north direction from the point of contact of PF 186/102/1 and PF186/102/2 and joins into 186/137/1;
- PF 186/137/1 – from the end point of PF 186/136/1 it runs in the north east direction meeting Viking Way south of the Greetwell Road close to a bridge over Lincoln to Market Rasen Railway;
- PF 186/134/1 – runs north from a point on Viking Way near Greet Well Hall to a point south of Greetwell road;

- PF 186/134/2 – forms part of the Viking Way from the south end of 186/134/1 to the north bank of River Witham ending up at the junction of 186/102/2 and PF 94/102/2;
- PF 94/102/1 – forms part of the Viking Way on the north bank of River Witham between Greetwell Hall and Fiskerton;
- PF 186/135/1 – starts at the northern point of PF 186/134/2 and runs north west to the point south of the bridge over Lincoln to Market Rasen Railway;
- PF 186/138/1 – starts from the end point of PF 186/135/1 and runs south of the railway track and meets PF 535/59/4;
- PF 85/9/2 – runs parallel to the south of the River Witham and ends at a fork from where Footpath PF 478/18/2 commences;
- PF 535/28/1 – runs immediately south and parallel to Footpath PF 85/9/2 and merges together at the fork;
- PF 478/18/2 – runs south and parallel to the River Witham before heading south over the delph towards Lincoln Road;
- PF 478/18/1 – connects from Footpath PF 478/18/2 and leads south to Lincoln Road;
- PF 478/13/1 – connects from Footpath PF478/18/2 and veers east parallel to meet Lincoln Road and opposite Church Hill;
- PF 535/54/1, PF85/4/1 – this footpath runs from Washingborough Road and links into the Heighington Road to the west of the Sewage Works;
- PF 85/3/1 – this public footpath runs from a point on Heighington Road near Canwick to south joining Lincoln Road;
- PF 478/8/2 – this footpath starts at a point on Heighington Road south of Sheepwash Grange and runs 50-60m southwards into Glebe Farm fields;
- PF 478/8/1 – it runs from a point on Cliff Lane north of Cliff Farm and runs in south west direction into Glebe Farm fields to join with PF 478/8/2;
- PF 478/16/1 – this is a short footpath which starts from a meeting point of PF 478/8/2 & 478/8/1 and runs into Glebe Farm fields;
- PF 478/10/1 – it starts at a point south of Cliff Lane and traversing through the fields in the south west direction joining into bridleway PB 58/11/1. This footpath links into a number of other pedestrian routes leading into towns of Washingborough, Heighington, and Branston;
- PF 58/4/3 – this short run of the footpath is located south of the Lincoln Road and links into a number of equestrian routes;
- PF 58/4/1 – from the town of Branston, it runs in the westerly direction passing through a hotel and then southwards joining into a network of bridleways;
- PF 58/1/1 – this public footpath starts south of Branston village and runs in the south westerly direction joining into Bloxholm Lane east of the ‘Aircraft Viewing Enclosure’;
- Wragby Road – footways are provided on the north and south side of the Wragby Road. The footway on the north side is provided only up to Greetwell Lane;
- Greetwell Road – a narrow footway exists on the northern side of the Greetwell Road; and

- Heighington Road – used by Ramblers to gain access between PF 85/3/1 and PF 85/4/1.

Public Bridleways and Equestrian Routes

14.4.15 The public bridleways and equestrian routes (routes used by equestrians that are not PRoW) within the study area include the following:

(PB = Public Bridleway)

- PB 94/133/1 – connects from Bridleway PB186/133/1 and runs north east ending west of Cherry Willingham;
- PB 186/133/1 – it runs from a point on Greetwell Road to the north east towards the Lincoln to Grimsby Railway linking near to Green Lane;
- PB 58/5/3 – this bridleway runs north east from a point on Bloxholm Lane that is east of Bracebridge Heath. It links into a chain of other bridleways eventually linking up into Hall Lane which leads into Branston;
- PB 58/5/2 – connects from Bridleway PB 58/5/3 and runs north for a short distance to connect with Bridleway PB 58/5/11;
- PB 58/5/11 – connects from Footpath PF58/5/2 and runs east to connect to Bridleway PB 58/7/2;
- PB 58/7/2 – starts from the junction of PB 58/5/11 and PF 58/4/3 and runs south-east to join into PB 58/7/1;
- PB 58/7/1 – starting at PB 58/7/2 it carries on running towards south east to link into Hall Lane;
- PB 58/2/1 – this bridleway starts at a point on Bloxholm Lane north of the 'Aircraft Viewing Enclosure' and passes through fields to link into the south western end of Hall Lane;
- Heighington Road – this road is currently used by equestrians for access to Branston Road; and
- Bloxholm Lane – equestrian usage is low on this route.

Cycle Routes

14.4.16 The cycle routes within the study area include the following:

- National Cycle Network Route No. 1 – runs along the Sustrans Route south of the River Witham;
- Wragby Road – an off-carriageway cycle path runs along the southern side of Wragby Road, continuing around the outside of the A158 roundabout onto Bunkers Hill;
- Lincoln Road – it currently has an off-road cycle path that runs along its northern side. It is a combined cycle and pedestrian facility; and
- Bloxholm Lane – there are no formal cycle facilities along this route. However, it has been identified by CycleLincs (a local cycle campaign group based in Lincoln) as a quiet road used by a number of local cyclists.

Greenway Routes

14.4.17 A Greenway route is a car-free off-road route that connects people to facilities and open spaces in and around towns, cities and to the countryside, for shared use by people of all abilities on foot, bike or horseback, for commuting, play or leisure.

14.4.18 The Greenway routes within the study area include:

- Hawthorn Road – a Greenways promoted quiet road, used by local cyclists and equestrians as a radial route into the city centre from Cherry Willingham and Reepham east of Lincoln;
- Greetwell Fields – a local access road running between Hawthorn Road and Greetwell Road. Greetwell Fields is found useful by cyclists and is identified as a greenway/quiet road in Lincoln Greenways Strategy. Its use extends to equestrians and ramblers;
- Greetwell Lane – Greetwell Lane is identified within the Lincoln Greenways Strategy as a quiet road and links into the bridleways to Nettleham; and
- Sustrans Route – runs between River Witham and South Delph and links the city centre to Washingborough and beyond.

Non-Motorised User Surveys

14.4.19 Non-motorised user surveys were carried out in December 2004 and October 2007 at a total of 26 locations shown in Figure 14.3. The surveys were carried out for a 12 hour period on a weekday and a weekend day. The weather conditions were observed to be cloudy and foggy during the December 2004 survey, whereas during the October 2007 survey the conditions were noted as fine and dry.

14.4.20 The survey results are located in Appendices B and E of Lincolnshire County Council Lincoln Eastern Bypass: NMU Context Report (Jacobs, December 2007).

14.4.21 The results of both the surveys showed an active use of the public rights of way and other routes in the study area. The routes were observed to be used for both leisure and commuting purposes. The most popular route within the study area appeared to be the Sustrans route which runs along the south bank of River Witham. This route is used by people in the nearby communities for making journeys both leisure and utility to and from Lincoln. The other useful routes within the study area include the following:

- Hawthorn Road;
- Greetwell Fields;
- Viking Way;
- Public rights of ways along the River Witham;
- Heighington Road;
- Lincoln Road; and
- Bloxholm Lane.

Non-Motorised User Accident Data

14.4.22 A total of three NMU related accidents were recorded within the scheme corridor for the period from 1st January 2003 to 30th June 2007. All three of the incidents involved cyclists. All these accidents were categorised as ‘slight’ accidents. The locations were:

- Granson Way, Washingborough village;
- Main Road, Washingborough village, east of LEB route; and
- B1188 Lincoln Road, Branston.

14.4.23 The accident data does not show any serious accidents. During the operation of bypass, re-assignment of traffic into the area would be likely to increase the likelihood of NMU related accidents if safe crossing facilities were not provided.

NMU Usage Predicted Increase with NEQ/SEQ Developments

14.4.24 As noted previously, these developments may have significant effects on NMU route usage, if completed. Figure 14.1 shows locations of the respective proposed developments.

14.5 PREDICTED IMPACTS

14.5.1 Potential effects of the proposed LEB, without mitigation, are described below. Mitigation measures to prevent, reduce or compensate for these effects are set out in Section 14.6, while the residual impacts after mitigation is assessed in Section 14.7 and Table 14.13.

Communities and Community Severance

Impacts During Construction

14.5.2 Most of the communities within the route corridor are self-contained apart from North Greetwell. The lack of the community facilities within North Greetwell means that people either have to travel into Lincoln or Cherry Willingham. During the construction of the roundabout with the A158 Wragby Road the cycle path along the southern side of the A158 Wragby Road would be affected resulting in some temporary closures. This would restrict the movement of the users on cycle path along the A158 Wragby Road. However, the footpaths from North Greetwell leading into Cherry Willingham would not be affected.

14.5.3 The communities of Cherry Willingham, Washingborough, Heighington, and Branston located on the eastern side of the proposed LEB would suffer some severance during construction resulting from the temporary closures of local roads and other routes leading into Lincoln.

14.5.4 The community of Bracebridge Heath located on the western side towards the southern end of the proposed LEB would suffer from the least severance. Only the people trying to access facilities in Branston from the west would suffer from the closure of Bloxholm Lane during the construction of the LEB and the Bloxholm Lane cycle/footbridge.

14.5.5 The identification and assessment of the impacts on the communities during the construction of the LEB is shown in Table 14.7. Refer to Figure 14.1 which highlights where communities are located. Refer to Tables 14.1 and 14.2 which describe Classification of Community Severance and Impact Assessment for Community Severance.

14.5.6 The table sets out the following, in respect of each community in the study area:

- For each community, the ‘baseline’ degree of severance;
- The impacts the proposed scheme would have on community severance during its construction;
- The predicted degree of severance during the construction of the bypass; and
- The degree of change in severance.

Table 14.7: Assessment of Community Severance During the Construction of the LEB

Community	Baseline severance	Impacts during the construction of the LEB	Construction severance	Impact Assessment
North Greetwell	Slight	Construction of the A158 Wragby Road roundabout with LEB to obstruct NMU journeys on the A158 Wragby Road Cycleway.	Moderate	Slight Negative
Cherry Willingham	None	Construction of the Greetwell Road roundabout and realignment of Greetwell Road	Moderate	Moderate Negative
Washingborough	None	Construction of the Washingborough Road roundabout.	Moderate	Moderate Negative
Heighington	None	Construction of the Heighington Road overbridge	Moderate	Moderate Negative
Branston	None	Construction of the Lincoln Road roundabout/subway.	Moderate	Moderate Negative
Bracebridge Heath	Moderate	Construction of Bloxholm Lane cycle/footbridge may obstruct some NMU journeys into Branston.	Moderate	None

Impacts During Operation

14.5.7 Operation is defined as the use of the LEB as a completed road (i.e. immediately after construction) and open to all classes of traffic.

14.5.8 The current traffic heading towards the southeast of Lincoln has to use the A15 and pass through Lincoln city. In the opening year (2016) traffic level would be in the order of 36,000 vehicles per day using the A15 Broadgate in Lincoln city centre.

14.5.9 The construction of the LEB would remove up to one third of the traffic from the A15 Broadgate within Lincoln in the opening year (2016). This should improve the conditions and make the non-motorised user routes within Lincoln more attractive than current conditions.

14.5.10 The bypass scheme would improve conditions for the NMUs within Lincoln by:

- Reducing the amount of through traffic on the A15 resulting in less interaction with the local traffic and causing less congestion; and,
- Reducing the amount of HGVs within Lincoln resulting in improved safety on the NMU routes and roads which should make them more attractive to users.

14.5.11 By removing the through traffic from the A15 onto LEB, there would be a reduction in severance within Bracebridge Heath resulting in a slightly positive affect on community severance.

14.5.12 The LEB scheme would also have a positive impact by providing a link over the River Witham thus reducing the severance between the communities north and south of the river.

14.5.13 The potential effects of the scheme in relation to community severance during operation are set out in Table 14.8. Refer to Tables 14.1 and 14.2 which describe Classification of Community Severance and Impact Assessment for Community Severance.

14.5.14 The table sets out the following, in respect of each community in the study area:

- For each community, the 'baseline' degree of severance;
- The effect the proposed scheme would have on community severance;
- The predicted degree of severance after opening of the bypass; and
- The degree of change in severance.

Table 14.8: Assessment of Community Severance During the Operation of the LEB

Community	Baseline severance	Impacts during the operation of the LEB	Permanent severance	Impact Assessment
North Greetwell	Slight	Creation of a four arm roundabout at a junction between A158 Wragby Road and LEB. Increase in traffic on the roundabout.	Severe	Moderate Negative
Lincoln City	Moderate	Creation of LEB would remove traffic through city centre thus improving "radial" severance	Slight	Slight positive
Cherry Willingham	None	At-grade crossing between Greetwell Road and LEB would increase traffic on Greetwell Road.	Moderate	Moderate Negative
Washingborough	None	At-grade crossing between Washingborough Road and LEB would increase traffic on Washingborough Road.	Moderate	Moderate Negative
Heighington	None	Grade separated crossing between Heighington Road and LEB would result in little increase in traffic on Heighington Road.	None	None
Branston	None	At-grade crossing between Lincoln Road and LEB would result in increase in traffic on Lincoln Road.	Moderate	Moderate Negative
Bracebridge Heath	Moderate	Reduction in the traffic flow on the A15 passing through Bracebridge Heath	Slight	Slight Positive

Community Facilities Before Mitigation

Impact during Construction

14.5.15 The only community facilities within the route corridor that would be impacted by the construction of the bypass are the leisure routes along the banks of the River Witham. During the construction of the bridge over the River Witham, these routes would be likely to need to be temporarily closed during beam lifts and construction of columns. The impact on these routes is assessed as minor adverse during the construction period.

Impacts during Operation

14.5.16 The affect on the leisure routes along the banks of the River Witham would only be 'minor adverse' due to the permanent 'minor loss' of amenity after the opening of the bypass.

Non-motorised User Routes Before Mitigation

Impacts during Construction

14.5.17 The construction of the LEB would impact a number of public rights of way and local roads/routes within the route corridor. Most of the routes would need to be temporarily closed or would need to be diverted during the construction of the LEB.

14.5.18 The impacts on the non-motorised user routes due to the construction of the bypass are set out in the Table 14.9. Refer to Tables 14.3 and 14.4 which describe Assessment of the Sensitivity of Public Rights of Way and Typical Criteria for Magnitude of Impact on Public Rights of Way.

14.5.19 The table sets out the following:

- The 'sensitivity' of each non-motorised user route;
- The impact the proposed scheme would have on route during the construction; and
- The magnitude of the predicted impact during the construction period.

Table 14.9: Impacts on NMU Routes During Construction

PRoWs and Local Roads/Routes	Sensitivity	Impacts during the construction of the LEB	Impact severity
Cycle path along the south end of the A158 Wragby Road	Medium	Temporary closure of the cycle path during the construction of the A158 Wragby Road roundabout.	Minor Adverse (Temporary closure < 1month)
PF 186/140/1	Low	A section of the footpath on the eastern side of the LEB would be permanently closed.	Major Adverse (permanent closure of a section of PF)
Hawthorn Road	Medium	Temporary closure of Hawthorn Road.	Moderate Adverse (Temporary closure > 1month)
PF 186/139/1	Medium	Northern section of the footpath to be diverted to link into Greetwell Fields	Negligible (Temporary closure <1day)
Greetwell Fields	High	The LEB would sever the route.	Moderate Adverse (Temporary closure > 1month)
Greetwell Road	High	Temporary closure of Greetwell Road during the construction of the roundabout.	Moderate Adverse (Temporary closure > 1month)
PF 535/58/2	Low	The footpath would be permanently closed.	Major Adverse (Permanent closure of PF)
Viking Way (186/138/1)	Very High	Temporary closure of the long distance footpath for 1 month or less.	Minor Adverse (Temporary closure < 1month)

PRoWs and Local Roads/Routes	Sensitivity	Impacts during the construction of the LEB	Impact severity
PF 535/26/1	High	Temporary closure of the footpath for 1 month or less.	Minor Adverse (Temporary closure < 1month)
Sustrans Route / NCN Route No. 1	Very High	Temporary closure of the route for 1 month or less.	Minor Adverse (Temporary closure < 1month)
Washingborough Road	Medium	None apart from construction traffic disruption/inconvenience	Negligible (possible temporary closures up to 1 day)
Heighington Road	High	Temporary closure of Heighington Road during the construction of the overbridge.	Moderate Adverse (Temporary closure > 1month)
Lincoln Road	High	None apart from construction traffic disruption/inconvenience	Negligible (possible temporary closures up to 1 day)
Bloxholm Lane	High	Temporary closure during the construction of the Bloxholm Lane cycle/footbridge.	Minor Adverse (Temporary closure < 1month)
A15 Sleaford Road	Negligible	None apart from construction traffic disruption/inconvenience	Negligible (possible temporary closures up to 1 day)

Impacts During Operation

14.5.20 A number of non-motorised user routes within the route corridor would be affected after the opening of the bypass.

