Great Yarmouth Third River Crossing

Application for Development Consent Order

Document 6.1: Environmental Statement Volume 1: Main Text

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended) ("APFP")

APFP regulation Number: 5(2)(a)

Planning Inspectorate Reference Number: TR010043

Author: Norfolk County Council

Document Reference: 6.1 – Environmental Statement

Version Number: 0 – Revision for Submission

Date: 30 April 2019

Foreword

This Environmental Statement accompanies an application ("the Application") submitted by Norfolk County Council ("the Applicant") to the Secretary of State for a Development Consent Order ('DCO') under the Planning Act 2008[1].

If made by the Secretary of State, the DCO would grant development consent for construction, operation and maintenance of a new bascule bridge highway crossing of the River Yare in Great Yarmouth, and which is referred to in the Application as the Great Yarmouth Third River Crossing (or 'the Scheme').

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended) require that an application for a DCO be accompanied by the documents specified at Regulation 5(2)(a) to (r). This is one of those documents and is specified at Regulation 5(2)(a).

[1] References to legislation in this document are to that legislation as amended at the date of this document.

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Glossary of Defined Terms and Acronyms

Defined Terms

Term	Definition
The Applicant	Norfolk County Council (in its capacity as Highway Authority and promoter of the Scheme).
Application Site	The land bounded by the Order Limits, as shown by a red line on the Land Plans (document reference 2.5) and the Works Plans (document reference 2.6) and being land within which the authorised development may be carried out.
The APFP Regulations	The Infrastructure Planning (Applications - Prescribed Forms and Procedure) Regulations 2009 (SI 2009/2264).
Beacon Park Enterprise Zone Site	15.7 hectare site within the Great Yarmouth and Lowestoft Enterprise Zone which falls under the broader 'Space to Innovate' Enterprise Zone.
Bridge Lowered	Position of the bascule bridge where it is closed to vessels, and open to vehicular traffic, cyclists and pedestrians.
Bridge Raised	Position of the bascule bridge where it is closed to vehicular traffic, cyclists and pedestrians, and open to vessels.
Crossing	The combined double leaf bascule bridge and the Southtown Road bridge structure (i.e. from its junction with the new roundabout on William Adams Way to the new junction on South Denes Road).
Double Leaf Bascule Bridge	Opening span and mechanism needed to operate the bridge.
Eastern Power Networks plc	The licenced distribution operator for the distribution electricity network in Great Yarmouth.
The EIA Regulations	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.
Great Yarmouth Enterprise Zone Sites	Collective term for the South Denes and Beacon Park Enterprise Zone Sites, which form part of the broader Great Yarmouth and Lowestoft Enterprise Zone.
The Highways and Railways NSIP Order	The Highway and Railway (Nationally Significant Infrastructure Project) Order 2013 (SI 2013/1883).

Term	Definition
Kingsgate Community Centre	Kingsgate Community Centre is occupied by the Kingsgate Community Church, providing regular community events/activities, and a café.
Knuckles	The areas of the River Yare into which the proposed development extends (from the existing quay walls). These areas consist of the following: • Physical protection systems (which are protective structures provided adjacent to the bascule abutments) to fully or partial absorb the design ship collision loads from an aberrant ship or vessel. These protection systems are located on both the south and north of each bascule abutment. They consist of sheet piles driven to dense sands infilled with stone or granular material and capped with a reinforced concrete slab. • A bascule abutment which accommodates and allows the movement of the counterweight and houses the mechanical, electrical, instrumentation, control and automation systems. The bascule abutment consists of driven piles and reinforced concrete slabs and walls. • Plant and control rooms on the western side and plant rooms on the eastern side. • Vessel Impact Protection Systems located at the interface between the physical protection systems, the bascule abutments and the River Yare. There are knuckles on both the east and west sides of the River Yare.
MIND Centre and Grounds	Land located to the south of Queen Anne's Road, comprised within Plot Nos. 1-27, 2-03, 2-05, 2-06 and 2-07 on the Land Plans (document reference 2.5), which is currently leased to Great Yarmouth and Waveney Mind for the purposes of its charitable aims and objectives.
NCC	Norfolk County Council (other than in its Highway Authority role as promoter of the Scheme).
New Dual Carriageway Road	Description of road type on the Crossing.
NPS	National Policy Statement.
NPS for Ports	National Policy Statement for Ports.
NPS NN	National Policy Statement for National Networks.

Term	Definition
Order Land	Land that is proposed to be acquired and land over which new rights are proposed to be created and acquired, as shown on the Land Plans (document reference 2.5).
Opening Span	Length of bridge structure that opens.
Order Limits	Limits of land within which the authorised development may be carried out, as shown on the Land Plans (document reference 2.5) and the Works Plans (document reference 2.6).
The Outer Harbour	Part of the Port of Great Yarmouth, the deep water Outer Harbour (completed in 2010) is situated at the southern end of the South Denes peninsula and offers direct access to the North Sea.
The Planning Act	The Planning Act 2008.
The Port	The Port of Great Yarmouth, comprising both commercial quays on both sides of the River Yare and Outer Harbour and within the jurisdiction of the Great Yarmouth Port Authority.
Principal Application Site	The land comprised in the Application Site but excluding the Satellite Application Sites.
Proposed Scheme	Great Yarmouth Third River Crossing project at the time of statutory pre-application consultation.
Proposed Scheme Boundary	The boundary of the land within which the Proposed Scheme was proposed to be carried out, at the time of statutory pre-application consultation, as delineated by a red line on Figure 2.3 of the PEIR.
Reinforced Earth Embankment	A reinforced earth or reinforced soil embankment is a general term which refers to the use of placed or in situ soil or other material in which tensile reinforcements act through interface friction, bearing or other means to improve stability. The reinforced earth embankment is supported by driven piles and pilecaps.
Satellite Application Sites	The parts of the Application Site within which Work Number 13 may be carried out, as shown on the Works Plans (document reference 2.6) and described in Schedule 1 to the draft DCO (document reference 3.1).
Scheme	The Great Yarmouth Third River Crossing project for which the Applicant seeks development consent.
Southtown Road Bridge	Bridge structure over Southtown Road.