14.5.21 Public footpath PF 186/140/1, between the A158 Wragby Road and the Hawthorn Road, is severed by the LEB route. A section of this footpath on the eastern side of the bypass would be permanently closed. Public footpath PF 535/58/2 located on the Greetwell Road would also be permanently closed. The usage of both these footpaths was observed to be 'low'.

14.5.22 The public footpath PF 186/139/1 on the western side of the Greetwell Fields is to be diverted to link into Greetwell Fields.

14.5.23 The predicted impacts on the non-motorised user routes during the operation of the LEB are set out in the Table 14.10.

Table 14.10: Impacts on NMU Routes During Operation

PRoWs and Local Roads/Routes	Sensitivity	Impacts during the operation of the LEB	Impact severity
Cycle path along the south end of the A158 Wragby Road	Medium	Creation of a four arm roundabout at a junction between the A158 Wragby Road and LEB. Increase in the journey time and loss of amenity.	Moderate Adverse (Journey time inc. > 10%, Loss of amenity)
PF 186/140/1	Low	The section of the footpath on the eastern side of the LEB to be permanently closed.	Major Adverse (Permanent closure)
Hawthorn Road	Medium	LEB to pass under the Hawthorn Road Overbridge	Negligible (grade-separation)
PF 186/139/1	Medium	Footpath to be slightly diverted to link into Greetwell Fields.	No Change
Greetwell Fields	High	LEB to sever route and prevent access between parts.	Major Adverse (Route would be severed)
Greetwell Road	High	At-grade crossing between the LEB and Greetwell Road to increase journey time for NMUs.	Moderate Adverse (at-grade crossing)
PF 535/58/2	Low	The footpath is likely to be permanently closed.	Major Adverse (permanent closure)
Viking Way (186/138/1)	Very High	LEB to sever route of the Viking Way.	Major Adverse (Route would be severed)
PF 535/26/1	High	LEB to sever route of the footpath.	Major Adverse (Route would be severed)
Sustrans Route / NCN Route No. 1	Very High	LEB to sever Sustrans route and NCN Route No.1	Major Adverse (Route would be severed)
Washingborough Road	Medium	At-grade crossing between the LEB and Washingborough Road to increase journey time for NMUs.	Moderate Adverse (at-grade crossing)
Heighington Road	High	LEB to pass under the Heighington Road Overbridge.	Negligible (grade-separation)
Lincoln Road	High	At-grade crossing between the LEB and Lincoln Road to increase journey time for NMUs.	Moderate Adverse (at-grade crossing)
Bloxholm Lane	High	LEB to pass under the Bloxholm Lane cycle/footbridge.	Negligible (grade-separation)
A15 Sleaford Road	Negligible	At-grade crossing between the LEB and A15 Sleaford Road.	Moderate Adverse (at-grade crossing)

PRoWs and Local Roads/Routes	Sensitivity	Impacts during the operation of the LEB	Impact severity
A15 into Lincoln city (London Road)	Negligible	None	Minor Beneficial (improvement to amenity – reduction in traffic)

Impacts on Physical Fitness

Impact During Construction

14.5.24 During the construction of the LEB a number of the public rights of ways and local roads/routes would be affected. The closure times would be kept to the minimum possible and suitable diversions would be put in place to maintain the safe continuity of the routes during the construction period. Despite this some people would be deterred from undertaking physical activities resulting in a negative affect on physical fitness.

Impact During Operation

14.5.25 The permanent closure of footpath PF 535/58/2 and a section of PF 186/140/1 would not have a major impact as the usage of these footpaths was observed to be low.

14.5.26 New crossing facilities have been included in the design of the bypass to maintain the continuity of the NMU routes. A principle of grade-separation has been adopted on popular routes to minimise the impact on the physical fitness of the communities by providing safe facilities.

14.5.27 The scheme includes the provision of a new cycle/footway along the length of the bypass on the western side. This facility provides new links to the existing public rights of way network, particularly the Sustrans route and the Viking Way. This would increase the accessibility of these routes resulting in a positive affect on the physical fitness.

14.5.28 The construction of the LEB would reduce the traffic within Lincoln thus improving conditions for the NMUs and encouraging people to either continue or take up walking and cycling. This would also have a positive impact upon the physical fitness of the people in and around Lincoln.

14.6 MITIGATION OF IMPACTS

Community Severance

Mitigation of Impacts During Construction

14.6.1 To reduce or eliminate Community Severance, the following NMU facilities are to be included within the LEB proposals (please refer to Figures 14.4a to 14.4c):

- A cycleway/footway is to be provided along the whole of the western side of the LEB – sections of the eastern side also have a facility proposed to link other facilities or existing NMU routes;
- Hawthorn Road overbridge would have equestrian parapets to allow passage of horse-riders across the LEB. Also, the LEB cycleway/footway would have links to Hawthorn Road to promote connectivity;
- Greetwell Fields would be diverted along the eastern boundary of the LEB to re-connect to Greetwell Road and Hawthorn Road. Greetwell Fields would become a bridleway, and would be stopped up to vehicles at Greetwell Road;

- A grade separated NMU overbridge would be provided north of the proposed Greetwell Road roundabout;
- A link to the Viking Way from the LEB cycleway/footway. The Viking Way would be retained under the Lincoln to Market Rasen Railway structure;
- The LEB cycleway/footway continues over River Witham;
- A link from the LEB cycleway/footway to the Sustrans route via a new footbridge over the South Delph;
- The LEB cycleway/footway would connect to Heighington Road, which would have equestrian standard parapets over the bridge;
- A subway would be installed under the LEB north of the proposed B1188 Lincoln Road roundabout; and
- A grade separated NMU bridge would be provided to allow safe movement of NMUs across the LEB at Bloxholm Lane.

14.6.2 Most of the communities within the route corridor were identified to suffer some sort of severance during the construction period.

14.6.3 Community severance is mainly caused by the impacts on the non-motorised user routes crossing the LEB during the construction of the bypass. The contractor would have the responsibility to provide safe continuity of the routes along the existing line of travel, where required or provide suitable diversions.

Mitigation of Impacts During Operation

14.6.4 A number of mitigation measures are proposed to reduce the impact on the community severance following completion of the LEB and to promote increased use by the non-motorised users. These measures are included in Table 14.11.

Table 14.11: Mitigation of Impacts on Community Severance During the Operation of the LEB

Community	Do minimum severance	Mitigation measures during the operation of the LEB	Do something severance	Residual Impact Assessment
North Greetwell	Slight	Cycle path along the A158 Wragby Road to be diverted along the eastern side of the LEB down to Hawthorn Road and across on the western side over Hawthorn Road overbridge. Increase in the journey length of approx 750m.	Moderate	Slight Negative
Lincoln City	Moderate	Major benefit to NMUs in city centre as less through traffic present	Slight	Slight Positive
Cherry Willingham	None	Footbridge provided on the north side of the Greetwell Road roundabout.	Slight	Slight Negative

Community	Do minimum severance	Mitigation measures during the operation of the LEB	Do something severance	Residual Impact Assessment
Washingborough	None	Uncontrolled pedestrian/cycle crossing facility provided north of the Washingborough Road roundabout. However, NMU routes parallel to the River Witham are easily accessible from Washingborough.	Moderate	Moderate Negative
Heighington	None	Grade-separation of Heighington Road (Heighington Rd. overbridge).	None	None
Branston	None	Subway provided north of the Lincoln Road roundabout.	Slight	Slight Negative
Bracebridge Heath	Moderate	NMU bridge at Bloxhom Lane	Slight	Slight Positive

Community Facilities

14.6.5 The temporary closure of the leisure routes along the banks of the River Witham may be unavoidable during the construction of the River Witham Bridge. However, the time of the closures would be kept to the necessary minimum and is likely to be less than one month. Reducing impact can also be explored by programming the construction during the months of low usage or night time. Temporary alternative routes would be provided by the contractor to minimise the disruption, where possible. The impact on the community facilities after mitigation is assessed as 'Minor Adverse'.

Non-Motorised User Routes

Mitigation of Impacts During Construction

14.6.6 A number of public rights of ways and other routes/roads would be affected during the construction of the LEB. Some of the routes would need to be temporarily closed while others would need to be diverted. Temporary alternative routes would be provided by the contractor to minimise the disruption, where possible. The Table 14.12 below shows the proposed mitigation of the impacts on the non-motorised user routes during construction.

Table 14.12: Mitigation of Impacts on NMU Routes During Construction of the LEB

PRoWs and Local Roads/Routes	Sensitivity	Mitigation measures during the construction of the LEB	Residual Impact severity
Cycle path along the south end of the A158 Wragby Road	Medium	Suitable temporary diversion for cycle path during construction of the A158 Wragby Road roundabout.	Minor Adverse (Journey time inc <10%, minor loss of amenity)
PF 186/140/1 (connection to Hawthorn Road)	Low	Temporary footpath diversion to re-connect to Hawthorn Road.	Moderate Adverse (Journey time inc >10%, closure > 1month)

PRoWs and Local Roads/Routes	Sensitivity	Mitigation measures during the construction of the LEB	Residual Impact severity
Hawthorn Road	Medium	Temporary closure of Hawthorn Road unavoidable. NMUs to be diverted onto Greetwell Fields and PB 186/133/1 and onto Footpaths leading into North Greetwell and then onto A158 Wragby Road.	Moderate Adverse (Journey time inc >10%, closure > 1month)
PF 186/139/1	Medium	None required – not directly affected	Negligible
Greetwell Fields	High	Route to be closed only after the construction of the new NMU route along the eastern side of the LEB to reduce impact on the NMU journeys.	Minor Adverse (closure < 1month)
Greetwell Road	High	Temporary closure of Greetwell Road unavoidable. Temporary NMU route to be provided on the south/north side to reduce impact on the NMU journeys.	Minor Adverse (Journey time inc <10% with temp div.)
PF 535/58/2 (connection to Greetwell Road)	Low	Temporary diversion to re-connect to Greetwell Road during construction.	Minor Adverse (closure < 1month)
Viking Way (186/138/1)	Very High	Either temporary closure to be programmed during the months of low usage or suitable temporary diversion to be made to allow continuity of Viking Way.	Minor Adverse (closure < 1month)
PF 535/26/1	High	Either temporary closure to be programmed during the months of low usage or suitable temporary diversion to be made to allow continuity of use of PF 535/26/1.	Minor Adverse (closure < 1month)
Sustrans Route / NCN Route No. 1	Very High	Either temporary closure to be programmed during the months of low usage or suitable temporary diversion to be made to allow continuity of use of Sustrans Route.	Minor Adverse (closure < 1month)
Washingborough Road	Medium	NMUs to be diverted along the Sustrans route.	Minor Adverse (Journey time inc <10% with temp div.)
Heighington Road	High	NMUs to be diverted along the Sustrans route or Lincoln Road.	Moderate Adverse (Journey time inc >10% with temp div.)
Lincoln Road	High	Temporary NMU route to be provided on the south/north side to reduce impact on the NMU journeys.	Minor Adverse (Journey time inc <10% with temp div.)

PRoWs and Local Roads/Routes	Sensitivity	Mitigation measures during the construction of the LEB	Residual Impact severity
Bloxholm Lane	High	Construction to be programmed such that Bloxholm Lane is closed to NMUs only after Bloxholm Lane footbridge is in operation.	Minor Adverse (closure < 1month)
A15 Sleaford Road (west and east sides)	Negligible	Temporary diversion to south verge to allow continuity of NMU route around proposed roundabout.	Minor Adverse (Journey time inc <10% with temp div.)

Mitigation of Impacts During Operation

14.6.7 The scheme design already incorporates permanent diversions of the A158 Wragby Road cycle path, and the Greetwell Fields, to mitigate for the severance caused by the LEB route. Details of proposed diversions and NMU facilities are shown on Figures 14.4a – 14.4c.

14.6.8 New grade-separated crossing facilities have been provided across the LEB on Hawthorn Road, Greetwell Road, Heighington Road, Lincoln Road, and Bloxholm Lane. The grade-separated crossing facilities include provisions for the use by equestrians and cyclists.

14.6.9 The route of the LEB runs on bridges over the Viking Way, the PF 535/26/1, and the Sustrans Route.

14.6.10 All new facilities and diversions along the LEB route have been designed in accordance with the relevant DMRB standard[39].

14.6.11 The mitigation of impacts caused by the operation of the LEB are summarised in Table 14.13.

Table 14.13: Mitigation of Impacts on NMU Routes During Operation of the LEB

PRoWs and Local Roads/Routes	Sensitivity	Mitigation of impacts during the operation of the LEB	Residual Impact severity
Cycle path along the south end of the A158 Wragby Road	Medium	Cycle path along the A158 Wragby Road to be diverted along the eastern side of the LEB down to Hawthorn Road and across on the western side over Hawthorn Road overbridge. Increase in the journey length of approx 750m.	Moderate Adverse (Journey time inc. >10%)
PF 186/140/1	Low	A new pedestrian/cycle facility is provided on the eastern side of the LEB between A158 Wragby Road and Hawthorn Road.	Minor Beneficial (provision of new and improved facility)
Hawthorn Road	Medium	Hawthorn Road overbridge to include improved facilities for NMUs including provisions for equestrians and cyclists.	Minor Beneficial (provision of new and improved facility)

[39] DMRB Volume 6, Section 3, Part 5, 'The geometric design of pedestrian, cycle and equestrian routes' (TA90/05)

PRoWs and Local Roads/Routes	Sensitivity	Mitigation of impacts during the operation of the LEB	Residual Impact severity
PF 186/139/1	Medium	Footpath to be slightly diverted to link into Greetwell Fields.	No Change
Greetwell Fields	High	Northern section of Greetwell Fields to connect to the cycle/footway facility on the western side of the LEB and southern section to run along the eastern side and connect into Hawthorn Road. Southern section to provide a new improved surface.	Negligible (slight inc in journey time but new and improved facility is provided)
Greetwell Road	High	Footbridge to be provided on the north side of the roundabout to cross LEB.	Minor Adverse (grade-separation)
PF 535/58/2	Low	None	Minor Adverse
Viking Way	Very High	LEB to pass on a bridge over Viking Way.	Minor Adverse (minor loss of visual amenity)
PF 535/26/1	High	LEB to pass on a bridge over footpath.	Minor Adverse (minor loss of visual amenity)
Sustrans Route / NCN Route No. 1	Very High	LEB to pass on a bridge over Sustrans route and NCN Route No.1. Improved linkages to Washingborough Road via the LEB cycleway/footway and bridge to Sustrans route.	Minor Adverse (minor loss of visual amenity)
Washingborough Road	Medium	Uncontrolled at-grade pedestrian/cycle crossing facility on the north side of Washingborough Road roundabout.	Moderate Adverse (Uncontrolled at-grade facilities)
Heighington Road	High	Heighington Road Overbridge to include improved facilities for NMUs including provisions for equestrians and cyclists.	Negligible (grade-separation)
Lincoln Road	High	A subway suitable for pedestrians and cyclists to be provided north of the Lincoln Road roundabout.	Minor Adverse (grade-separation)
Bloxholm Lane	High	Bloxholm Lane cycle/footbridge to include improved facilities for NMUs including provisions for equestrians and cyclists.	Negligible (grade-separation)
A15 Sleaford Road	Negligible	New cycle/footway to be provided to the south of the roundabout with A15 Sleaford Road.	Minor Adverse (Provision of new NMU facility)

PRoWs and Local Roads/Routes	Sensitivity	Mitigation of impacts during the operation of the LEB	Residual Impact severity
A15 into Lincoln city (London Road)	Negligible	Motorised traffic expected to reduce on A15 route into city centre	Minor Beneficial (improvement to amenity – reduction in traffic)

Consultation with NMU Organisations

14.6.12 The results of the consultations with the non-motorised user organisations undertaken in October 2007 and January 2009 are summarised in Appendix 14A.

14.7 RESIDUAL IMPACTS

Community Severance

14.7.1 The construction of the bypass would result in an increase in traffic on some of the local roads but would reduce the traffic flows in other areas. It is anticipated that certain vulnerable users would be deterred from making non-motorised journeys. However, the scheme design incorporates new crossing facilities across the bypass and over River Witham and improved access to the existing facilities within the study area. The resulting impact on the community severance is therefore assessed as 'Neutral'.

Community Facilities

14.7.2 There would be a minor loss of amenity on the NMU routes along the banks of River Witham after the opening of the bypass. The assessment of landscape and visual impact has been undertaken in Chapter 9 of this Environmental Statement. The residual impact on the community facilities is therefore assessed as 'Slight Negative'.

Non-Motorised User Routes

14.7.3 The residual impacts after mitigation on the non-motorised user routes are identified in Table 14.14 below.

Table 14.14: Residual Impacts on NMU Routes

PRoWs and Local Roads/Routes	Sensitivity	Residual Impact	Residual Impact severity
Cycle path along the south end of the A158 Wragby Road	Medium	Increase in the journey length of approx 750m.	Moderate Negative
PF 186/140/1	Low	The footpath on the eastern side of LEB is permanently stopped but a new pedestrian/cycle facility is provided.	Neutral
Hawthorn Road	Medium	Grade-separation of Hawthorn Road. Improvement in the amenity of the route.	Neutral
PF 186/139/1	Medium	Footpath to be slightly diverted to link into Greetwell Fields.	Neutral
Greetwell Fields	High	Permanent diversion of the route. Increase in the journey time. Provision of new improved surface.	Slight Positive

PRoWs and Local Roads/Routes	Sensitivity	Residual Impact	Residual Impact severity
Greetwell Road	High	Increase in the traffic on Greetwell Road. Footbridge to be provided on the north side of the roundabout.	Slight Negative
PF 535/58/2	Low	Footpath to be permanently stopped but new foot/cycleway facilities provided on the Greetwell Road west of the LEB route.	Neutral
Viking Way	Very High	Loss of amenity on the route.	Slight Negative
PF 535/26/1	High	Loss of amenity on the route.	Slight Negative
Sustrans Route / NCN Route No. 1	Very High	Loss of amenity on the route.	Slight Negative
Washingborough Road	Medium	Increase in traffic on Washingborough Road. At-grade pedestrian/cycle crossing facility provided. Increase in the journey time, reduction in safety and amenity.	Moderate Negative
Heighington Road	High	Grade-separation of Heighington Road. Improvement in the amenity of the route.	Neutral
Lincoln Road	High	A subway provided north of the Lincoln Road roundabout.	Slight Negative
Bloxholm Lane	High	Improvement in the amenity of the route.	Neutral
A15 Sleaford Road	Negligible	Provision of new cycle/pedestrian facility on the south side.	Neutral
A15 into Lincoln city (London Road)	Negligible	New route along LEB would connect to other NMU routes so NMUs would not need to use A15 into Lincoln city centre	Major Beneficial

Physical Fitness

14.7.4 The design of the LEB incorporates continuity of the existing routes where possible and provides suitable diversions of other routes. This would encourage people to maintain the existing level of walking and cycling in the region.

14.7.5 The design of the LEB also includes the provision of a new cycle/footway facility on the western side with new links to the existing network of NMU routes. This would provide new facilities for walking and cycling in the region thus having a positive affect on the physical fitness.

14.7.6 The existing conditions for NMUs within Lincoln would also be improved by the reduction of traffic on A15, thus encouraging more people to take up walking and cycling.

14.7.7 It is therefore assessed that the scheme would have a 'Moderate Positive' affect on the physical fitness of the communities within the route corridor.

15 VEHICLE TRAVELLERS

15.1 INTRODUCTION

15.1.1 This chapter assesses the impact of the development on existing vehicle travellers using the A15 through Lincoln and local roads (See Fig. 15.1). The way in which these are assessed is in relation to aspects of the travellers' experience: the amount of stress felt by drivers; and the quality and extent of views had by drivers as they travel through the study area. Therefore, the assessment has been split to reflect these aspects of the driver's experience.

15.1.2 Views have been considered in terms of the main north-south movement of traffic along the A15 roads from the existing A158 Lincoln Relief Road / Wragby Road roundabout to A15 Sleaford Road. Roads which are crossed by or join the proposed alignment / junction areas of the LEB, have also been carried out for each direction travelled (mostly east-west).

15.2 POLICY AND LEGAL CONTEXT

15.2.1 The need to consider vehicle travellers as part of the Environmental Impact Assessment of roads is required by European and UK legislation as described in Chapter 1.

15.3 APPROACH AND METHODS

15.3.1 For the purposes of clarity and comparison, the assessment of both divers stress and views from the road have been undertaken separately and therefore each section assesses the existing condition (baseline); predicted impacts, mitigation and the summary of effects independently.

Driver Stress

15.3.2 The DMRB guidance identifies three factors which can lead to a driver becoming stressed. These are:

- Frustration;
- Fear of potential accidents; and
- Uncertainty.

15.3.3 A driver's frustration will increase as speed falls in relation to their expectations. A reduction in speed can occur due to anything from high flow levels to road works.

15.3.4 A driver's level of fear may increase due to a combination of factors, notably, the presence of other vehicles, inadequate sight distances and the likelihood of pedestrians, particularly children, stepping into the road. Fear is highest when speeds, flows and the proportions of HGVs are high.

15.3.5 Additional factors affecting driver stress are inadequate lighting, narrow roads, road works and poorly maintained road surfaces.

15.3.6 Route uncertainty is primarily caused by inadequate signage. The DMRB guidance for Vehicle Travellers (1993:4) states that "good design and layout of signs can go a long way towards eliminating this cause of stress from new road schemes".

15.3.7 Evidence available on the causes and affects of driver stress is not comprehensive enough to permit a detailed assessment. The core of this assessment has used the three point descriptive scale as set out for dual carriageways and single carriageways, illustrated in DMRB and as shown in Tables 15a and 15b below.

15.3.8 In brief, the scales are based on assessing the inter-relationship between traffic speeds and flows. From this a traffic movement along a link is assigned a stress level; low, moderate or high.

Table 15a: Three-Point Descriptive Scale for Dual Carriageway Roads

Average peak hourly flow per lane, in flow units/ 1 hour	Average Journey Speed Km/hr		
	Under 60	60-80	Over 80
Under 1200	High*	Moderate	Low
1200-1600	High	Moderate	Moderate
Over 1600	High	High	High

* ”Moderate” in Urban Area

Table 15b: Three-Point Descriptive Scale for Single Carriageway Roads

Average peak hourly flow per lane, in flow units/ 1 hour	Average Journey Speed Km/hr		
	Under 50	50-70	Over 70
Under 600	High*	Moderate	Low
600 – 800	High	Moderate	Moderate
Over 800	High	High	High

* ”Moderate” in Urban Area

15.3.9 Traffic flows have been produced based on the assumption that a car or light van equals one flow unit.

15.3.10 Although the core of this assessment used a three point descriptive scale, information on local conditions collected during site visits have also been considered. Specifically, lighting, signage, road widths, frequency of road works, and road surface quality.

15.3.11 The assessment has been made for the Opening Year (2016) ‘do nothing’ and ‘do something’ scenario and the Design Year (2031) ‘do nothing’ and ‘do something’ scenarios.

15.3.12 The ‘do nothing’ assessment has used traffic data modelled for the A15 through the centre of Lincoln. This approach has been taken with consideration of the DMRB guidance which states that “driver stress should be assessed… for the existing route network which would be affected by a scheme”. Figure 15.1 and Appendix 15A, illustrate the movements of the existing route, assessed alongside those of the proposed LEB.

Views from the Road

15.3.13 Information was gathered through field surveys undertaken in January and February 2009. These surveys were undertaken at the same time as the wider landscape and visual impact assessment survey (see Chapter 9 and Appendices 9A-D).

15.3.14 The assessment of views from the road are in accordance with DMRB Volume 11, Section 3, Part 9, however in light of the lack of criteria within this guidance, the scoring criteria identified within Transport Analysis Guidance (WebTAG) section 3.3.13 has been adopted, which provides a simple “*neutral, better* or *worse*” score for comparison of views. The full assessment of views are described in Appendix 15B.The assessment consists of a description of existing views (baseline) for the each of the routes; followed by a description of anticipated views (predicted impacts) from the same route / movement using the proposed LEB (design year). The

difference in views (effects) is then summarised for all assessment years and compiled in Appendix 15B

15.3.15 The effects were assessed with and without mitigation for the construction year (2013), opening year (2016) and design year (2031) taking account of mitigation planting proposed within the Environmental Masterplan (Refer to Appendix 9E).

15.4 ASSUMPTIONS AND LIMITATIONS

15.4.1 The baseline condition for drivers stress is assumed to be high due to drivers having to pass through the city centre and their route being restricted to narrow, low speed roads. The typical route is shown on Figure 15.1.

15.4.2 It has also been assumed that for the future baseline views, that there are no major road schemes affecting any of the existing routes assessed.

15.4.3 Further for the 'do minimum' scenario, it is assumed that there will be no change from existing views from the road as there are no known or planned developments that would affect them.

15.4.4 It is assumed that on many of the minor roads crossing the scheme, traffic management would be incorporated to divert traffic during the construction phase of the works.

15.5 BASELINE CONDITIONS

Driver Stress

15.5.1 Drivers can experience stress as a result of frustration, route uncertainty and fear of accidents. These can occur as a result of congestion and slow moving traffic, poor signage and negotiating busy junctions.

15.5.2 At present, drivers' experience of frustration is concentrated between South Park Avenue, along Canwick Road and over the Pelham Bridge to the top of Broadgate, where the majority of slow moving traffic and congestion is most noticeable with few alternative routes available to the driver.

15.5.3 There are particularly confusing road signs along Neville Street and Canwick Road where gantries and the shared lane use alter depending on peak hours flows, which creates a high level of fear of accidents at certain times of the day.

15.5.4 There are also two junctions that are confusing to negotiate (junction with Cross O' Cliff Road and South Park Avenue to the south; and Lindum Road and Greetwell Gate in the city centre to the north).

Views from the Road

15.5.5 The existing route as shown on Fig 15.1 is described and assessed in detail in Appendix 15B and summarised below. Views from other routes that would either pass over or under the alignment of the LEB are also described

Main Route from Wragby Road to Sleaford Road

15.5.6 Views travelling southbound from the Wragby Road roundabout are focussed towards Lincoln along Wragby Road. The views extend to semi-detached housing across gardens and open space areas. Views are also focussed towards Lincoln Cathedral ('Long' View into Lincoln (Policy 55 - City of Lincoln Local Plan)) a noticeable landmark of Lincoln. These views become more enclosed when turning south through denser housing and some commercial buildings.

15.5.7 Views open out on Lindum Road and then become restricted again on Broadgate until crossing the River Witham on Melville Street where brief glimpses to industrial buildings are available to the east.

15.5.8 On passing the railway and bus stations, the views become more open over the Pelham Bridge but are still contained to the east by large industrial buildings.

15.5.9 From here the views are contained by housing and industrial buildings on Canwick Road. Gantries also detract and are noticeable in the restricted and narrow view.

15.5.10 Views are then directed west along South Park Avenue towards South Common and housing with commercial warehouses noticeable larger scale buildings and forecourts.

15.5.11 The route continues around the foot of South Common and uphill on Cross O'Cliff Hill, where views are contained by vegetation and semi-detached houses along the roadside. There are some glimpsed views to agricultural land to the northeast and south through gaps in vegetation, but these are only partially visible before entering Bracebridge Heath semi-detached housing on London Road.

15.5.12 On passing the junction with Canwick Road onto Sleaford Road, views extend to some industrial units to the north and newer housing to the south before opening out to agricultural land on leaving the village edge.

15.5.13 Views out to the countryside are therefore confined to glimpsed views along certain roads and to the ends of the route where the roads extend out of Lincoln into the rural countryside beyond (Wragby Road and Sleaford Road).

15.5.14 Views travelling northbound on the route would be similar to those described above. However, on travelling from Pelham Bridge to Broadgate, Lincoln Cathedral is particularly focussed due to the direction of travel.

Other Routes

15.5.15 Travelling west on Hawthorn Road, views are dominated by housing to the east of Lincoln with views south west over agricultural fields, with the Cathedral in the distance. Travelling east, views extend across fields towards North Greetwell and Cherry Willingham. The southern slope of the Witham valley is visible in the distance to the south.

15.5.16 Travelling west on Greetwell Road, good quality views look out towards the Witham valley bottom and towards industrial edges of Lincoln with the Cathedral noticeable on the horizon, partially restricted by undulating topography and vegetation to the edge of Lincoln and along the road itself. Travelling east, views are enclosed by vegetation and industrial buildings until they become more open, across agricultural fields towards Greetwell, the valley bottom and the southern slope.

15.5.17 Travelling west on Washingborough Road, views look out towards the River Witham Valley bottom, the Lincoln to Spalding railway embankment and towards Lincoln and the Cathedral. Views towards the northern slope of the valley are restricted by vegetation along road, the South Delph and the River Witham. Travelling east, views are restricted by embankments and vegetation of the sewage works and the Lincoln to Spalding railway embankment, but then partially open out to the valley bottom fenland, on passing under the railway bridge, mostly restricted by vegetation along the South Delph and the River Witham.

15.5.18 Travelling west on Heighington Road, views look out over agricultural fields towards the woodland at Canwick and Sheepwash Grange, Glebe Farm and Manor Farm on the ridgeline. Lincoln Cathedral, Lincoln and the northern slope of the Witham valley are visible in the distance. Low level views into the valley bottom are partially obstructed by the roadside hedgerow. Travelling east, views look out over agricultural fields towards Washingborough with Sheepwash Grange, Glebe Farm and Manor Farm on the ridgeline. Branston is visible in the distance to the south east and the northern slope of the Witham valley to the north east.

15.5.19 Travelling west from Branston on Lincoln Road, views look out over undulating agricultural fields towards Canwick Heath Farm, Highfield Grange and the woodland at Canwick. Lincoln Cathedral is visible in the distance on the horizon. In the opposite direction, views look out over agricultural fields towards Canwick Heath Farm, Highfield Grange and towards Branston. Views north east are partially obstructed in places by woodland blocks to the north of the road. Low level views are partially obstructed by the roadside hedgerow.

15.5.20 Travelling west on Bloxholm Lane, views look out over agricultural fields towards the woodland at the Manor House and towards Bracebridge Heath. Low level views to the west are partially obstructed by the roadside hedgerow; views to the north are screened by vegetation on the road side and near to Westfield bungalows. Travelling east, views look out over agricultural fields towards Westfield Farm Bungalows and towards the woodland at Branston in the distance.

15.6 PREDICTED IMPACTS – DRIVERS' STRESS (FOR TABLES REFER TO APPENDIX 15A)

Construction Impacts

15.6.1 There is potential for a temporary increase in frustration, and therefore stress, along the existing route during the construction of LEB. This is considered in more detail in Chapter 16; disruption due to construction.

Operational Impacts – Opening Year 2016

15.6.2 Table 15-D indicates that, under the 'do nothing' scenario, drivers using the A15 to travel into or through Lincoln experience a moderately stressful journey. Drivers travelling south along Bunkers Hill (A15) would experience moderate levels of stress.

15.6.3 Table 15-E indicates that, under the 'do something' scenario, drivers travelling north and south along the LEB would experience low levels of stress throughout. Therefore, for drivers travelling between the north and the south, the 'do something ' scenario would be less stressful than the do minimum.

15.6.4 Drivers using many of the road links that adjoin the LEB along its route would largely experience high levels of stress.

15.6.5 In summary, drivers using the LEB and the roads affected by the LEB would experience low stress levels on 16 movements, moderate stress levels on one of the movements and high stress levels on eleven movements.

Operational Impacts – Design Year 2031

15.6.6 Table 15-F indicates that in 2031, under the 'do nothing' scenario, drivers using the A15 to travel into or through Lincoln would experience moderate levels of stress throughout their journey. This level of stress has been assessed following the DMRB guidance, which states that movements on single carriage roads in an urban area, with an average speed of less than 50 km/h and with an average peak hourly flow (flow Units/ hour) of below 600, should be categorised as moderately stressful. In a non-urban area, a movement under the same conditions would be assessed as highly stressful.

15.6.7 Table 15-G indicates that, under the 'do something' scenario, in 2031, drivers travelling north and south along the LEB would experience low levels of stress throughout. However, drivers using many of the roads that adjoin the LEB along its route would experience high levels of stress. In summary, drivers using the LEB and the roads affected by the LEB would experience low stress levels on 14 movements, moderate stress levels on three movements and high stress levels on eleven movements.

15.6.8 Tables 15-H and 15-I show the traffic flows and speeds along the A15, following the construction of the LEB, in 2016 and 2031 respectively. Although the tables, which have adopted the DMRB three point descriptive scale, indicate no change in stress levels experienced by drivers using the A15, it does show a large reduction in the numbers of cars along the A15.

15.6.9 This would inevitably have a beneficial impact upon driver's frustration when driving through Lincoln, and therefore reduce driver stress levels; however this reduction is not quantifiable with the level of detail the DMRB permits.

Fear of Accidents

15.6.10 The DMRB guidance notes that although fear, and therefore stress, should theoretically increase due to the higher speeds along the LEB, the perception of danger is likely to be more than offset by the superior design standards to which the new scheme would be built.

Route Uncertainty

15.6.11 The LEB is designed to provide the current best practice standards for signage and therefore it is predicted that there would be a better provision of route signage on the new route, however there would be greater concentration of signage at roundabout junctions.