Term	Definition
South Denes Enterprise Zone Site	58.8 hectare site within the Great Yarmouth and Lowestoft Enterprise Zone which falls under the broader 'Space to Innovate' Enterprise Zone.
Statutory Designated Sites	Sites which have been designated under UK and in some cases European or international legislation which protects areas identified as being of special nature conservation importance.
Study Area	The boundary/extents of a specific assessment.
Underpass	The underpass beneath the Crossing, located on the east side of the River Yare, to be constructed to provide a new private means of access for the benefit of owners and occupiers of adjoining land.
Vessel Impact Protection Systems	These are specific protection systems located at the interface between the physical protection system, the bascule abutments and the River Yare. These systems will take the form of fenders or equivalent (formed of different materials) which are used to deflect or redirect an aberrant vessel away from the knuckles. The fenders are designed to provide required levels of protection to both vessels, the "knuckles" and the fenders themselves in accordance with national and international recommendations for the protection of bridge structures on navigable waterways.
Vessel Waiting Facilities	Provision of vessel waiting facilities to the north and south of the Crossing, either as floating pontoons or additional fendering to the existing berths, including any dredging and quay strengthening works that may be required.

Acronyms

Abbreviation	Definition
AADT	Average Annual Daily Traffic
AAP	Area Action Plan
AAWT	Annual Average Weekday Traffic
AAWT	Annual Average Weekday Traffic
ADMS	Atmospheric Dispersion Model System
AEP	Annual Exceedance Probability
AIA	Arboricultural Impact Assessment

Abbreviation	Definition
AM	Ancient Monuments
AMCB	Analysis of Monetised Costs and Benefits
ANPR	Automatic Number Plate Recognition
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty
APIA	UK Air Pollution Information System
AQMA	Air Quality Management Areas
AST	Appraisal Summary Table
ATC	Automatic Traffic Counts
BCR	Benefit to Cost Ratio
BGL	Below Ground Level
BGS	British Geological Survey
BNL	Basic Noise Levels
BOD	Biological Oxygen Demand
BoR	Book of Reference
BPM	Best Practical Means
BS	British Standard
CA	Compulsory Acquisition (a power to acquire land, or to create and acquire new rights over land, compulsorily, for the purposes of constructing, operating and maintaining the Scheme)
CAS	Clean Air Strategy
CCME	Canadian Sediment Quality Guidelines for the Protection of Aquatic Life
CDE	Construction, Demolition and Excavation
CEA	Cumulative Effects Assessment
CeFAS	Centre for Environment Fisheries and Aquaculture Science
CFMP	Catchment Flood Management Plan
CftS	Case for the Scheme
CIEEM	Chartered Institute for Ecological and Environmental Management
CIRIA	Construction Industry Research and Information Association

Abbreviation	Definition
CJEU	Court of Justice of the European Union
COBA-LT	Cost and Benefits to Accidents – Light Touch
CoPA	Control of Pollution Act 1974
CoCP	Code of Construction Practice
CO_2	Carbon Dioxide
CoC	Contaminants of Concern
CPI	Consumer Price Index
CPO	Compulsory Purchase Order
CRTN	Calculation of Road Traffic Noise
CSM	Conceptual Site Model
CWS	County Wildlife Site
dB	Decibel
DCLG	Department for Communities and Local Government (as was)
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DM	Do Minimum
DML	Deemed Marine Licence
DMRB	Design Manual for Roads and Bridges
DO	Dissolved Oxygen
DoS	Degree of Saturation
DR	Design Report
DS	Do Something
EA	Environment Agency
EAR	Economic Appraisal Report
EAST	Early Assessment Sifting Tool
EC	European Commission
EFT	Defra's Emission Factor Toolkit
EHOs	Environmental Health Officers
EIA	Environmental Impact Assessment

Abbreviation	Definition
EM	Explanatory Memorandum
EQIA	Equalities Impact Assessment
EQS	Environmental Quality Standards
ES	Environmental Statement
EU	European Union
FBC	Full Business Case
FCTMP	Framework Construction Traffic Management Plan
FCWTP	Framework Construction Worker Travel Plan
FRA	Flood Risk Assessment
FTE	Full Time Equivalent
GA	General Arrangement
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GP	General Practitioners
GQA	General Quality Assessment
GQRA	Generic Quantitative Risk Assessment
GVA	Gross Value Added
GWDTE	Groundwater Dependent Terrestrial Ecosystem
GYBC	Great Yarmouth Borough Council
GYPA	Great Yarmouth Port Authority
GYPC	Great Yarmouth Port Company
GYTRC	Great Yarmouth Third River Crossing
HAWRAT	Highways Agency Water Risk Assessment Tool
HAT	Highest Astronomical Tide
HDV	Heavy Duty Vehicle
HE	Highways England
HEHRE	Highways England Historic Railways Estate
HGV	Heavy Goods Vehicles
HLC	Historic Landscape Characterisation