15.7 PREDICTED IMPACTS - VIEWS FROM THE ROAD (REFER TO APPENDIX 15B)

'Do Nothing'

15.7.1 It is assumed that under the 'do nothing' scenario, there would be no change from existing travellers' views as there are no known developments that would affect them.

'Do Something'

Construction Impacts 2013

15.7.2 It is assumed that the views experienced by drivers travelling both north and southbound would experience changes at both ends of the route, where the junction works would be noticeable. There may be some diversions through works to the roundabouts, especially on Sleaford Road before the driver continues on the existing route through the city centre.

15.7.3 Similarly, views from the other roads that cross the LEB alignment would experience changes as the respective roundabout junctions were constructed, and would be redirected around the works before continuing on the existing alignments east and west.

Operational Impacts 2016 & 2031

15.7.4 There would be considerable changes to drivers views on opening and in design years which would include:-

- Open views across rural landscapes to the south of the LEB whilst the road is at grade or on embankments;
- The junction at Lincoln Road would be noticeable on approach both north and southbound directions on the LEB and also noticeable on Lincoln Road when approaching from east/west directions;
- Views would be restricted by deep cuttings on the southern slope;
- Views to and around the Washingborough Road junction would be enclosed by cuttings and railway embankments, from drivers both on the LEB and travelling east-west on Washingborough Road;

- New elevated views would be experienced in both north and southbound directions across the valley bottom between the two railway crossings as drivers pass over the River Witham on embankment and bridge with views extending to the edge of Lincoln to the west and the Witham valley extending to the east;
- Greetwell Road junction area would be a noticeable junction on the northern ridge on approach northbound on the LEB and from drivers on the road itself travelling in both east and westerly directions due to the road being realigned as part of the works;
- To the north the views north and south would be directed due to the LEB being in cutting adjacent to the Greetwell Quarry;
- To the north-eastern edge of Lincoln, views would be open to the new housing edge to the west and to fields to the east where the LEB is at grade or on embankment;
- On passing underneath Hawthorn Road, views on the LEB north and southbound would be restricted by cuttings and focussed to the direction of travel; and
- Views on Hawthorn Road would be elevated over the LEB here with glimpsed views to the south and the edge of Lincoln to the west.

15.8 MITIGATION

15.8.1 The latest standards of design and signage would mean drivers using the route would have better directions and therefore less route uncertainty when compared to the existing route through Lincoln.

15.8.2 A clearly organised traffic management plan would be implemented for traffic using the road network during the construction of the scheme in order to prevent travellers' stress and reduce congestion that might otherwise result from the works.

15.8.3 All mitigation proposals as described in Chapter 9 Landscape and Visual Amenity are considered in the summary of effects as the "Do Something scenario". These would include native planting and habitat creation to integrate the proposals into the surrounding landscape and allow certain views into good quality landscape / historic landscape character areas)

15.9 RESIDUAL EFFECTS

Driver Stress

15.9.1 If the LEB was not constructed, drivers travelling through Lincoln in 2016 and 2031 would, on the whole, experience moderately stressful journeys.

15.9.2 In contrast, if the scheme was to go ahead, in 2016 and 2031, drivers travelling north and south along the LEB would experience low levels of stress. However, drivers joining or traversing the LEB would experience moderate or highly stressful movements.

15.9.3 In addition, although the LEB would have no quantifiable impact on stress levels through Lincoln in 2016 and 2031, traffic figures indicate that the LEB would significantly reduce the numbers of cars passing through Lincoln by drawing them out of the city centre onto the LEB therefore being of benefit to drivers in the centre.

Views from the Road (refer to Table 15C below and Appendix 15B)

Construction Year 2013

15.9.4 The construction of the Lincoln Eastern LEB would have a neutral effect on travellers' views on the main movements from north to south on the A15 route between Wragby

Road and Sleaford Road. It would, however, make the views worse for travellers on all of the roads which it crosses including the A158, Wragby Road, Hawthorn Road, Greetwell Road, Washingborough Road, Heighington Road, Lincoln Road, Bloxholm Lane and Sleaford Road.

15.9.5 In general, views experienced by motorists would benefit from more open views to agricultural land whilst travelling along the LEB north and southbound, as well as suffer from a perceived lack of integration of the scheme from views towards it travelling east / westbound on the minor roads. This would result in both 'better' and 'worse' views depending on the quality of landscape character made visible and the existing quality of views. These effects have been summarised in Table 15C below.

Opening Year 2016

15.9.6 Views northwards and southwards would be better when travellers use the LEB to cross Lincoln between Wragby Road and Sleaford Road. Views on roads the LEB crosses would remain worse apart from the A158, Wragby Road and Hawthorn Road east where views would be neutral.

Design Year 2031

15.9.7 Views northwards and southwards would be better when using the LEB to cross Lincoln between Wragby Road and Sleaford Road. Views on roads the LEB crosses would remain worse apart from the A158, Wragby Road, Hawthorn Road west and Sleaford Road south which would be neutral and Hawthorn Road east which would be better.

Table 15c: Views from the Road - Summary Table

Traffic Movement	Year	Visual Effect	
		Without mitigation	With mitigation
SOUTHBOUND (northern section) Wragby Road to River Witham	Construction (2013)	Neutral	Neutral
	Opening (2016)	Better	Better
	Future (2031)	Better	Better
SOUTHBOUND (southern section) River Witham to Sleaford Road.	Construction (2013)	Neutral	Neutral
	Opening (2016)	Better	Better
	Future (2031)	Better	Better
NORTHBOUND (southern section) Sleaford Road to River Witham	Construction (2013)	Neutral	Neutral
	Opening (2016)	Better	Better
	Future (2031)	Better	Better
NORTHBOUND (northern section) River Witham to Wragby Road	Construction (2013)	Neutral	Neutral
	Opening (2016)	Better	Better
	Future (2031)	Better	Better
A158 southwards	Construction (2013)	Worse	Worse
	Opening (2016)	Neutral	Neutral
	Future (2031)	Neutral	Neutral
Wragby Road westbound	Construction (2013)	Worse	Worse
	Opening (2016)	Neutral	Neutral
	Future (2031)	Neutral	Neutral

Traffic Movement	Year	Visual Effect	
		Without mitigation	With mitigation
Wragby Road eastbound	Construction (2013)	Worse	Worse
	Opening (2016)	Neutral	Neutral
	Future (2031)	Neutral	Neutral
Hawthorn Road westwards	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Neutral
Hawthorn Road eastbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Neutral
	Future (2031)	Worse	Better
Greetwell Road westbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Greetwell Road eastbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Washingborough Road westbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Washingborough Road eastbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Heighington Road westbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Heighington Road eastbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Lincoln Road westbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Lincoln Road eastbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Bloxholm Lane westbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse
Bloxholm Lane eastwards	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse

Traffic Movement	Year	Visual Effect	
		Without mitigation	With mitigation
Sleaford Road southbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Neutral
Sleaford Road northbound	Construction (2013)	Worse	Worse
	Opening (2016)	Worse	Worse
	Future (2031)	Worse	Worse

16 DISRUPTION DUE TO CONSTRUCTION

16.1 INTRODUCTION

16.1.1 'Disruption due to construction' is defined in Volume 11, Section 3, Part 3 of DMRB as 'a term which covers the effects on people and on the natural environment which can occur between the start of pre-construction works and the end of the contract maintenance period'. Disruption due to construction tends to be localised.

16.1.2 Many construction impacts have been identified in the other specialist chapters of this Environmental Statement. To avoid 'double counting', this chapter makes reference to specialist chapters, where appropriate. This chapter considers the impacts of construction activities, timings, compound areas, storage areas and construction access routes, which are not considered elsewhere in this Environmental Statement.

16.2 APPROACH AND METHODS

16.2.1 Information has been gathered from the contractor appointed by Lincolnshire County Council to provide Early Contractor Involvement (ECI). The information gathered relates to the construction activities, locations, haul routes, road closures and timings. At this stage in the design, some of this information remains provisional.

16.2.2 Residential and other sensitive properties within 100 metres of the construction sites have been identified, as these are the properties most likely to be affected by construction activities.

16.2.3 Sites of ecological and archaeological value within 100 metres of the construction sites have been identified, as these may need to be protected from the effects of construction.

16.2.4 Based on the scheme design, an assessment has been made of the balance between materials to be excavated and materials required for construction, in order to identify whether there would be a materials surplus or whether additional material would be required from elsewhere, and how this could be managed.

16.2.5 Consideration has been given to the re-use, recycling and disposal of waste arising form the construction activities. At this stage, the information available in this regard is not yet finalised. A general earthworks balance has been achieved. There may be the need to import some material once excavated site-won material has been tested.

16.2.6 Potential impacts arising from the construction phase have been identified, mitigation measures incorporated into the design have been described, and the residual impacts have been identified.

16.3 BASELINE CONDITIONS

Properties

16.3.1 There are 182 residential properties and one other sensitive property, St Barnabas Day Hospice, within 100 metres of the construction areas. These are indicated on Figure 16.1.

Ecology

16.3.2 Designated sites are listed in Chapter 10 of this Environmental Statement, and identified on Figure 10.1.

16.3.3 Greetwell Quarry is a Site of Special Scientific Interest (SSSI), designated for its geological, rather than ecological, interest. This site extends into the footprint of the proposed bypass.

16.3.4 Greetwell Wood Site of Nature Conservation Interest (SNCI) and the Witham Corridor Local Wildlife Site (LWS) also extend into the footprint of the proposed bypass.

Cultural Heritage

16.3.5 There are no designated heritage sites within 100 metres of the proposed scheme.

16.3.6 For the majority of the proposed site compound or storage areas, no archaeological surveys have been carried out, as investigations have been limited to the footprint of the proposed bypass. Archaeological surveys would be carried out in advance of establishing such sites. Areas within the Witham floodplain especially have a high potential for the presence of unknown archaeological remains.

16.3.7 Consultations have been held with English Heritage, and they have indicated that they have no concerns in relation to archaeology in the study area.

Earthworks

16.3.8 Excavations would be required for the areas of cutting along the proposed bypass. Excavated material would be used in the construction of the scheme, including as foundations for the highway and in embankments.

16.3.9 Top soil currently covers the majority of the area of the proposed road, and would be removed to make way for the scheme.

16.4 CONSTRUCTION ACTIVITIES

Pre-Construction Works

16.4.1 In addition to the mitigation measures identified elsewhere in this Environmental Statement for implementation in advance of construction, there would be actions required to prepare the areas required for site compounds, soil storage areas and access routes. These actions would include gaining approvals from Network Rail, including railway possessions, carrying out archaeological surveys, and carrying out any necessary environmental mitigation measures for the works areas. Mitigation measures may, for example, include translocation of species to suitable receptor sites.

Mobilisation

16.4.2 Site compounds and materials storage areas would be established in locations shown on the environmental master plan drawing in Appendix 9E. There would be two or three compound areas, plus a number of storage areas and a material / rock crushing area.

16.4.3 Temporary ditch crossings would be installed, and a temporary bridge over the River Witham and other watercourses would be required to haul material from the Lincoln Edge to the proposed embankment to the north of the River Witham.

16.4.4 Statutory services (pipes and cables) in the roads crossed by the bypass would be diverted, as would overhead power lines at locations where they would be directly affected by the line of the bypass.

Construction

16.4.5 The phasing of the construction works has not been identified at this stage with in the scheme design. However it is likely that construction activities would be undertaken at a number of locations simultaneously, with the majority of the early construction activities focussed on the central section of the bypass, between Greetwell Road and Lincoln Road.

16.4.6 Construction of each section of highway would be in the following sequence:

- Topsoil strip;
- Pre-earthworks drainage;
- Attenuation pond construction;
- Primary limestone processing;
- Bulk earthwork movement;
- Drainage installation;
- Lay sub-base;
- Lay base, binder and surfacing courses (bituminous road pavement components);
- Lay road markings and studs;
- Verge earthworks;
- Install vehicle restraint systems;
- Erect road signs; and
- Install street lighting.

16.4.7 Construction of the bridges would be in the following sequence:

- Excavation to formation level;
- Piling, if required;
- Foundation construction;
- Substructure wall/piers construction;
- Bearings installation;
- Deck construction (lifted or constructed in-situ); and
- Waterproofing.

16.5 PREDICTED IMPACTS WITHOUT MITIGATION

Noise and Vibration

16.5.1 The highest levels of noise and vibration would be associated with rock excavation, rock crushing and piling. In addition, construction vehicles and machinery could create vibrations that might be felt at nearby properties.

16.5.2 The 183 sensitive properties identified above would be likely to be bothered by the noise and vibration caused by the construction activities.

Dust and Mud

16.5.3 Dust created by on-site construction activity, particularly excavation and transportation of soil materials, can occur throughout the construction period particularly during periods of dry weather, and can cause a nuisance for receptors in the surrounding area.

16.5.4 During periods of intense construction activities, levels of dust could cause damage to property or disturbance to the surrounding community. Measures to mitigate these impacts are outlined in section 16.6 below.

Traffic Movements

16.5.5 Construction works can impact on accessibility. In particular, vehicle travellers may experience longer journey times and delays due to congestion, road closures and diversions, which in turn may lead to increased stress for drivers.

16.5.6 The routes that would be used by construction traffic are shown in Table 16.1, together with the road closures that would be required

Table 16.1: Construction Access Routes

Route to Site	Closure Required
A15 Sleaford Road	None
Lincoln Road	None
Heighington Road	9 months during bridge construction
Washingborough Road	None
Greetwell Road	20 weeks during highway improvement construction
Hawthorn Road	9 months during bridge construction
A158 Wragby Road	None

16.5.7 In addition, Greetwell Fields, whilst not a construction access route, would be closed during the construction period, and remain closed as shown on the environmental masterplan in Appendix 9E.

16.5.8 Whilst the A15, Lincoln Road, Washingborough Road and Wragby Road would remain open throughout the construction period, there would be disruption to traffic on these routes as a result of site accesses and the construction of the new junctions with the bypass on the line of these existing roads. Lane closures and temporary traffic controls may be necessary.

Impacts on Ecological Sites

16.5.9 The habitat loss associated with the scheme is detailed in Chapter 10 of this report. Therefore, the impacts described here relate specifically to the additional areas of land required for site compounds, storage areas and haul routes during the construction phase.

16.5.10 Figure 10.2 shows the habitat types in the study area, as identified during a Phase 1 Habitat Survey. The site compounds, storage areas and haul routes would occupy areas that are currently of the following habitat types:

- Arable;
- Bare ground;
- Dense scrub;
- Neutral grassland – semi improved;
- Defunct hedge – Species poor; and
- Improved grassland.

16.5.11 Mitigation measures to minimise adverse impacts on ecological features are outlined in section 16.6 below.

Impacts on Cultural Heritage

16.5.12 Chapter 8 provides details of the impacts of the proposed bypass on cultural heritage, but does not include information relating to the site compounds, storage areas and haul roads to be used during the construction phase.

16.5.13 While not all of these additional locations have been evaluated, based on the archaeological surveys that have been undertaken to-date, the impacts that have been identified are shown in Table 16.2 below.

Table 16.2: Impacts of Construction on Archaeology

Site No.	Site Name	Description of Impact	Value	Magnitude of Impact (Un-mitigated)
105	Greetwell Medieval Village, Cultivation and Post-Medieval Garden Remains	Visual presence of compound during construction of the Witham Crossing, foreshortening views upstream.	High	Negligible
146	Bronze Age Round Barrow Cemetery South of the Witham	Removal of identified features	High	Major
151	Prehistoric Land Surface South of The Witham	Removal of land surface deposits and potential Mesolithic artefacts identified through trial trenching and auger survey	Medium	Major
152	Medieval-Post Medieval Pottery Scatter, South of The Witham (Field C1)	Removal of features that may be associated with this pottery scatter	Negligible	Moderate
153	Roman Pottery From South of The Witham (Field C1)	Removal of features that may be associated with this pottery scatter	Negligible	Moderate
173	Original Site of Sheepwash Grange	Removal of identified features	High	Moderate
451	Linear Ditch	Removal of identified features	Low	Major
452	Geophysical Anomaly - Possible Ditch	Removal of identified features	Low	Major
456	Curvilinear Feature	Removal of identified features	Low	Major

16.5.14 It is also considered likely that additional, currently undiscovered archaeological remains are present in the areas in which no archaeological works have been undertaken.

Landscape and Visual

16.5.15 The location and construction of temporary construction-related facilities could result in either permanent or temporary damage to landscape features and could be visually intrusive, with potential adverse effects on visual amenity for nearby receptors.

16.5.16 The areas for site compounds, storage areas and haul routes have been selected for practical construction reasons, with input from a landscape architect to minimise the adverse effects. Mitigation measures are outlined in section 16.6 below.

Land Use

16.5.17 The impacts of temporary land take on land use have been assessed in Chapter 13, and are not repeated here.

16.6 MITIGATION

16.6.1 At the current time, mitigation measures for the construction activities have not been fully designed. A contractor has recently been appointed to the scheme, and mitigation measures will be more fully developed as the contractor makes preparations for the start of construction. A Construction Environmental Management Plan (CEMP) will be developed.

Noise and Vibration

16.6.2 The contractor would establish measures to minimise noise and vibration from construction activities. These measures are expected to be as follows:

- The use of 'best practicable means' during all construction activities;
- Switching off plant and equipment when it is not in use for longer periods of time;
- Establish agreement with the local authority on appropriate controls for undertaking significantly noisy works or vibration-causing operations close to receptors;
- Programming works so that the requirement for working outside normal working hours is minimised (taking into account the highway authority's statutory duties under the Traffic Management Act 2004);
- Use of low noise emission plant where possible;
- The use of temporary noise screens around particularly noisy activities; and
- Regular plant maintenance.

Dust and Mud

16.6.3 The contractor would take measures to reduce the risk of dust causing a nuisance to the local area. These measures would include the following:

- Open lorries and skips leaving site would be covered with an impervious material such as a tarpaulin;
- Stockpiles of soil and unmade haul roads would be regularly dampened down;
- Wheel wash facilities would be used as appropriate for vehicles leaving site; and
- Road sweepers would be used as appropriate to keep public roads clean.

Traffic Movements

16.6.4 The road closures identified in Section 16.5 above have been kept to a minimum level possible. A traffic management plan would be agreed with the highway authority prior to the start of construction.

Ecology

16.6.5 Materials and oil would be stored away from waterbodies and watercourses to protect against potential contamination. Oil would be stored in compliance with the Control of Pollution (Oil Storage) (England) Regulations, 2001.

16.6.6 Wherever possible, existing trees would be retained, with fencing around their root protection zones to exclude construction machinery from those areas. Lighting would be angled away from any trees with potential for bat roosts. Any trees to be removed would be removed outside of the bird breeding season.

16.6.7 Existing hedgerows would also be retained wherever possible, and the site locations have been identified with this in mind. The hedge running through the proposed rock

processing area would be protected with fencing, so that vehicles and site personnel could cross it only at pre-existing gaps.

16.6.8 The locations of the compounds, storage areas and haul roads have been determined in consultation with an ecologist, to ensure that the highest quality ecological features would be avoided.

16.6.9 An ecologist would carry out pre-construction surveys of the site areas to identify the species present. Where necessary, species may be translocated to appropriate receptor sites. For protected species, this translocation would be carried out under licences to be obtained from Natural England.

16.6.10 Arable land in the area is used by ground nesting birds. The compounds on arable land would need to be created during the winter months, to avoid disturbance of breeding birds.

Cultural Heritage

16.6.11 Where no previous works have been undertaken, it is recommended that a staged programme of archaeological evaluation (i.e. preliminary field investigations designed to clarify the presence, absence, nature and sensitivity of archaeological remains) is implemented prior to confirmation of the full scope of mitigation works required for these areas.

16.6.12 There is a wide range of evaluation techniques available, which may be applied separately or in combination, or as part of a staged programme. An approach will be agreed with the County Archaeologist. Potentially suitable methods could include a combination of any of the following, although this list is not exhaustive:

- Field walking (i.e. the systematic search for artefacts on the surface of ploughed fields);
- Magnetometer survey;
- Resistivity survey; and
- Intrusive trial trenching, trial pitting and/or borehole/auger surveys. This could be targeted at sites and features identified by the methods outlined above or in blank areas where no sites have been identified.

16.6.13 The results of the evaluation would enable the scope and scale of mitigation works required in advance of, or during, construction to be determined. The preferred mitigation option for any sites or archaeological deposits affected by the scheme would be to preserve the remains *in situ*. However, where preservation *in situ* is not feasible, then preservation by record would be the appropriate alternative mitigation strategy. This may be achieved by a combination of the following techniques:

- No further action: in some cases, the results of any evaluations may provide sufficient information to mitigate any impact;
- Detailed archaeological excavation: where particularly significant, complex or densely-concentrated archaeological remains are expected to be present, and the occurrence of an impact cannot be avoided, then a detailed archaeological excavation in advance of construction would be undertaken;
- Strip and record: where archaeological remains of relatively low significance and/or complexity are expected to be present, and particularly where they are expected to be spread over a large area at low density, then strip and record works may be appropriate. Topsoil/overburden would be stripped over relatively large, defined areas using methods designed to maximise archaeological visibility, followed by inspection to define the scope of any archaeological recording works that might be required; and

- Archaeological watching brief: where there is some potential for archaeological remains to be present, but the risk is considered to be low, then archaeological monitoring of the main topsoil/overburden stripping operations, and other excavation works as appropriate, would be applied, followed by appropriate archaeological investigation and recording of any remains that are identified.

16.6.14 Where archaeological evaluation works have been undertaken and sites identified, archaeological mitigation works are recommended, as presented in Table 16.3 below.

Table 16.3: Archaeological Impact Mitigation

Site No.	Site Name	Proposed Mitigation
146	Bronze Age Round Barrow Cemetery South of the Witham	Detailed excavation, Level 2 Earthwork survey (to include detailed topographic survey and modelling of the buried land surface between the barrows)
151	Prehistoric Land Surface South of The Witham	Detailed excavation of one or several transects across the site.
152	Medieval-Post Medieval Pottery Scatter, South of The Witham (Field C1)	Strip, map and sample
153	Roman Pottery From South of The Witham (Field C1)	Strip, map and sample
173	Original Site of Sheepwash Grange	Detailed excavation
451	Linear Ditch	Strip, map and sample
452	Geophysical Anomaly - Possible Ditch	Strip, map and sample
456	Curvilinear Feature	Strip, map and sample

Landscape and Visual

16.6.15 Wherever possible, existing boundaries and hedgerows would be retained around site compounds and storage areas, to screen the sites from view and so to minimise adverse effects on visual amenity.

16.6.16 Soil storage areas have been identified alongside the proposed scheme, and so would offer some visual screening of the construction activities.

16.6.17 A hedge runs through the area identified for rock processing activity, on the western side of the route down Lincoln Edge. This hedge would be protected using fencing, and site vehicles would be able to cross the hedge only through pre-existing gaps.

Land Use

16.6.18 Compound and storage areas would be limited in extent as far as possible within the indicated areas. In this way, the temporary impacts on land use would be minimised.

Waste

16.6.19 All excavated rock would be re-used within the scheme, with crushing used where necessary to ensure that all extracted material is made suitable for its intended use. No excess rock would remain, and therefore there would be no need for off-site disposal.

16.6.20 Topsoil stripped from the scheme area would be used up in part for grading of embankments and for the construction of bunds to mitigate noise and visual amenity impacts. There would be excess quantities of topsoil remaining, which could not be

used within the scheme. Efforts would be made to avoid disposal of this soil to landfill. This topsoil would be made available to local farmers who may wish to use it. In addition, if the North East Quadrant development, which is expected to be subject to a planning application in the near future, goes ahead, top soil may be offered to the scheme's developers for use in their development. Any transfer of topsoil to third parties would be agreed in advance with the Environment Agency. Soil taken off the construction site would be classified as waste, and the arrangements for carriage and treatment would need to comply with waste management legislation.

16.6.21 A site waste management plan (SWMP) would be produced in advance of the construction to ensure that building materials would be used efficiently, re-use and recycling would be maximised, and waste disposal would be in accordance with legal requirements.

16.7 RESIDUAL IMPACTS

Noise and Vibration

16.7.1 The residual impacts during the construction period would be as described in Section 7.7 of this environmental statement. No additional impacts are described here.

Dust and Mud

16.7.2 With mitigation measures in place, there would be no residual impacts relating to dust and mud.

Traffic Movements

16.7.3 Disruption to traffic on existing roads in the area would be experienced throughout the construction period, although a traffic management plan would keep this disruption to a minimum.

Ecology

16.7.4 The establishment and use of site compounds, storage areas and haul routes would cause temporary loss of habitat within those areas and disturbance of species in the surrounding areas. At the end of construction, the areas would be reinstated in line with the environmental masterplan shown in Appendix 9E, and the habitats would re-establish.

Cultural Heritage

16.7.5 While archaeological recording works can reduce impacts identified by production and retention of an archive and wide dissemination of results (preservation by record), they cannot mitigate the impact completely, as the physical damage to the site from construction works would have simply been replaced by damage from archaeological works. In the case of sites of Low or Negligible value, the reduction to the predicted impact is often sufficient to reduce the significance of impact to Neutral.

16.7.6 For more sensitive sites, the reduction of the magnitude of impact may still result in a significance of impact greater than Neutral. This reflects the loss of potential information which may be only possible to gain from future improvements in recording techniques and greater scientific understanding of archaeological remains.

Landscape and Visual

16.7.7 Landscape and visual impacts would be temporary in nature. With mitigation in place, the temporary works would lead to slight adverse impacts on the landscape, and moderate to large adverse impacts on visual amenity.

Land Use

16.7.8 The impacts of temporary land take on land use have been assessed in Chapter 13, and are not repeated here.

Waste

16.7.9 Whilst waste would be minimised, it is not possible at this stage to quantify waste impacts.

17 CUMULATIVE EFFECTS

17.1 INTRODUCTION

17.1.1 Cumulative effects have been defined as “both the combined effects of different development activities within the vicinity of the site and those different aspects of a single development on a particular receptor” (Department for Communities and Local Government, 2006).

17.1.2 In terms of assessing the potential cumulative effects in relation to other relevant developments, the guidance provided by the document Environmental Impact Assessment: A guide to the procedures refers to the need to assess the potential cumulative effects on “other existing or proposed development” (DTLR, 2000). The DCLG consultation paper Environmental Impact Assessment: A guide to good practice and procedures provides further information by describing other developments as those that are “already begun or constructed or those that have not been commenced but have a valid planning permission.” (DCLG, 2006)

17.1.3 In order to understand the cumulative effects, it is important that the ability of a receptor to accommodate the combined changes is assessed.

17.1.4 In the context of the proposed LEB, there are two types of cumulative effects to be assessed, as follows:

- The effects of the proposed bypass in combination with the effects of other developments in the area, on particular receptors; and
- Whether, for the proposed bypass, the effects identified for individual EIA topics could result in more significant effects when considered in combination.

17.2 METHODOLOGY

17.2.1 Our assessment of cumulative effects considers the following:

- Would any individual receptor or receptor group experience multiple impacts of the same type from this and other projects?
- Would any individual receptor or receptor group experience several different types of effect from this project?
- Would different impacts occur that would interact and therefore alter their significance?
- Would the effects of this project on any individual receptor or receptor group compound similar effects from another recent project, or would they be compounded by the effects of a future project already planned?
- Would the project stimulate proposals for new developments, in ways that would compound its effects?
- Would any cumulative effects that are identified be temporary or permanent?

17.3 OTHER DEVELOPMENTS IN THE AREA

17.3.1 The predicted environmental impacts of the proposed scheme could potentially combine with other projects to result in significant cumulative environmental impacts. It is considered that minor developments in the area, such as dwelling improvements, would be unlikely to result in any significant cumulative impacts with the proposed scheme. This section therefore considers only the following types of ‘other project’ as described in DMRB document HA 205/08 - Assessment and Management of Environmental Effects:

- Other projects with significant potential environmental impacts – projects requiring statutory Environmental Impact Assessment (EIA) would be likely to result in significant environmental impacts, which could combine with those of the proposed scheme, resulting in larger cumulative impacts; and
- Other transport projects – these could result in environmental impacts which may not be significant in themselves, but combined with the proposed scheme would result in significant cumulative impacts.

17.3.2 The main focus for current and proposed development has been in the vicinity of Wragby Road to the northeast of Lincoln. A large number of housing developments are currently under construction to the north of Greetwell Quarry in the Bunkers Hill area. To the west and south of the quarry are several commercial developments that are proposed or under construction. These commercial developments are located within the existing industrial estates. Figure 13.2 shows all developments that are under construction or have planning permission in the vicinity of the proposed LEB route.

17.3.3 Some of these developments fall within the category of development that would require an Environmental Impact Assessment. The majority of the residential developments are nearing completion and as such it is not anticipated that construction impacts associated with the LEB would coincide with construction of these developments.

17.3.4 The East Midlands Regional Plan supports the principle of the development of sustainable urban extensions in order to accommodate the total amount of proposed regional development. The Alternative Strategic Development Areas (ASDA) Study undertaken by Lincolnshire County Council in 2001 and subsequently updated, indicated the considerable potential for locations in the west, north east and south east of Lincoln to satisfy the requirements for sustainable urban extensions. Two of the areas identified have been proposed as the North East Quadrant and South East Quadrant development areas as shown in Figure 14.1. Planning applications for these developments have not been submitted at the time of writing this report and as such would not usually be considered by a cumulative impacts chapter. However, as these developments are substantial in their nature and within many of the regional and local development proposals it is considered appropriate to include them in this assessment. It should be noted that the specific details of these developments are not yet known and as such any conclusions made can only be based on the assumption that they would form mixed use developments with a focus on the provision of additional housing.

17.3.5 Due to the largely completed status of the housing sites in the vicinity of Wragby Road and the location of commercial developments within existing industrial estates it is not anticipated that these developments would result in significant cumulative impacts with the LEB project. It is considered that the North East and South East Quadrant developments, due to their scale and location, would have the potential to create cumulative impacts and as such form the focus of the following section.

17.4 CUMULATIVE EFFECTS OF THE PROPOSED LEB AND POTENTIAL NEIGHBOURING DEVELOPMENTS

Air Quality

Construction Phase

17.4.1 There is the potential that there may be a cumulative decline in air quality and dust generation should construction of the LEB coincide with significant construction associated with one of the proposed major mixed use developments (North East Quadrant or South East Quadrant). However, it is assumed that these developments

would implement best practice construction methodologies to minimise emissions and dust generation as has been proposed for the LEB and as such the potential for a cumulative impact is considered to be minor. In addition these developments would necessitate the production of an Environmental Impact Assessment that would need to assess the impact of the scheme in the context of the LEB.

Operational Phase

17.4.2 It is not possible at this stage to identify emissions levels associated with the neighbouring developments. However, it is expected that national air quality objectives would continue to be met.

Noise and Vibration

Construction Phase

17.4.3 There is the potential for a localised cumulative noise impact should construction works of the LEB coincide with the construction of other developments proposed in the vicinity of the route.

Operational Phase

17.4.4 Once operational it is possible that noise from the LEB may combine with construction noise related to on going developments associated with those proposed for the urban fringe of Lincoln to create a cumulative impact on sensitive receptors. These impacts would be temporary and would last for the duration of construction for the neighbouring development.

Cultural Heritage

Construction Phase

17.4.5 Adverse impacts on archaeology during the construction phase are largely associated with sites which lie within the footprint of the proposed LEB route and as such there would not be a cumulative impact associated with other proposed developments. The three sites which would a receive a slight adverse impact as a result of a change in setting (Sites 105, 129 and 146) would not receive a greater cumulative impact as there are no other proposed developments in the vicinity of these sites.

17.4.6 In relation to historic buildings, construction work on the South East Quadrant may be visible in views protected under Policy 55 of the City of Lincoln Local Plan. These are views from Lincoln Cathedral and Lincoln Castle. If construction of the South East Quadrant took place at the same time as construction of the proposed bypass, then the cumulative impact would be more significant than the slight adverse impact identified in relation to the construction of the bypass. Without further details, it is not possible to determine the degree of significance at this stage.

17.4.7 The increased sense of urbanisation on the historic landscape would be more significant with the development of the North East Quadrant and South East Quadrant than with the bypass alone. Assuming that the various construction periods overlap, then the cumulative impacts would occur during the construction period, and would remain in the long term. These impacts from the bypass alone have been assessed as neutral to slight adverse. The cumulative impacts cannot be accurately assessed at this stage, as details of mitigation measures for the two development areas are not known.

Operational Phase

17.4.8 As identified for construction, in terms of impacts on archaeology, there would be an operational impact on sites 105, 129 and 146 due to a change in setting. It is

believed there would be no greater cumulative impact upon the setting of these cultural heritage features as a result of the operation of the LEB and adjacent proposed developments than that already assessed for the scheme.

17.4.9 Once built, the South East Quadrant development may be visible in views protected under Policy 55 of the City of Lincoln Local Plan. These are views from Lincoln Cathedral and Lincoln Castle. The cumulative impacts of the South East Quadrant development and the bypass on these views would be more significant than the slight adverse impacts identified for the bypass alone. At this stage, insufficient information is known about the height and scale of development or its screening to allow the degree of significance to be stated.

Landscape and Visual Amenity

Construction Phase

Landscape

17.4.10 There would be potential cumulative impacts on topographical features (Greetwell Quarry SSSI, Witham valley northern slopes) as well as existing vegetation on the north eastern edges of Lincoln, as a result of the construction of the NEQ at the same time as the LEB.