Abbreviation	Definition
HPI	Habitats of Principal Importance
HRA	Habitat Regulations Assessment
HSE	Health and Safety Executive
HUDU	Healthy Urban Development Unit
IAN	Interim Advice Note
IAQM	Institute of Air Quality Management
ICD	Inscribed Circle Diameter
IDB	Inland Drainage Board
IEMA	Institute of Environmental Management and Assessment
IMD	Indices of Multiple Deprivation
ISO	International Standards Organisation
IROPI	Imperative Reasons of Over-Riding Public Interest
JNCC	Joint Nature Conservation Committee
kgCO_2e	Kilograms of Carbon Dioxide Equivalents
ktCO_2e	Thousand Tonnes of Carbon Dioxide Equivalents
LAQM	Local Air Quality Management
LAT	Lowest Astronomical Tide
LDO	Local Development Order
LFRMS	Local Flood Risk Management Strategy
LGV	Light Goods Vehicle
LIQs	Land Interest Questionnaires
LLFA	Lead Local Flood Authority
LMVR	Local Model Validation Report
LNR	Local Nature Reserve
LOAEL	Lowest-Observed-Adverse-Effect Level
LoDs	Limits of Deviation
LSE	Likely Significant Effects
LSOAs	Lower Layer Super Output Areas
MA&D	Major Accidents and/or Disasters
MAGIC	Multi-Agency Geographic Information for the Countryside
MCC	Manual Classified Count

Abbreviation	Definition
ME	Matrix Estimation
MHCLG	Ministry of Housing Communities and Local Government
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MHWST	Mean High Water Spring Tide
MLWN	Mean Low Water Neap
MLWS	Mean Low Water Spring
MLWST	Mean Low Water Spring Tide
MMO	Marine Management Organisation
MMP	Materials Management Plan
MMQ	Mean Maximum Queue
MPS	Marine Policy Statement
$MtCO_2e$	Million Tonnes of Carbon Dioxide Equivalents
NAEI	National Atmospheric Emissions Inventory
NBIS	Norfolk Biodiversity Information Service
NCC	Norfolk County Council (in all capacities other than Highway Authority acting as promoter of the Proposed Scheme)
NERC	Natural Environment and Rural Communities
NHER	Norfolk Historic Environment Record
NIA	Noise Important Areas
NIR	Noise Insulation Regulations (1975) (as amended) (SI 1975/1763)
NMU	Non-motorised user
NNR	National Nature Reserve
NPPF	National Planning Policy Framework (2019)
NOEL	No Observed Effect Level
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NPSE	Noise Policy Statement for England
NPV	Net Present Value
NRA	Navigational Risk Assessment

Abbreviation	Definition
NSIP	Nationally Significant Infrastructure Project
NSR	Noise Sensitive Receptor
O_3	Ozone
OAR	Option Assessment Report
OBC	Outline Business Case
Outline CoCP	Outline Code of Construction Practice
OGV	Other Goods Vehicle
ONS	Office of National Statistics
OS	Ordnance Survey
PA	Public Accounts
PAH	Polyaromatic Hydrocarbons
PCM	Pollution Climate Mapping
PEA	Preliminary Ecological Appraisal
PEIR	Preliminary Environmental Information Report
PEL	Probable Effect Levels
PFRA	Preliminary Flood Risk Assessment
PHE	Public Health England
PIA	Personal Injury Accidents
PINS	Planning Inspectorate
PM	Particulate Matter
PM_{10}	Particulate Matter to 10 Microns
$PM_{2.5}$	Particulate Matter to 2.5 Microns
PMA	Private Means of Access
PPK	Pence per Kilometre
PPG	National Planning Practice Guidance
PPK	Pence per Minute
PPV	Peak Particle Velocity
PRA	Preliminary Risk Assessment
PRC	Practical Reserve Capacity
ProPG	Professional Planning Guidance
PRoW	Public Rights of Way

Abbreviation	Definition
PSD	Particle Size Distribution
PVB	Present Value of Benefits
PVC	Present Value of Costs
QRA	Quantified Risk Assessment
RBMP	River Basin Management Plan
RCP	Representative Concentration Pathways
RFC	Ratio of Flow to Capacity
RIGS	Regionally Important Geological and Geomorphological Study Area
RPA	Root Protection Area
RSI	Road Side Interview
RSPB	Royal Society for the protection of Birds
SAC	Special Areas of Conservation
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SDI	Social and Distributional Impact
SFRA	Strategic Flood Risk Assessment
SMP2	Shoreline Management Plan 2
SNCI	Sites of Nature Conservation Importance
SOAEL	Significant Observed Adverse Effect Level
SoR	Statement of Reasons
SoS	Secretary of State
SPA	Special Protection Area
SPI	Species of Principal Importance
SPZ	Source Protection Zones
SRN	Strategic Road Network
SSSI	Site of Special Scientific Interest
SWMP	Site Waste Management Plan
SuDS	Sustainable Drainage Systems
tCO_2e	Tonnes of Carbon Dioxide Equivalents
TA	Transport Assessment

Abbreviation	Definition
TAG	Transport Appraisal Guidance
TCA	Townscape Character Area
tCO_2	Tonnes of carbon dioxide equivalents
TDCR	Traffic Data Collection Report
TEE	Transport Economic Efficiency
TEL	Threshold Effect Levels
THI	Townscape Heritage Initiative
TOC	Total Organic Carbon
TP	Temporary Possession (a power to use and possess land temporarily for the purposes of constructing and maintaining the Scheme)
TPO	Tree Preservation Order
TUBA	Transport Users Benefits Appraisal
T&T	Turner and Townsend
UAE	Unacceptable Adverse Effect
UK	United Kingdom
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018
UN/ECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
UTC	Urban Traffic Control
UXO	Unexploded Ordnance
VA	Vehicle Actuated
VDV	Vibration Dose Value
VfM	Value for Money
VMS	Variable Message Sign
VOC	Vehicle Operating Costs
WAC	Waste Acceptance Criteria
WebTAG	Web Transport Analysis Guidance
WFD	Water Framework Directive
WITA	Wider Impacts in Transport Appraisal

Abbreviation	Definition
WLMP	Water Level Management Plan
Wm^{-2}	Watts per Square Metre
WQS	Water Quality Standards
ZTV	Zone of Theoretical Visibility

1 Introduction

1.1 Background

1.1.1 Norfolk County Council, in its capacity as Highway Authority and promoter, (hereinafter referred to as 'the Applicant') is seeking to obtain consent for the construction of the Great Yarmouth Third River Crossing (hereafter referred to as the 'Scheme'), in the town of Great Yarmouth, Norfolk. The location is identified in Figure 1.1: Site Location Plan, presented in Volume III: Figures (document reference 6.3).