17.4.11 To the south of the river valley, it is assumed that any proposals for the SEQ to be undertaken at the same time of the LEB, would have further impacts on hedgerows and significant vegetation to the east and south of Canwick and Bracebridge Heath. Furthermore, the landscape character would be adversely impacted as a result of extending construction of urban areas of Lincoln into the rural character areas.

Visual Amenity

17.4.12 Views from the north east and on the southern ridgeline of the Witham Valley views towards Lincoln, would consist of the bypass under construction as well as phased construction of the NEQ on the northern plateau. There would be a greater adverse effect as a result of the larger extent of construction works within these views. Receptors located *within* this north eastern edge currently with views out to the countryside (Stocking Way, Whitefriars Road), would experience greater adverse impacts due to construction works of NEQ visible in close range views. As the NEQ development progresses and buildings are erected, these views would become more and more confined / restricted by built form.

17.4.13 Views from receptors to the edges of Branston and Bracebridge Heath, as well as individual properties within the southern plateau farmland, would experience greater adverse visual impacts on views to the north and west due to the potential construction works of the SEQ extending out to LEB works.

Operational Phase

Landscape

17.4.14 Cumulative adverse impacts on landscape elements and features would have been experienced during the construction phases of the LEB and associated developments. Therefore there would be no further impacts once the developments are assumed to be in operation.

Visual Amenity

17.4.15 There would be cumulative visual impacts on receptors described for the construction year above, however, the final developments would remain permanent features in the views. Views from the east towards the north eastern edge of Lincoln

would see both the LEB road with traffic and the housing edge as a newly defined urban edge. Views from within the existing edge of Lincoln would no longer extend to the countryside but be confined to new estate housing / gardens / internal space. Views from receptors to the edges of Bracebridge Heath would no longer experience rural views and instead extend to housing / gardens / internal open space. Views from Branston and other properties further west would extend to a new urban fringe of Bracebridge Heath contained by the LEB road.

Design Year

Landscape

17.4.16 Cumulative effects of mitigation planting of the LEB and NEQ/SEQ developments should provide additional vegetation and help to reduce the effects of the developments, however the rural landscape character would be reduced due to expanding urban edge.

Visual Amenity

17.4.17 Boundary planting of the housing developments, in conjunction with planting and raised embankments / bunds of the LEB would provide greater beneficial effects on longer distance views from the east, providing better screening of the NEQ/SEQ developments behind the road.

Ecology and Nature Conservation

Construction Phase

17.4.18 It is noted that construction disturbance of ecology is an adverse impact of the scheme. Areas where proposed developments are constructed at the same time as the LEB have the potential to exacerbate the severity of impact upon local ecology. Issues such as elevated noise, lighting and a decline in local water quality associated with construction site drainage have the potential to in combination affect local ecology to a greater degree than that assessed for the scheme alone. In addition landtake associated with the LEB would result in some loss of habitat which could be exacerbated by additional landtake for other developments. If construction of the NEQ development were to coincide with the LEB construction it is possible that the current assessment conclusions of construction impact upon ecology could become more significant in this area. It should be noted that mitigation measures proposed for the scheme would create additional habitat, however these mitigation measures would take time to become established and as such would not provide benefits during the construction period.

Operational Phase

17.4.19 Operational impacts associated with LEB include severance of habitat by the highway. It is possible that developments, especially those to the west of the proposed highway, could increase severance as movement of wildlife is restricted further. It is assumed that large scale developments such as the NEQ would address such issues as part of their environmental assessment process and suitable mitigation measures would be implemented. In addition it is assumed that such developments would be required to provide mitigation measures which may increase and/or improve the suitable habitat available which in combination with that proposed for the LEB could generate a cumulative positive impact.

Road Drainage and the Water Environment

Construction Phase

17.4.20 There is the potential that if construction of the LEB were to coincide with the construction of other proposed developments, there could be a cumulative impact if both sites drained into the same watercourses. Adverse impacts previously identified such as increased turbidity, while controlled to acceptable levels by both developments could reach levels that are detrimental to the receiving watercourses when combined. However, the drainage scheme for LEB is suitably designed to prevent such adverse impacts to such an extent that it is unlikely that such a cumulative impact would occur. It is also assumed that any other proposed developments would be subject to similar conditions as part of their planning application. If this issue were to arise it is recommended that the Environment Agency should be consulted regarding the need for additional mitigation measures as part of the construction phase drainage design.

Operational Phase

17.4.21 As a result of mitigation measures implemented in the scheme drainage design potential issues such as increased run-off and discharge and risk of pollution have been suitably mitigated. It is assumed that other developments as part of their planning condition would also need to ensure that their scheme would not result in an adverse impact upon the water environment. Discharge consents would not be granted if these mitigation measures did not avoid the potential for a cumulative impact upon the water environment and as such the risk to the water environment is considered to be negligible.

Soils and Geology

Construction Phase

17.4.22 It is not anticipated that there would be a cumulative impact upon soils and geology as a result of the construction of LEB and other proposed developments.

Operational Phase

17.4.23 It is not anticipated that there would be a cumulative impact upon soils and geology as a result of the operation of LEB and other proposed developments.

Land Use

Construction Phase

17.4.24 It is not anticipated that there would be any cumulative impact upon land use during construction. Construction of the LEB would require temporary landtake for construction compounds and top soil storage. However it is not anticipated that any other projects would require temporary land outside of their development footprint that may exacerbate this issue.

17.4.25 It is anticipated that the loss of agricultural land associated with major new developments combined with that lost as result of LEB could result in a cumulative adverse impact. Some loss of agricultural land associated with the NEQ development and potentially significant agricultural landtake for the SEQ development could result in a cumulatively greater impact when assessed with those impacts related to the LEB.

Operational Phase

17.4.26 There would be no additional impacts on land use during the operational phases of the developments, although the long term loss of agricultural land that would begin during construction would continue throughout the operational period.

Pedestrians, Equestrians, Cyclists and Community Effects

Construction Phase

17.4.27 It is possible that local pedestrians, cyclists and horse riders would be adversely affected should further large scale developments be constructed during a time which coincides with the construction of the LEB. It is possible that this would result in increased HGV traffic on local roads and an associated increase in disruption, traffic, noise and a decline in air quality which would further decrease the amenity of any prospective journey to a greater extent than was assessed for the construction of the LEB alone.

Operational Phase

17.4.28 It is considered that the operational impacts upon non-motorised users would be a decline in amenity associated with the loss of open space and an increase in vehicle traffic on some local radial routes. This impact has the potential to be cumulatively greater if the impacts of the LEB and any large scale development in this area are considered in tandem.

17.4.29 The beneficial impacts of a new cycleway and footway along the proposed bypass would not change as a result of neighbouring developments.

Vehicle Travellers

Construction Phase

17.4.30 It has been identified that vehicle travellers traversing the LEB would experience moderate or highly stressful movements. It is possible that these movements could be made worse if a significant development were also to be developed in the vicinity of these radial routes due to construction traffic and road works associated with construction.

Operational Phase

17.4.31 Once operational these additional developments could increase the number of road movements along these radial routes and as identified for construction increase driver stress due to the higher volumes of traffic.

17.5 CUMULATIVE EFFECTS OF THE PROPOSED BYPASS ON SENSITIVE RECEPTORS

Landscape and Cultural Heritage

17.5.1 The introduction of new infrastructure into the environment has been identified as having the potential to adversely affect the landscape character and the setting of cultural heritage features. The landscaping proposals for the scheme have been designed to incorporate naturally occuring elements from the existing landscape in order minimise the visual intrusion of the scheme on the landscape and to be sympathetic to the existing setting in general and of specific cultural heritage features.

Landscape and Ecology

17.5.2 The loss of trees in Greetwell Wood would have an adverse impact on local biodiversity and visual amenity and landscape. This adverse impact would be

mitigated through creation of additional replacement habitat. However, during construction there would be a minor impact due to the loss of the existing habitat and the time it would take for replacement habitat to become established.

Air, Noise and Landscape

17.5.3 Adverse impact upon residential properties during construction could be exacerbated if they were to experience a series of different impacts. Issues such as local air pollution, dust, noise and loss of visual amenity during the construction process have the potential to result in a greater impact upon the receptor than that originally identified on a discipline by discipline basis. It should be noted that each potential impact has been mitigated either through design or by on-site construction management. Through the use of best practice construction management all potential adverse impacts would be minimised.

Hydrology and Ecology

17.5.4 Construction of the scheme and development of the associated drainage design has the potential to change the local hydrology of rivers, ditches and other bodies of water. This in turn could also adversely impact upon ecology within these water bodies. The drainage system and construction of the LEB has been designed and would be managed to ensure that there would be no adverse impact upon local hydrology.

17.5.5 The implementation of attenuation ponds associated with the scheme drainage design would be constructed in a manner which would provide additional habitat and could provide a beneficial impact.

Landscape and Noise

17.5.6 Through the development of noise mitigation measures there is a requirement for noise bunding along the route. These structures have the potential to impact upon the visual amenity of the landscape and alter views. However, these bunds have already been considered as an integral part of the scheme in the assessment of visual impacts, and so no additional impacts are identified here.

Pedestrians, Equestrians, Cyclists and Community Effects, Noise and Landscape.

Construction Phase

17.5.7 During construction there would be various closures of NMU routes. Mitigation measure would be put in place to provide alternative routes. However, there would be adverse impacts as a result of increased journey times related to these diversions. The adverse impact of closures and diversions would be likely to be compounded by increased noise and a decline in air quality and visual amenity. Cumulatively these impacts would reduce the attractiveness of making a non-motorised journey across the proposed route of the LEB during construction.

Operational phase

17.5.8 It is anticipated that there would be cumulative impact upon non-vehicle travellers as a result of a loss of visual amenity and impacts to the journey as a result of crossing the LEB once operational. Sites that would experience notable cumulative impacts include the cycle path along the A158 Wragby Road and Washingborough Road.

17.5.9 The section of cycle route on Wragby Road would have an increase in journey length of approximately 750m which has been assessed as a moderate negative impact. In addition this area has been assessed as receiving a large adverse visual impact in 2013 (construction year), 2016 (opening year) and a moderate negative impact in 2031. The combination of the increase in journey length and decrease in visual

amenity have the potential to cumulatively impact on users of this route in combination to a greater extent than those issues addressed separately in the main assessment. The knock on effect of these impacts cannot be fully understood, but it is possible that the option to cycle this route would become a less desirable option and that cycling to and from North Greetwell and other settlements along Wragby Road may decline as a result.

17.5.10 A similar cumulative impact has been identified for the non-motorised users of Washingborough Road. It has been assessed that the operation of the LEB would result in a moderate negative impact upon non-motorised users of Washingborough Road as a result of an increase in traffic and journey time and a reduction in safety. In addition all routes which cross the LEB have been considered to some extent to have a reduction in the quality of their views. As discussed in Chapter 15, views from Washingborough Road would remain affected through construction and operation. Again the cumulative impact of a reduction in visual amenity and safety and an increase in traffic and journey time have the potential to impact on the desirability of walking, cycling or horse riding along Washingborough Road.

17.6 STIMULATION OF FURTHER DEVELOPMENT

17.6.1 Large scale urban extension developments such as the NEQ and SEQ are already discussed in The Regional Plan as a viable and sustainable method of development. The construction of major urban fringe developments would not be direct consequence of the development of the LEB, but would reflect regional development planning guidance.

17.6.2 It is not strictly true that the construction of the LEB would facilitate urban fringe developments either. The NEQ Development could be developed with the construction of the North East Quadrant link road and as such is not dependent upon the LEB for its development.

17.7 CONCLUSION

17.7.1 It has been assessed that the greatest potential for significant cumulative effects are related to the development of the NEQ and SEQ developments in tandem with the construction of the LEB.

17.7.2 It is likely that there could be cumulative impacts if construction of the LEB were to coincide with construction of one or both of the major quadrant development projects. Use of best practice construction methodologies for both projects would mitigate and minimise the majority of adverse impacts and as such would minimise any cumulative impacts.

17.7.3 Cumulative inter-disciplinary impacts are likely to occur as a result of the construction and operation of the LEB. These impacts have been assessed during the design process and have been mitigated as much as is practicable.

18 CONCLUSION

18.1 INTRODUCTION

18.1.1 This Environmental Statement describes the potential environmental impacts of the proposed LEB.

18.1.2 The objectives of the bypass would be:

- To further the growth of Lincoln as a regional centre;
- To open up land to the east of the city for further development;
- To relieve congestion to the east of the city, bringing environmental benefits to areas such as the historic core; and
- To offer opportunities to provide additional facilities to encourage the greater use of public transport, cycling and walking.

18.1.3 The bypass would be a dual carriageway running from Wragby Road in the north to Sleaford Road in the south. It would cross under Hawthorn Road and Heighington Road, and would have junctions with Greetwell Road, Washingborough Road, and Lincoln Road. The road would cross the River Witham, North Delph and Canwick Fen Drain on a new bridge. It would also cross over the Lincoln to Market Rasen railway line and under the Lincoln to Spalding railway line.

18.1.4 A cycleway and footway would be provided along the length of the bypass, with links to existing routes including the Sustrans route adjacent to the River Witham.

18.2 ENVIRONMENTAL IMPACTS

Air Quality

18.2.1 During construction, local air quality could be reduced due to fugitive dust emissions. However, best practice construction methods would be used to minimise the generation of dust and so ensure that dust would not be a nuisance.

18.2.2 Pollutant concentrations have been calculated for receptors in the local area for both the opening year (2016) and the design year (2031).

18.2.3 A larger number of receptors (properties) are found close to the exisiting route through Lincoln than close to the proposed bypass. As traffic numbers passing through the centre of Lincoln would reduce as a result of the bypass, the greatest number of receptors would experience an increase in air quality. These improvements in air quality range from negligible to moderate beneficial.

18.2.4 Receptors close to the proposed bypass would experience reductions in local air quality, ranging from slight adverse to moderate adverse. The number of receptors affected is smaller than the number that would experience improvements in air quality. In all cases, the predicted concentrations would be well within national air quality objective (AQO) levels.

18.2.5 Calculated greenhouse gas emissions have been assessed at a regional level. These emissions would be reduced with the bypass in place as traffic would be more free-flowing.

Noise and Vibration

18.2.6 Noise and vibration impacts would arise during both the construction and operational phases of the scheme.

18.2.7 During construction, noise and vibration would affect receptors in close proximity to the site, and would be reduced as far as possible through good site practice, such as the use of low noise machinery and careful programming of works.

18.2.8 Once the bypass was open to traffic, the noise impacts would be both beneficial and adverse. Properties on the main arterial routes through Lincoln would experience reduced noise levels, compared to the situation if the bypass were not built. These reductions would be noticeable to residents of these properties.

18.2.9 Properties close to Hawthorn Road would experience a significant adverse impact once the scheme was open to traffic. Rural properties close to the southern part of the scheme would also experience increased noise levels, but these have been predicted to be negligible, due to the proposed mitigation measures (noise bunds).

Cultural Heritage

18.2.10 The assessment of impacts on cultural heritage has considered archaeology, historic buildings and the historic landscape.

18.2.11 The scheme would result in permanent impacts on archaeology, caused during the construction phase. Of these impacts, 35 would be neutral, seven would be slight adverse, one would be moderate adverse, and the impacts on 15 sites would be unknown because the exact nature of the sites cannot be determined until the construction work starts.

18.2.12 The scheme would also result in long term impacts on archaeology caused during the construction phase. Of these, two would be slight adverse, one would be moderate adverse, and two would be slight beneficial.

18.2.13 Three archaeological sites would experience long term impacts caused by the use of the road, once it was open to traffic. These impacts would all be slight adverse.

18.2.14 The impacts on historic buildings would be as follows. There would be short term impacts from the construction of moderate adverse significance on one site, slight adverse impacts on four sites, and neutral impacts on the remaining 23 sites. Once the road was open to traffic, there would be slight adverse impacts on five sites and neutral impacts on the other 23 sites.

18.2.15 An imperceptible positive impact during operation has been identified for Listed Buildings and Conservation Areas within the City of Lincoln, resulting from the reduction of traffic within the city centre.

18.2.16 There would be slight adverse impacts on the historic landscape which would be caused during the construction of the scheme and would continue in the long term. The historic agricultural and riverside landscapes would seem increasingly urbanised as the road was built and opened to traffic.

Landscape and Visual Amenity

18.2.17 The most significant landscape effects of the proposed route would be on topography, pattern and landscape character of the area.

18.2.18 The effects on topography would be due to its alignment running in contrast to both the distinctive slopes of the Witham valley and the openness of its lowland areas adjacent to the River Witham.

18.2.19 There would be slight adverse effects, after mitigation, on the landscape pattern to the northern and southern slopes and southern upland agricultural fields due to the diagonal alignment of the scheme.

18.2.20 The adverse effect to Greetwell Wood SNCI due to loss of trees as result of the scheme alignment would be moderate with mitigation in place.

18.2.21 There would be moderate adverse impacts experienced by two national character areas (North Lincolnshire Edge with Coversands and South Lincolnshire Edge) due to the impact on the distinctive topographical elements of the Witham valley. However, there would be greater impacts on local character units and areas with particular effects on the southern slope and the bottom of the valley.

18.2.22 There would be a number of different visual impacts experienced within the study area ranging from elevated, long distance views to close range and direct views towards the scheme. The largest adverse effects would be experienced by properties with close range views within the rural landscape (e.g. Canwick Heath & Canwick Manor Farms, Manor House and cottages), views out from urban edges to a rural landscape (Bracebridge Heath eastern edge, Hawthorn Chase / Washingborough Road) and elevated views to the scheme over rural landscape areas.

Ecology and Nature Conservation

18.2.23 The bypass would have negative impacts on ecology at a local level. In many cases, these impacts would reduce with time, as areas of new habitat creation included in the scheme design would become established.

18.2.24 In the short term, the species that would be affected would be amphibians, bats, birds including barn owls, reptiles and invertebrates. In the long term, these impacts would become negligible, with the exception of impacts on bats through disturbance, and barn owls, through loss of foraging land.

18.2.25 Impacts on designated sites would be negligible, with the exception of the Witham Corridor Local Wildlife Site, which would experience a negative impact at a local level.

Road Drainage and the Water Environment

18.2.26 The rainwater draining from the proposed bypass would be held in attenuation ponds before being discharged to the North Delph, Canwick Fen Drain and a tributary of Branston Beck. There would be no discharges to groundwater, as the geology in the northern section would not be suitable, and in the southern section the unsaturated zone is not sufficiently deep to allow for a soakaway.

18.2.27 Good site practice during construction would protect watercourses from contamination with sediment, oil or chemicals. Impacts on surface water quality, groundwater and flood risk during construction would all be neutral.

18.2.28 During the operation of the road, there would be impacts on surface water quality in each of the three watercourses that would receive road run-off. However, the attenuation ponds would incorporate reed bed systems to treat the water before it was discharged, and so the impact would be only slight.

18.2.29 The impacts on groundwater and flood risk during the operation of the bypass would both be neutral.

Soils and Geology

18.2.30 Significant impacts would be associated with Greetwell Quarry designated site. Potential impacts relating to the site history include impacts arising from potentially contaminated land and mineworkings. Investigation and assessment will allow the design of appropriate mitigation measures. Residual impacts from mitigation of any contaminated land and mineworkings would result in a slight positive benefit for the scheme.

Land Use

18.2.31 The LEB would have adverse impacts on agricultural land quality, soil resources and nine farm businesses. With mitigation measures in place, there would be eight slight adverse impacts, and three moderate adverse impacts.

Pedestrians, Equestrians, Cyclists and Community Effects

18.2.32 Impacts on routes used by walkers, cyclists and horse riders would vary from moderate negative where a route would be lengthened, to major beneficial for users of the new cycleway and footway who would no longer need to travel along the busy A15 to access the centre of Lincoln. In general, routes running east-west across the line of the bypass would be adversely affected, whilst there would be benefits for people moving north-south.

18.2.33 The scheme would have beneficial effects on physical fitness, as a new cycleway and footway would give access along the route and provide a new crossing point over the River Witham, providing new opportunities for walking and cycling.

Vehicle Travellers

18.2.34 Without the bypass, drivers would use the A15 to travel north-south through Lincoln. In 2016 and 2031, without the bypass, these drivers would have moderately stressful journeys, compared to low levels of stress if the bypass was built and they used the new route instead. This would be because the bypass would be less congested, there would be better signage and drivers would be more certain of their route. Drivers joining or crossing the bypass would experience moderate or highly stressful movements.

18.2.35 The views available to drivers would vary, with some becoming better and some becoming worse with the bypass in place. In general, views north and south along the bypass would be better than those experienced without the scheme, whilst views east and west towards the new bypass would be worse than without it.

Disruption due to Construction

18.2.36 In addition to the construction impacts assessed in the specialist chapters, a further assessment has been made of the impacts arising from site compound and storage areas that would be set up by the contractor.

18.2.37 The use of these areas would cause temporary impacts on ecology, possible impacts on unrecorded archaeology, and temporary slight impacts on the landscape and visual amenity. Following the end of construction, the impacts on ecology, landscape and visual amenity would come to an end, as the areas would be reinstated.

Cumulative Impacts

18.2.38 The proposed bypass would affect certain places in a number of ways. For example, Greetwell Wood would experience impacts in terms of both ecology and visual amenity; and some residents experiencing changes to their views would also experience increases in noise and reductions in air quality.

18.2.39 The possible future developments of the NEQ and SEQ, close to the proposed bypass, may cause some combined impacts on the environment which would be more significant than the impacts of the bypass alone. No planning applications have yet been made for these schemes, but they are expected to be large developments consisting mainly of housing.

18.2.40 The potential neighbouring developments could add to the impacts of the bypass on air quality, noise, cultural heritage, landscape and visual amenity, ecology, land use

and pedestrians, cyclists and horse riders. It is expected that these developments would both be subject to separate Environmental Impact Assessments.

GLOSSARY

A

Abstraction: Removal of water from a groundwater or surface water body- usually by means of a pump. Groundwater is water that is contained in porous rocks underground.

Above Ordnance Datum (AOD): "Ordnance Datum" is a standard average sea-level, used as the basis for measuring the height of any point on land above sea-level.

Agricultural Land Classification (ALC): A system of assessing and classifying agricultural land by its quality. Agricultural land can be classed from Grade 1 to Grade 5, with Grade 3 subdivided into Grade 3a and 3b.

Air Quality Management Area (AQMA): An area formally designated by the local authority in which levels of air pollution are above specified levels known as "air quality objectives".

Air Quality Objective (AQO): A health-based standard for air pollutant concentrations everywhere, which should be reached by a specific year (by type of pollutant) as established by the Government's Air Quality Strategy.

Alluvium: Sediment deposited by water.

Amenity Grassland: Grassland associated with open spaces in the vicinity of residential developments. Tend to be species poor and highly managed.

Amenity: Amenity refers to qualities of a place that make it pleasant or agreeable. Amenity value therefore refers to the contribution that a given location makes to quality of life, by being pleasant or agreeable.

Annual Mean: An average over the period of one year.

Appraisal Summary Table (AST): A one page tabular summary of the main economic, environmental and social impacts of a transport solution created as part of the TAG process.

Aquifer: A porous body of rock capable of holding quantities of water that can be abstracted for human use.

Arable: Land that is used for the growth of crops.

Artefact Scatters: concentrations of archaeological objects found on the surface of the land, usually in ploughed fields.

Artesian: Water in an aquifer that is under sufficient pressure to be forced above the confining surface.

Attenuation: Attenuation refers to an action or facility that reduces or slows down an effect, for instance slowing down rapid run-off of rainwater by capturing it in lagoons and releasing it slowly.

Attenuation lagoons/ ponds: A small artificial pond that temporarily stores rainwater running off the highway, allowing it to be released slowly.

B

Background levels: A constant existing level of any particular condition (e.g. levels of specific pollutants in the air or in a body of water), which can be raised or lowered by changing other conditions such as the presence or absence of a bypass.

Barrow: An archaeological term referring to a mound of earth or stones placed over a burial site.

Baseline: Information which represents the environmental conditions immediately prior to the implementation of any scheme. Environmental impacts or benefits are assessed by measuring how much the baseline conditions would change.

'Best and most versatile' agricultural land: Land that has been classified as being of Grades 1, 2 or 3a using the Agricultural Land Classification (ALC) system.

Biodiversity: The number and variety of organisms found within a specified area. It is an important measure of the health and vitality of an area's ecology.

Bisect: To divide something into two parts.

Borrow pits: A pit excavated to provide rock or other materials for use in construction works elsewhere, usually excavated for the purpose of a specific project.

Brashy: Composed of angular rock fragments

Bund: An earth embankment used as a barrier to visual impacts or to noise. Also used to describe low walls erected around storage tanks for fuels, oils or other potentially harmful materials, to contain any accidental spillages and prevent their escaping into the environment.

Bypass: A road that routes through traffic around a town or village to reduce conflicts with local road users and congestion.

C

Canalised: The process of turning a watercourse into a canal.

Cartographic: From maps.

Conservation Area: a settlement (whole or partial) or other area locally designated under the Planning (Listed Buildings and Conservation Areas) Act 1990 for its architectural, historical or cultural significance, including in terms of its overall character and feel. This designation can offer protection to the features of the area beyond the buildings themselves.

Contaminant: A substance which adversely pollutes air, water or soil.

Copse: Small area of woodland

Cretaceous: A geological period of time

Cutting: The excavated area created where it is necessary for a highway to run below the level of the surrounding land.

Cyprinid: Family of freshwater fish which includes carp.

D

Db (A): Sound levels measured in decibels, calculated by a method ('A-weighted') that takes particular account of the frequencies most significant in traffic-generated noise.

Deciduous: Trees which shed the leaves annually at the end of the growing season.

Diffusion tube: Equipment for measuring the level of air pollution (small tubes that absorb atmospheric pollutants, for subsequent laboratory analysis).

Dip: Angle of rock strata slope.

Dip slope: A relatively gentle slope down from a raised plateau area, on the opposite side from a much steeper 'escarpment' or 'scarp'; for instance, the east and north-east facing slopes of Lincoln Edge, on the opposite site from the steep west-facing escarpment known as the 'Cliff'.

Directive / **European Directive:** A type of legislation made by the European Union that must be adopted and implemented by the Member States of (i.e. countries belonging to) the European Union. They usually allow Member States some flexibility in how they apply the Directive in their respective countries.

Discharge: Outflow of water.

DMRB: The Department for Transport's Design Manual for Roads and Bridges, a multi-volume work that gives guidance on all matters relating to highway construction. Volume 11 relates to Environmental Impact Assessment.

Do-minimum: A standard type of alternative scenario against which the environmental effects of a proposed new highway scheme can be measured. The 'do-minimum' scenario in any particular case would represent the situation that would exist in the proposed year of opening of the new road, if the new road itself were not built. It would take into account all other expected changes in the highway network, together with predicted traffic levels. This represents a more realistic standard of comparison for environmental effects than a comparison with the existing situation.

Do-something: Scenario in which one of the proposed road scheme options is constructed.

Dual carriageway: A divided highway; a highway where the lanes for opposing traffic flow (i.e. traffic going different directions) are separated by a central reserve or barrier.

Dyke: Drainage ditch.

E

Earthworks: In construction, this means any operations involved in moving, loosening, depositing, shaping, compacting and stabilising soil and rock.
In archaeology, it means any archaeological features that are visible as slopes, mounds, banks or depressions in the ground surface.

Environmental Impact Assessment (EIA): A systematic process for assessing a project's likely significant environmental effects so that they can be taken into account in decision-making about the project.

Environmental Quality Standard (EQS): Maximum acceptable levels of certain specific substances. The substances for which standards are required is prescribed by the European Union; the EQS for each substance is set and enforced by each member state.

Environmental Statement: A formal document produced to report the findings of an Environmental Impact Assessment.

Escarpment: A long steep slope/ cliff.

Extant Route: Original Lincoln Eastern Bypass route that was subject to an Environmental Impact Assessment in 2004 and was subsequently granted planning permission in April 2005.

F

Façade corrections: A façade noise level is the noise level 1m in front of the most exposed window or door on the face of a building. The effect of reflection is to produce a slightly higher (+2.5dB) sound level than it would if the building was not there. This factor needs to be added when predicting noise levels.

Fault: A rock fracture along which movement has occurred.

Fen: A wetland environment fed by surface and/ or groundwater.

Findspot: An individual location where archaeological objects have been found on the surface of the land.

Floodplain: Flat lowland areas adjacent to rivers which are subject to periodic flooding.

Footprint: The area of land physically covered by a feature, such as a new road; alternatively, the area within which a feature such as a new road may have an influence.

Funerary: Objects, materials, or rituals associated with a human burial.

G

General Quality Assessment (GQA): Method of assessing the chemical, biological and aesthetic quality of a watercourse.

Glacio-: Derived from a glacier.

Grassland: A vegetation community in which grasses are the most conspicuous plants.

Greenfield runoff rate: After rainfall (or other precipitation), the 'natural' rate of overland water movement for an area, or the rate at which water would move over the average greenfield (i.e. undeveloped) land surface.

Groundwater: Water held underground within porous rocks.

H

Habitat: The locality, site and particular type of environment inhabited by particular species of animals and plants.

Hardness: A characteristic of water determined by the concentration of dissolved mineral salts.

Haul routes: Temporary roads or tracks built within or adjacent to a construction site for the purpose of transporting bulk materials within the site.

Heavy Duty Vehicle (HDV): Any vehicle with a gross weight greater than 3.5 tonnes, including heavy goods vehicles (HGVs) and coaches.

Heritage: The culture, property, and characteristics of past times.

Hertz: A unit of frequency, equivalent to one cycle per second.

Historic Environment Record (HER): An entry in the local authority's register of historic sites and features.

Hydraulic Connection: A link between two bodies of water (e.g. surface water and groundwater).

Hydrogeology: The study of groundwater.

Hydrology: The study of surface water.

I

Improved grassland: Grassland which shows clear signs of agricultural improvement (e.g. by drainage, application of fertilisers, application of herbicides). Generally lacking in biodiversity.

***in situ*:** In cultural heritage terms, referring to being found or preserved in the place where it was originally deposited.

Inert: No or limited ability to chemically react.

Inscribed Circle Diameter (ICD): As relevant to road design, the diameter of a roundabout as perceived by an approaching driver. This measurement therefore varies for irregularly shaped (i.e. non-circular) roundabouts.

Interim Advice Notes (IANs): Documents issued by the Highways Agency which provide additional guidance and/or amendments to the Design Manual for Roads and Bridges (DMRB).

J

Jurassic: Geological period of time.

K

L

Landscape Character Unit (LCU): Discrete areas within the landscape, defined by specific homogeneous landscape components for example: landform, land cover vegetation, settlement pattern, remoteness and degree of tranquillity.

Leachate: Fluid that has passed through a material and has collected dissolved substances.

Legislation: A law or set of laws that derives from a parliamentary process (Primary Legislation = Acts of Parliament; Secondary Legislation = Regulations or other Statutory Instruments, made by Government under powers given to them through an Act).

Lenticular: Lens shaped.

Listed Building: A building or other structure that is nationally designated for its architectural, historical or cultural significance, under the Planning (Listed Buildings and Conservation Areas)

Act 1990. Structures are classified as Grade I, Grade II* or Grade II Listed, according to their interest.

Loam: A fertile soil composed of sand, clay and organic matter.

Local Biodiversity Action Plan (LBAP): A plan or set of plans containing actions and/or targets for the conservation and enhancement of habitats and wildlife in an area (e.g. a local authority or county), whether designated or not.

Local receptors: Receptors are features of the environment that are capable of 'receiving' an impact (e.g. people, in the case of air quality or noise effects).

Local Wildlife Site (LWS): A specific area designated by a local council or councils for its nature conservation interest.

M

MAGIC: A website provided by government to make certain types of environmental information, particularly about protected sites, easily available (http://www.magic.gov.uk/).

Magnetometer: An instrument that detects changes in the earth's magnetic field. Used by archaeologists to detect and map historic features and artefacts in the ground.

Magnetic susceptibility survey: An archaeological survey method which detects changes to the soils as a result of heat from man-made fires which indicates past human activity at a site.

Magnitude (of an effect): The degree or level of an environmental effect, often categorised in order to provide a comparative analysis (e.g. 'major' versus 'minor').

Medieval: In classifying certain sites, of or from the period of history between 1066 A.D. (the Norman Conquest) and 1540 A.D. (the Reformation), also known as the Middle Ages. The period from 410 A.D. (fall of Roman occupation) to 1066 A.D. is sometimes referred to as the 'Early Medieval' period, also known as the Anglo-Saxon period.

Mitigation: Measures, including any process, activity or design to avoid, reduce, remedy or compensate for adverse effects of a development project.

Monastic: Relating to a monastery.

N

Neolithic: Latest period of the Stone Age.

Non-Motorised User (NMU): A pedestrian, cyclist, equestrian, or other user of the highway network (traditional definition – i.e. including roads, footpaths, cycle paths, etc.) not assisted by a powered road or off-road vehicle.

Non-statutory: A rule or code or set of criteria which is not found in a law but which is adopted by an organisation and may have enforcement mechanisms attached.

Non-statutory organisation: An organisation not set up by law.

Nucleated settlement: A settlement with the buildings clustered together, often around a central feature such as a village green or a church.

O

Oolithic Limestone: Type of sedimentary rock composed of calcium carbonate.

Organophosphate: A compound used in fertilizers and pesticides.