1.1.2 WSP has been commissioned by the Applicant to carry out an Environmental Impact Assessment (EIA) to inform the design of the Scheme and the application for consent. As explained in Section 1.4 below, the Scheme has been directed by the Secretary of State to be a Nationally Significant Infrastructure Project (NSIP) and consent is therefore sought in the form of a Development Consent Order (DCO) under the Planning Act 2008.

1.1.3 The EIA has incorporated technical input from a range of environmental specialists, as outlined in Table 1.3. The Application Site for the Scheme is presented on the Land Plans (document reference 2.5) and the Works Plans (document reference 2.6).

1.1.4 This Environmental Statement (ES) reports the findings of the EIA process, which has been undertaken in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref 1.1) (hereafter referred to as the 'EIA Regulations'). This ES is one of the supporting documents submitted to the determining planning authority (The Planning Inspectorate) in support of the DCO.

1.1.5 This chapter provides an overview of the Scheme, the legal framework for EIA, and the structure of the ES and other related core documents. A breakdown of the information required by the EIA Regulations is provided in Table 1.1 alongside guidance on the location of this information within the ES.

1.2 Overview of the Scheme

1.2.1 The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. The Scheme consists of a new dual carriageway road, including a road bridge across the river, linking the A47 at Harfrey's Roundabout on the western side of the river to the A1243 South Denes Road on the eastern side. The Scheme would feature an opening span double leaf bascule (lifting) bridge across the river,

involving the construction of two new 'knuckles' extending the quay wall into the river to support the bridge. The Scheme would include a bridge span over the existing Southtown Road on the western side of the river, and a bridge span on the eastern side of the river to provide an underpass for existing businesses, enabling the new dual carriageway road to rise westwards towards the crest of the new crossing.

1.2.2 If constructed, the Scheme would comprise the following principal elements:

- A new dual carriageway road, crossing the River Yare in an east-west orientation, comprising:
  - A new double-leaf bascule bridge providing an opening span to facilitate vessel movement within the river. This would include structures to support and accommodate the operational requirements of the bridge-opening mechanism, including counterweights below the level of the bridge deck. The bridge would be supported on driven piles;
  - New substructures, supported by driven piles, to support the double leaf bascule bridge within the existing quays either side of the river and within the river itself, requiring new permanent ‘knuckle’ walls, creating cofferdams in the waterway to accommodate their construction;
  - A new five-arm roundabout connecting the new dual carriageway road with Suffolk Road, William Adams Way and the western end of Queen Anne's Road. Sections of the new five arm roundabout would be supported on driven piles where deep soft ground is encountered;
  - A single-span bridge over Southtown Road, with reinforced earth embankments joining that bridge to the new roundabout at William Adams Way. Southtown Road bridge and the reinforced earth embankments would be supported on driven piles;
  - A single-span bridge to provide an underpass on the eastern side of the river, with reinforced earth embankments joining that single span bridge to South Denes Road. The underpass and reinforced earth embankments would be supported on driven piles; and
  - A new signalised junction connecting the new road with A1243 South Denes Road.
- The closure of Queen Anne's Road, at its junction with Suffolk Road, and the opening of a new junction onto Southtown Road providing vehicular

and pedestrian access to residential properties and the MIND Centre and Grounds at the eastern end of Queen Anne's Road;

- Revised access arrangements for existing businesses onto the local highway network;
- Dedicated provision for cyclists and pedestrians which ties into existing networks;
- Implementation of part of a flood defence scheme along Bollard Quay that is proposed to be promoted by the Environment Agency, and works to integrate with the remainder of the flood defence scheme;
- A control tower structure located immediately south of the crossing on the western side of the river. The control tower would facilitate the 24/7 operation of the opening span of the new double-leaf bascule bridge;
- A plant room located on the eastern side of the river for the operation of the opening span of the new double-leaf bascule bridge;
- The demolition of an existing footbridge on William Adams Way;
- Associated changes, modifications and/or improvements to the existing local highway network;
- Additional signage, including Variable Message Signs (VMS) at discrete locations, to assist the movement of traffic in response to network conditions and the openings / closings of the double-leaf bascule bridge;
- The relocation of existing allotments to compensate for an area to be lost as a result of the Scheme and other works, including those at the MIND Centre and Grounds; and
- New public realm, landscape, ecology and sustainable drainage measures.

1.2.3 The Scheme also includes works to facilitate the construction, operation and maintenance of the above elements including:

- Creation of temporary construction sites and accesses from the public highway;
- Provision of new utilities and services and the diversion of existing utilities;
- Provision of drainage infrastructure, lighting and landscaping;
- Demolition of a number of existing residential and commercial / business properties; and
- Provision of vessel waiting facilities to the north and south of the new crossing, either as floating pontoons or additional fendering to the

existing berths, including any dredging and quay strengthening works that may be required.

1.2.4 Chapter 2 of this ES (document reference 6.1) provides a full description of the Scheme, and is accompanied by the General Arrangement Plan (document reference 2.2).

1.3 Need for the Scheme

1.3.1 The need for the Scheme derives from the need for an improvement in connectivity and resilience to Great Yarmouth Port ('the Port') from the SRN, which itself has a nationally significant role in the renewable energy sector and the offshore gas and oil industry. The Scheme objectives are as follows:

- To support Great Yarmouth as a centre for both offshore renewable energy and the offshore oil and gas industry, enabling the delivery of renewable energy NSIPs and enhancing the Port's role as an international gateway;
- To improve access and strategic connectivity between the Port and the national road network, thereby supporting and promoting economic and employment growth (particularly in the Enterprise Zone);
- To support the regeneration of Great Yarmouth, including the town centre and seafront, helping the visitor and retail economy;
- To improve regional and local access by enhancing the resilience of the local road network, reducing congestion and improving journey time reliability;
- To improve safety and to reduce road casualties and accidents, in part by reducing heavy traffic from unsuitable routes within the town centre;
- To improve access to and from the Great Yarmouth peninsula for pedestrians, cyclists and buses, encouraging more sustainable modes of transport and also reducing community severance; and
- To protect and enhance the environment by reducing emissions of greenhouse gases and minimising the environmental impact of the Scheme.

1.3.2 Further information relating to the need for the Scheme is presented within the DCO Application documents and the Case for the Scheme (document reference 7.1).

1.4 Legislative and Policy Context of the Scheme

1.4.1 In a Direction dated 26th February 2018 made under section 35 of the Planning Act (2008) (Ref 1.2), the Secretary of State (SoS) confirmed that he

was satisfied that the Scheme was nationally significant and directed that the Scheme, together with any matters associated with it, was to be treated as a development for which Development Consent is required. The SoS was of the opinion that the Scheme was nationally significant for the following reasons:

- *"The Port has a nationally significant role in the renewable energy sector and the offshore gas and oil industry and the scheme will substantially improve connectivity and resilience for port activities;*
- *The scheme will support the delivery of existing and potential renewable energy NSIPs; and*
- *The Scheme supports the Port's role as an International Gateway".*

1.4.2 It was also noted that, in addition, "… *the scheme will improve the offer of the Port through better connectivity to the Enterprise Zone"*.

1.4.3 The consequence of the Direction is that the Scheme is now subject to the consenting regime comprised in the Planning Act 2008 and associated subordinate legislation (including the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 ('the EIA Regulations'). The Scheme, therefore, cannot proceed unless the SoS decides to grant Development Consent by making a DCO under section 114 of the Planning Act 2008.

Environmental Impact Assessment

1.4.4 EIA is a procedure that must be followed for certain types of projects before they can be given consent. The procedure is a means of drawing together, in a systematic way, an assessment of a project's likely significant environmental effects. This helps to ensure that the importance of the predicted effects and the scope for reducing them are properly understood by the public and the relevant competent authority before it makes its decision.

1.4.5 EIA is often defined as (Ref 1.3):

"…the process for identifying the environmental effects (beneficial and adverse) of proposed developments before development consent is granted. The aim of the EIA is to prevent, reduce or offset the significant adverse environmental effects of development proposals, and enhance positive ones. It is a means to ensure that planning decisions are made in the knowledge of the attendant environmental effects and with full engagement of statutory bodies, local and national groups and members of the public."

1.4.6 The process and content of EIA is summarised in Regulations 5(1) and (2) of the EIA Regulations. EIA is a process through which the environmental effects of development are identified, assessed and considered in deciding

whether the development should be consented. Central to the process is the preparation of an ES and the carrying out of associated procedural steps, including consultation, publicity and notification.

1.4.7 Only certain types of development require EIA. Schedules 1 and 2 of the EIA Regulations define categories of development, for which EIA is mandatory (Schedule 1 development); or which require EIA if they are "… *likely to have significant effects on the environment by virtue of factors such as its nature, size or location"* (Schedule 2 development). The Scheme is not Schedule 1 development, but it does constitute Schedule 2 development as the "*construction of roads (unless included in Schedule 1)"*.

1.4.8 The need for an EIA is, therefore, dependent on whether the Scheme would be likely to have significant effects on the environment, taking into account specified matters, including the selection criteria at Schedule 3 of the EIA Regulations. Having considered the nature of the Scheme, the receiving environment, and the characteristics of the potential impact of the Scheme, the Applicant is of the opinion that the Scheme has the potential for likely significant effects upon the environment and, therefore, EIA is required.

1.4.9 On 3rd April 2018, the Applicant notified the SoS that it will provide an ES in relation to the Scheme. The effect of this notification was to determine for the purposes of the EIA Regulations, Regulations 6(1),6(2)(a) and 8(1)(b), that the Scheme is to be an 'EIA Development'. Alongside the notification, the Applicant submitted an EIA Scoping Report on 3rd April 2018 (document reference 6.6), requesting a Scoping Opinion (document reference 6.7) for the Scheme from the SoS, pursuant to EIA Regulation 10(1), as to what should be included in an ES for the Scheme. This is discussed further in Section 1.5 below.

National Policy Statements

1.4.10 National Policy Statements (NPS) are required to be produced by Government under the Planning Act 2008 and they present the planning policy framework for all decision making for NSIPs. Under section 104 of the Planning Act 2008, the SoS must have regard to the 'relevant NPS' when determining an application for which development consent applies.

1.4.11 The Scheme is a NSIP under section 35 of the Planning Act 2008 (as amended). Paragraphs 1.3 and 1.5 of the National Policy Statement for National Networks (NPS NN) (Ref 1.4) state that applications for a DCO for NSIP proposals under section 35 of the Planning Act 2008 need to be considered in accordance with the NPS NN.