Overbridge: A bridge constructed in order to allow passage over a structure of topic (e.g. railway or road).

P

Palaeoenvironmental remains/deposits: Buried deposits which contain evidence of past environmental conditions.

Peat: A ground deposit made of partially decomposed vegetation

Permeable: Allows fluid to pass through it.

Phase 1 habitat survey: A system for rapidly surveying, classifying and mapping wildlife habitats, developed by the Nature Conservation Council and adopted by the Institute of Environmental Assessors.

Photochemical oxidants: A type of air pollutant produced by combining NO_x with Volatile Organic Compounds (VOCs), the most well-known of which is ozone (O_3). At high levels, it can have negative effects on plant life and other organisms.

Piling: The act of driving 'piles' (supports) into the ground.

Planning Policy Statements/Guidance: A series of government documents that provide guidance, principally to Local Planning Authorities, about various aspects of government policy in relation to the planning system.

Plateau: An area of higher and generally flat land.

Public Right of Way (PRoW): An overland route which grants everyone the right to cross the land, whether public or private. There are a number of different types, including those for pedestrians, cyclists and equestrians, and in some cases, off-road vehicles as well.

Pyrethroid: A type of insecticide.

Q

Qualitative: Qualities or characteristics that cannot be measured numerically (e.g. how 'good', 'bad', or 'beautiful' something might be).

Quantitative: Qualities or characteristics that can be measured numerically (e.g. length, height, area, volume).

R

Radial Route: Roads emanating from the centre outwards or from the outskirts inwards.

Receptor: Receptors are features of the environment that are capable of 'receiving' an impact or effect (e.g. people, in the case of air quality or noise effects).

Regional Spatial Strategy: A document which sets out the long term land use and transport planning framework for a region.

Registered Park / **Garden:** A site designated nationally under the Historic Buildings and Ancient Monuments Act 1953 for its special historic interest, including age, designer, associations and group value.

Regulations: a type of legislation made by Government under powers given to them through an Act

Rectilinear: A geometric shape composed of straight lines.

Resitivity: A means of detecting buried features and areas of disturbance by measuring the resistance of an electrical current passed through the ground.

Retaining Wall: A wall which holds back earth or stone.

Riparian: Located by the banks of a river, stream, or other body of water.

River Ecosystem Classification: A system of five hierarchical classes which indicate a river's ability to support biodiversity.

River Quality Objective: Environmental standards set by the Environment Agency in respect of the quality of the water in a particular stretch of river.

Route Corridor: A broad area of land within which a route may be defined. Alternatively, a broad area of land either side of a route that may be influenced by it in some way.

Ruderal: Tall herbaceous vegetation

S

Salmonid: Members of the salmon and trout family

Scarp: A steep cliff face.

Scheduled Ancient Monument (SAM): An historical site of national importance, which is designated under the Ancient Monuments and Archaeological Areas Act 1979 and the National Heritage Act 1983.

Scrub: Dense vegetation consisting of stunted trees or bushes.

Severance / **community severance:** Separation of an individual or group from a facility, or of a single entity into two parts (e.g. a footpath divided into two dead-ends).

Significance / **significant effect:** A change to a receptor which passes a given threshold and becomes an issue that may require further consideration or analysis.

Siliceous: Containing silica.

Siltation: The deposition or accumulation on the bottom of a body of water of fine or intermediate sized mineral particles known as 'silt'.

Site of Nature Conservation Interest (SNCI): A specific area designated by a local council or councils for its nature conservation interest.

Site of Special Scientific Interest (SSSI): A site designated for its national nature conservation or geological interest, and protected under the Wildlife and Countryside Act 1981 (as amended).

Site Waste Management Plan (SWMP): A plan with actions and measures for the duration of a project's construction to minimise the amount of waste disposed of in landfill, and ensure waste disposal is in accordance with legal requirements.

Source Protection Zones (SPZ): A defined zone surrounding a groundwater abstraction point (e.g. a well or a spring), within which certain activities are restricted to prevent contamination of the groundwater.

South East Quadrant: …

Stage 1 Assessment: A type of wider project assessment including Environmental Impact Assessment (EIA) of road projects, which is the first of three. In England, it occurs 'pre-programme' (prior to considering options) and identifies the environmental, engineering, economic and traffic advantages, disadvantages and constraints associated with broadly defined improvement strategies.

Stage 2 Assessment: The second of the three types of project assessment (including EIA) of road projects. In England, it occurs prior to public consultation and identifies the factors to be taken into account in choosing alternative routes or improvement schemes, as well as the environmental, engineering, economic and traffic advantages, disadvantages and constraints associated with those routes or schemes.

Stage 3 Assessment: The third of the three types of project assessment (including EIA) of road projects. It occurs after selection of a preferred route and prior to publication of Orders, and identifies clearly the advantages and disadvantages, in environmental, engineering, economic and traffic terms, of the preferred route or scheme option. This includes an assessment of the significant environmental effects of the project, in accordance with legislation.

Stand: A term used to describe an area of similar vegetation (usually in reference to trees).

Statutory: Required by law.

Statutory Instrument: A type of legislation made by Government under powers given to them through an Act

Strata: A layer of soil or rock.

Study area: A defined area for which data has been, or will be, gathered for a particular purpose.

Superficial deposits: Surface deposits which lie on top of rock which are younger than 2 million years old.

Surface water run-off: Precipitation which travels to watercourses over the surface of the land

Sustainable Urban Drainage System (SUDS): Various techniques which can be adopted to reduce the adverse environmental impact of urban drainage.

Sward: Surface layer of ground containing a mat of grass and grass roots

T

TAG: The Transport Analysis Guidance is an appraisal tool designed to meet the specific appraisal criteria of highways and transport schemes in England.

Tertiary: Geological period of time.

Topography: Description of the shape and physical features of the earth's surface.

Trial Trenching: An method of evaluating the archaeological potential of a site through a series of minor ground excavations.

Tributary: A small river or stream which flows into a larger watercourse.

Two-span: A bridge or ceiling created using a single support, and thus with two 'spans' of bridge connecting each embankment to the pier/support.

U

Underbridge: A bridge constructed in order to allow passage under a structure (e.g. railway or road), whether for people or environmental features (e.g. rivers).

Underpass: A passage crossing under a structure such as a railway or road, which is for pedestrians, cyclists, equestrians, vehicles or other travellers; a short tunnel under a road or railway.

Understory: Area under the shade of larger plants or trees.

Unitary Development Plan: A document which outlines land use provision and policies and proposals for new developments within a unitary district. These documents are currently being superseded by Local Development Frameworks (LDF)

V

Visual envelope: Extent of land within which a particular feature, such as a new road, may be visible.

W

Walkover survey: A survey that involves walking through a study area to obtain information through visual observation alone.

Watching brief: A form of archaeological investigation during which an archaeologist observes ongoing construction works (especially topsoil stripping and mechanical excavation works) so as to identify any unexpected archaeological remains and record them.

X

Y

Z

Zone of Theoretical Visibility (ZTV): The possible areas that might experience views of the scheme assuming a worst case scenario of lorries (4.2m tall) visible on the road during operation.

REFERENCES

Acorus (2003 & 2009?) Agricultural Impact Assessment

Altringham, J.D. (2003) British Bats. *Harper Collins, London.*

Bat Conservation Trust (2007) – Bat Surveys Best practice Guidelines, Bat Conservation Trust, London.

Babtie (2003) Lincoln Eastern Bypass Environmental Statement

Bern Convention (1979) Bern Convention on the Conservation of European Wildlife and Natural Habitats.

Bonn Convention (1979) Bonn Convention on the Conservation of Migratory Species of Wild Animals

British Standards Institute (1997) BS5228. Noise & Vibration Control on Construction & Open Sites. *BSI.*

British Trust for Ornithology (1998) Breeding Bird Survey 1998 – instructions. *British Trust for Ornithology, Thetford.*

City of Lincoln Council (Adopted 1998) City of Lincoln Local Plan

City of Lincoln Council (2005) Local Air Quality Management, 2nd Progress Report.

City of Lincoln Council (2006) Air Quality Action Plan.

Clay, P. (2006) An Archaeological Resource Assessment and Research Agenda for The Neolithic and Early-Middle Bronze Age of the East Midlands

Countryside Agency (1996) Countryside Character Initiative Area Map.

Department for Communities and Local Government (2006) Environmental Impact Assessment: A Guide to Good Practice and Procedures. *London: HMSO*

DEFRA (2003) Local Air Quality Management Technical Guidance. *DEFRA*

DEFRA (2007) Air Quality Strategy for England, Scotland, Wales and Northern Ireland. *HMSO*

DoE (1990) Planning Policy Guidance Note 16: Archaeology and Planning. (PPG16). *London: HMSO*

DoE (1994) Planning Policy Guidance Note 15: Planning and the Historic Environment. (PPG15). *London: HMSO*

DoE (1995) Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide. *London: HMSO.*

Department for Transport (1988) Control of Road Traffic Noise

Department for Transport (2004) Transport White Paper: The Future of Transport – a Network For 2030

Department for Transport (Updated October 2007) Transport Appraisal Guidance. *Department for Transport*

DTLR (2000) Environmental Impact Assessment: A guide to procedures. *Thomas Telford, London.*

East Midlands Regional Assembly (2006). Draft Regional Spatial Strategy for the East Midlands (RSS8)

English Heritage (2007) Understanding the Archaeology of Landscapes. *Swindon: RCHME.*

Environment Agency (1999) Otters and River Habitat Management, 2nd Edition

Environment Agency (2004) PPG 2: Above Ground Oil Storage Tanks. *Environment Agency*

Environment Agency (undated) PPG 5: Work in, near or liable to affect watercourses. *Environment Agency*

Environment Agency (2000) PPG 6: Working at construction and demolition sites. *Environment Agency*

Environment Agency (2000) PPG 18: Managing fire water and major spillages. *Environment Agency*

Environment Agency (2004) PPG 21: Pollution incident response planning. *Environment Agency.*

Environment Agency (1999) PPG 22: Dealing with spillages on highways. *Environment Agency*

Environment Agency (2003) PPG 23: Planning and Pollution Control. *Environment Agency.*

Environment Agency (2001) PPG 25: Development and Flood Risk. *Environment Agency.*

Environment Agency (2004) PPG 26: Storage and Handling of Drums and Intermediate Bulk Containers. *Environment Agency*

Environment Agency (2008) River Witham Catchment Flood Management Plan (CFMP)

European Commission (2001) Guidance on EIA: Screening

European Commission (2001) Guidance on EIA: Scoping

European Council (1978) Freshwater Fisheries Directive (78/659/EEC), Adopted 1978 and Updated 2006

European Council (1979) European Council Directive on the Convention of Wild Birds (Birds Directive 1979) as amended (79/409/EEC)

European Council (1985) European Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, as amended by Council Directive 97/11/EC.

European Council (1992) European Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive 1992) as amended (92/43/EEC)

Faber Maunsell (2007) Witham Catchment Flood Map Improvements, Upper Witham Hydraulic Modelling Report

Faber Maunsell (2008a) Lincoln Integrated Urban Drainage Pilot – SLD2309

Faber Maunsell (2008b) Lincoln Water Cycle Study

Government Office for the East Midlands (2005) Regional Spatial Strategy for the East Midlands. *London, TSO*

Government Office for the East Midlands (2009) East Midlands Regional Plan. *London, TSO.*

Highways Agency (1994) Design Manual for Roads and Bridges (DMRB) volume 11 – Environmental Assessment Techniques. *Highways Agency*

Highways Agency (2000) Encouraging Sustainable Travel – Highways Agency Strategic Plan for Accessibility

Highways Agency (2005) DMRB volume 6, Section 3, Part 5- The geomatic design of pedestrian, cycle and equestrian routes (TA90/05). *Highways Agency.*

Highways Agency (2008) Interim Advice Note 116/08. Nature conservation advice in relation to bats. *Highways Agency.*

HM Government (1974) Control of Pollution Act

HM Government (1975) Noise Insulation Regulations

HM Government (1981) Wildlife and Countryside Act 1981 (as amended);

HM Government (1990) Environmental Protection Act

HM Government (1991) Water Resources Act

HM Government (1992) Protection of Badgers Act

HM Government (1993) Clean Air Act

HM Government (1995) Environment Act

HM Government (1996) Wild Mammals (Protection) Act

HM Government (1997) Hedgerow Regulations

HM Government (1999) The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (S.I.293)

HM Government (2000) Air Quality (England) Standard Regulatons

HM Government (2000) Countryside and Rights of Way ('CRoW') Act

HM Government (2001) Control of Pollution (Oil Storage) (England) Regulations

HM Government (2003) The Water Resources (Water Framework Directive) Regulations.

HM Government (2006) Natural Environment and Rural Communities Act

HM Government (2007) Air Quality (England) Standard Regulations

HM Government (2007) Conservation (Natural Habitats & c.) Regulations 1994, as amended 2007

HM Government (2007) The Environmental Permitting (England and Wales) Regulations

HM Government (2008) Town and Country Planning (Environmental Impact Assessment) (England) (Amendment) Regulations.

Institute for Ecology and Environmental Management (2006) Guidelines for Ecological Impact Assessment in the United Kingdom. *IEEM*

Institute of Environmental Assessment (1995) Guidelines for Baseline Ecological Assessment. *Taylor & Francis*

Jacobs (December 2007) 'Non-Motorised Users Context Report'. *Unpublished Report*

Jacobs & Lincolnshire County Council (January 2008) Lincoln Eastern Bypass Stage 2 Environmental Assessment Report.

Jacobs & Lincolnshire County Council (February 2008) Lincoln Eastern Bypass Stage 1 Assessment Report.

JBA (2004) Lincoln Policy Area – Strategic Flood Risk Assessment

Jefferies, D.J. (1989) The changing otter population in Britain 1700-1989. *Biological Journal of the Linnaean Society*, 38, 61-69.

Joint Nature Conservation Committee (2003). Handbook for Phase 1 Habitat Survey.

Joint Nature Conservation Committee (2003). The Herpetofauna Workers' Manual

Joint Nature Conservation Committee (2008) The Population Status of Birds in the UK - Birds of Conservation Concern: 2002-2007 Red and Amber List.

Joint Nature Conservation Committee. UK Biodiversity Action Plan

Landscape Institute & IEMA (2002) Guidelines for Landscape and Visual Impact Assessment (GLVIA) 2nd Edition. *Spon Press*

Liles, G. (2003) Otter Breeding Sites: Conservation & Management. Conserving Natura 2000 River Conservation Techniques, Series No5. *English Nature, Peterborough*

Lincolnshire County Council (2001) The Alternative Strategic Development Areas Study

Lincolnshire County Council (March 2006) Local Transport Plan.

Lincolnshire Biodiversity Partnership (2006) Lincolnshire Biodiversity Action Plan 2nd Edition

National Rivers Authority (1995) Groundwater Vulnerability Map, Sheet 19, Lincolnshire, 1:100 000.

Natural England (2001) Great Crested Newt Mitigation Guidelines

Natural England (2005) Character of England Landscape, Wildlife and Cultural Features Map

Nature Conservancy Council (1989) Guidelines for the Selection of Biological SSSIs. *Nature Conservancy Council, Peterborough.*

Neal, E & Cheesman, C (1996) Badgers. *Poyser Books*

North Kesteven District Council (Adopted September 2007) North Kesteven Local Plan

North Kesteven District Council (September 200**7)** North Kesteven Landscape Character Assessment

ODPM (2001) Planning Policy Statement (PPG) 13 'Transport'. *TSO*

ODPM (2004) Planning Policy Statement (PPS) 7 'Sustainable Development in Rural Areas'. *TSO*

ODPM (2005) Planning Policy Statement (PPS) 1'Delivering Sustainable Development'. *TSO*

ODPM (August 2005) Planning Policy Statement 9, 'Biodiversity and Geological Conservation'. *TSO.*

ODPM (2005) Minerals Policy Statement2: Controlling and Mitigating the Environmental Effects of Minerals Extraction in England. Annex 1: Dust.

Ordnance Survey (2006) OS 1:50,000 scale Landranger map sheet 121

Ordnance Survey (2006) OS 1:25, 000 scale Explorer map sheet 272

Ratcliffe, D. A. (1977). A nature conservation review. The selection of biological sites of national importance to nature conservation in Britain. *Cambridge University Press, Cambridge*.

Richardson, P. (2000) British Natural History Series: Bats. *Whittet Books.*

Strachan, R. (2006). Water Vole Conservation Handbook. Wildlife and Conservation Research Unit, University of Oxford;

Taylor, J. (2006) An Archaeological Resource Assessment and Research Agenda for the Roman Period in the East Midlands

UK Biodiversity Partnership (2004) UK Biodiversity Action Plan. *HMSO*

United Nations (1992) Convention on Biological Diversity

West Lindsey District Council (1999) West Lindsey Landscape Character Assessment

West Lindsey District (June 2006) West Lindsey District Local Plan