1.4.12 National Policy Statements also include the Government's objectives for the development of NSIPs.

1.4.13 National Policy Statements have been produced for many different types of infrastructure development. In relation to the Scheme, the NPS NN is the relevant NPS, whilst the National Policy Statement for Ports (NPS for Ports) is also considered where appropriate (Ref 1.5), as is explained in the Case for the Scheme (document reference 7.1).

National Policy Statement for National Networks

1.4.14 The NPS NN was published by the SoS in December 2014 and sets out the Government's policies for nationally significant road and rail projects. It sets out the principles by which the SoS will assess NSIPs and the information that should be provided as part of a DCO application.

1.4.15 The NPS NN has, therefore, informed the development of the baseline information, assessments and mitigation measures provided within this ES. Appendix A to the Case for the Scheme (document reference 7.1) provides a full assessment of generic impacts, as set out in Section 5 of the NPS NN. Where relevant, the applicable paragraphs of the NPS NN are referenced within the relevant ES chapter so that the Scheme's compliance with the NPS NN can be appraised.

National Policy Statement for Ports

1.4.16 The NPS for Ports was designated by the SoS in January 2012 and sets out the Government's policies for new nationally significant port development projects.

1.4.17 The Scheme does not provide for port development. However, where aspects of the PNPS are pertinent to aspects of the Scheme that may affect existing port facilities, assessments within this ES have appropriately referenced the statement. This is further explained in the Case for the Scheme (document reference 7.1).

1.5 The Environmental Statement

Purpose of the ES

1.5.1 The ES provides an assessment of the likely significant effects of the Scheme.

1.5.2 As stated in Paragraph 1.4.9, the Applicant submitted an EIA Scoping Report on 3rd April 2018. The EIA Scoping Report set out the potentially significant environmental effects that were proposed to be scoped into the EIA, as well as those considered unlikely to be significant, which could therefore be scoped out of the assessment. The EIA Scoping Report also set out how the Applicant proposed undertake the assessment, including how

baseline data was to be gathered and the method to be used in assessing likely significant effects.

1.5.3 In response to the EIA Scoping Report, the SoS prepared a Scoping Opinion (document reference 6.7), which was issued to the Applicant on 17th May 2018. The ES is based on this Scoping Opinion, as required by Regulation 14(3)(a) of the EIA Regulations. Compliance tables cross-referencing the requirements of the Scoping Opinion are presented in each of the Technical Chapters (Chapters 6-19).

1.5.4 A Preliminary Environmental Information Report (PEIR) (Appendix G of the Consultation Report (document reference 5.2)) was prepared by the Applicant and issued in August 2018 as part of the statutory pre-application consultation process required under Sections 42, 47 and 48 of the Planning Act 2008. The PEIR enabled consultees and other interested parties to develop an informed view of the potential environmental effects of the Scheme, as envisaged at that stage of the assessment process, to allow them to provide informed comments on the proposals. Consultation feedback related to the PEIR, with commentary provided as to where any issues have been addressed in the ES, is set out in each of the Technical Chapters (Chapters 6-19).

1.5.5 This ES provides an assessment of the likely significant environmental effects of the Scheme, drawing on sources, including the EIA Scoping Report, Scoping Opinion, PEIR, stakeholder meetings, consultation responses and subsequent assessment work.

EIA Regulations

1.5.6 The ES has been produced in accordance with Regulation 5, Regulation 14 and Schedule 4 of the EIA Regulations. Schedule 4 of the EIA Regulations outlines the information required for inclusion in the ES. Part 1 of the Schedule identifies information that the applicant could reasonably be required to compile; Part 2 of the Schedule identifies the minimum amount of information that must be compiled in order to assess the environmental effects of the Scheme.

1.5.7 Regulation 14(2) specifies what environmental information must be included in an ES. Regulation 14(3)(b) requires that an ES must include information *"… reasonably required for reaching a reasoned conclusion on the significant effects of the development on the environment, taking into account current knowledge and methods of assessment"* (Ref 1.1). However, the EIA Regulations do not define 'significant' and the approach to defining what is and is not 'significant' is outlined in Chapter 4: Approach to EIA and, where relevant, in each Technical Chapter 6-19, along with further information about the approach to preparing the ES.

1.5.8 A summary of the relevant information required by the EIA Regulations, alongside the location of this information in this ES, is provided in Table 1.1.

Table 1.1: Location of Required Information within the ES

EIA Regulations Reference	Required Information	Location within this ES
Regulation 5 (Paragraph 2)	*"The EIA must identify, describe and assess in an appropriate manner, in light of each individual case, the direct and indirect significant effects of the proposed development on the following factors:*	As below.
	(a) population and human health;	Technical Chapters 6, 7, 11, 14, 16, 18, 19
	(b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC (1) and Directive 2009/147/EC (2);	Chapter 8: Nature Conservation
	(c) land, soil, water, air and climate;	Technical Chapters 6, 11, 13, 16
	(d) material assets, cultural heritage and the landscape;	Technical Chapters 9, 10, 15
	(e) the interaction between the factors referred to in sub-paragraphs (a) to (d)".	Chapter 19: Cumulative Effects
Regulation 5 (Paragraph 3)	*"The effects referred to in paragraph (2) on the factors set out in that paragraph must include the operational effects of the proposed development, where the proposed development will have operational effects".*	Chapter 4: Approach to EIA and Technical Chapters 6-19
Regulation 5 (Paragraph 4)	*"The significant effects to be identified, described and assessed under paragraph (2) include, where relevant, the expected significant effects arising from the vulnerability of the proposed development to major accidents or disasters that are relevant to that development".*	Chapter 18: Major Accidents and Disasters and Technical Chapters 6-17, 19
Regulation 14 (Paragraph 2)	*"An environmental statement is a statement which includes at least:*	As below.

EIA Regulations Reference	Required Information	Location within this ES
	(a) a description of the proposed development comprising information on the site, design, size and other relevant features of the development;	Chapter 2: Description of the Scheme
	(b) a description of the likely significant effects of the proposed development on the environment;	Technical Chapters 6-19
	(c) a description of any features of the proposed development, or measures envisaged in order to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment;	Technical Chapters 6-19
	(d) a description of the reasonable alternatives studied by the applicant, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment;	Chapter 3: Consideration of Alternatives
	(e) a non-technical summary of the information referred to in sub-paragraphs (a) to (d); and	Non-Technical Summary (document reference 6.5)
	(f) any additional information specified in Schedule 4 relevant to the specific characteristics of the particular development or type of development and to the environmental features likely to be significantly affected".	As below.
Regulation 14 (Paragraph 3)	*"The environmental statement referred to in Regulation 14 (Paragraph 2) must:*	As below.
	(a) where a scoping opinion has been adopted, be based on the most recent scoping opinion adopted (so far as the proposed development remains materially the same as the proposed development which was subject to that opinion);	Chapter 1: Introduction, Chapter 4: Approach to EIA and Technical Chapters 6-19

EIA Regulations Reference	Required Information	Location within this ES
	(b) include the information reasonably required for reaching a reasoned conclusion on the significant effects of the development on the environment, taking into account current knowledge and methods of assessment; and	Technical Chapters 6-19
	(c) be prepared, taking into account the results of any relevant UK environmental assessment, which is reasonably available to the applicant with a view to avoiding duplication of assessment".	Chapter 4: Approach to EIA and Technical Chapters 6-19
Regulation 14 (Paragraph 4)	*"(a) the applicant must ensure that the environmental statement is prepared by competent experts; and outlining the relevant expertise or qualifications of such experts.*	Chapter 1: Introduction, Chapter 4: Approach to EIA and Technical Chapters 6-19
	(b) the environmental statement must be accompanied by a statement from the applicant".	Introduction to the Applicant and the Application (document reference 1.3)
Schedule 4 (Paragraph 1)	*"Description of the development, including in particular:*	Chapter 2: Description of the Scheme
	(a) a description of the location of the development;	
	(b) a description of the physical characteristics of the whole development, including, where relevant, requisite demolition works, and the land-use requirements during the construction and operational phases;	
	(c) a description of the main characteristics of the operational phase of the development (in particular, any production process), for instance, energy demand and energy used, nature and quantity of the materials and natural resources (including water, land, soil and biodiversity) used; and	

EIA Regulations Reference	Required Information	Location within this ES
	(d) an estimate, by type and quantity, of expected residues and emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation and quantities and types of waste produced during the construction and operation phases".	Chapter 4: Approach to EIA and Technical Chapters 6-19
Schedule 4 (Paragraph 2)	*"A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects".*	Chapter 3: Consideration of Alternatives
Schedule 4 (Paragraph 3)	*"A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof, without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge".*	Chapter 4: Approach to EIA and Technical Chapters 6-19
Schedule 4 (Paragraph 4)	*"A description of the factors specified in Regulation 4(2) likely to be significantly affected by the development: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion, compaction, sealing), water (for example hydromorphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape".*	Technical Chapters 6-19

EIA Regulations Reference	Required Information	Location within this ES
Schedule 4 (Paragraph 5)	*"A description of the likely significant effects of the development on the environment resulting from, inter alia:*	As below.
	(a) the construction and existence of the development, including, where relevant, demolition works;	Technical Chapters 6-19
	(b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;	Technical Chapters 8, 11, 15, 16
	(c) the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;	Technical Chapters 6, 7, 10, 11, 13, 16
	(d) the risks to human health, cultural heritage or the environment (for example due to accidents or disasters);	Technical Chapters 6-19
	(e) the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;	Chapter 19: Cumulative Effects
	(f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change; and	Chapter 15: Climate Change
	(g) the technologies and the substances used.	Technical Chapters 6-19
	The description of the likely significant effects on the factors specified in regulation 4(2) should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the development. This description should take into account the	Technical Chapters 6-19

EIA Regulations Reference	Required Information	Location within this ES
	environmental protection objectives established at Union or Member State level which are relevant to the project, including in particular those established under Council Directive 92/43/EEC(a) and Directive 2009/147/EC(b)".	
Schedule 4 (Paragraph 6)	*"A description of the forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved".*	Technical Chapters 6-19
Schedule 4 (Paragraph 7)	*"A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example, the preparation of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases".*	Technical Chapters 6-19
Schedule 4 (Paragraph 8)	*"A description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters, which are relevant to the project concerned. Relevant information available and obtained through risk assessments pursuant to EU legislation, such as Directive 2012/18/EU (3) of the European Parliament and of the Council or Council Directive 2009/71/Euratom (4) or UK environmental assessments, may be used for this purpose, provided that the requirements of this Directive are met. Where appropriate, this description should*	Chapter 2: Description of the Scheme, Chapter 18: Major Accidents and Disasters and Technical Chapters 6-17 and 19

EIA Regulations Reference	Required Information	Location within this ES
	include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies".	
Schedule 4 (Paragraph 9)	*"A non-technical summary of the information provided under paragraphs 1 to 8".*	Non-Technical Summary (document reference 6.5)
Schedule 4 (Paragraph 10)	*"A reference list detailing the sources used for the descriptions and assessments included in the environmental statement".*	All Chapters

Additional Assessment Requirement with Respect to Maritime Effects

1.5.9 Overall it is expected that the Scheme will result in a benefit to maritime activities, largely attributed to the enhancement of the port as an international gateway. Nevertheless, in their scoping response, dated the 14th of May 2018, Peel Ports requested that maritime related effects associated with the scheme be assessed within the ES and that these should be are clearly signposted. The assessment in relation to maritime activities are therefore listed in Table 1.2: Scope of Assessment of Maritime Effects. This table signposts the reader to the appropriate assessment for each of the potential maritime effects assessed. This is discussed further in Chapter 4: Approach to EIA.

Table 1.2: Scope of Assessment of Maritime Effects

Assessment	Chapter
<u>Impacts of lighting:</u> A Lighting Report has been produced and appended to the Design Report (document reference 7.4D). The Lighting Report has been used as the starting point to assess the impacts of the proposed artificial lighting, including the risk of light spill on the navigation channel.	Chapter 10: Townscape and Visual
<u>Hydromorphological assessment:</u> A hydromorphological assessment has been undertaken which includes sediment transport modelling of the Scheme to understand the impact	Chapter 11: Road Drainage and The Water Environment (notably the Sediment Transport Assessment

Assessment	Chapter
of the presence of the bridge infrastructure on the hydromorphology of the River Yare. It discusses the potential effects on river bed scour/erosion and sediment deposition patterns.	presented in Appendix 11C (document reference 6.2))
Generation of employment opportunities: Once operational, the Scheme is anticipated to lead to an increase in economic activity in Great Yarmouth due to the greater connectivity afforded. An assessment of the generation of direct, indirect and induced employment opportunities including consideration of existing on-site employment displacement has been undertaken and considers the potential effects on enhanced economic activity and enhanced access for local businesses, including port activities.	Chapter 14: People and Communities
Land-take, severance and disruption to marine businesses and associated activities: The assessment of effects on marine commercial businesses and activities focuses on land-take, severance and disruption to operations within the River Yare and Port operations, including the potential negative impact of the bridge as a barrier to the river port north of the new bridge location. A Preliminary Navigational Risk Assessment has been prepared and used to inform the ES (document reference 6.14). In addition, initial vessel simulation modelling has been undertaken that considers a virtual navigation of a vessel through the River Yare to test how the Scheme interacts with Port operations. Further development of the vessel simulation modelling will be undertaken as the design progresses. The Vessel Simulation Report which summarises the Vessel Simulation Modelling undertaken is included as Appendix C to the Navigational Risk Assessment (document reference 6.14).	Chapter 14: People and Communities

Project Team and Environmental Statement Structure

1.5.10 In line with Regulation 18(5)(a) and (b) of the EIA Regulations, the ES and technical assessments which inform it, have been undertaken by a suitably qualified project team.

1.5.11 WSP is responsible for the coordination, compilation and procedural review of the ES. The Institute of Environmental Management & Assessment (IEMA) has awarded WSP the EIA Quality Mark for WSP's holistic activity around EIA. The company was one of the original eight pilot organisations in the UK that trialled the process in 2011 and developed the scheme from the former Corporate Registered Assessor process. WSP has continued to maintain its EIA Quality Mark, following ongoing examination by IEMA in relation to WSP's products, staff, innovation and promotion of EIA within the industry.

1.5.12 WSP has developed, and applies, an in-house set of processes, procedures and guidance, based on sound project management principles.

1.5.13 This ES provides an assessment of the likely significant effects of the Scheme. The ES forms Section 6 of the DCO Application Documents and is itself composed of three volumes. The Written Statement, this document, is Volume I of the ES (document reference 6.1) and it is supported by Volume II: Appendices (document reference 6.2) and Volume III: Figures (document reference 6.3).

1.5.14 In accordance with Regulation 14(4)(b) Table 1.3 presents the Structure of the ES and provides details of the competent Project Team for the ES, with associated roles and expertise. The Project Team members stated are responsible for the scope, content and assessment of effects of their respective technical chapters, where relevant. Further details regarding each competent expert are included within each technical chapter. Details with regards to the competent experts for Chapters 1 to 5, and the overall ES coordination, are as follows:

- Environmental Project Director: Marcus Wood is a Chartered town planner with over 30 years' experience in local government, property agency and planning/environmental consultancy. He is a town planning and EIA specialist with wide ranging experience in sectors including, infrastructure, transport, commercial, retail residential, leisure, sustainable development and policy advice. He has led EIAs for road, rail, port and energy schemes including a number of NSIP developments.
- Environmental Project Manager: Jenny Warhurst is a Chartered Principal Environmental Consultant who holds a MEnvSci (Hons) degree from the

University of Southampton (2013) in Environmental Sciences. Jenny has significant experience regarding environmental coordination, environmental management, the preparation of EIAs, the DCO process and also sector-specific experience in waste and resources management.

- Assistant Environmental Project Manager: Helen Hedworth is a Senior Environmental Consultant, with over ten years' collective experience in consultancy, research and teaching. Helen holds a first degree in Zoology (Cardiff) and a Master's degree in Applied Marine and Fisheries Ecology (Aberdeen). In addition to experience of EIAs, Helen has worked in environmental monitoring and mitigation of offshore wind farms and port development, and in aquatic and terrestrial ecology.
- Assistant Environmental Coordinator: Bryony Stocking is a Chartered Associate Consultant, with nearly 15 years' experience in the environmental sector. Bryony holds a BSc (Hons) in Marine Biology and Coastal Ecology (University of Plymouth) and a MRes in Environmental Biology (University of St. Andrews). Bryony specialises in EIAs for energy and infrastructure projects and has had roles within the regulatory, consultancy and developer side from smaller permitted development projects to those classified as an NSIP.
- Assistant Environmental Coordinator: Helen Davies is a Chartered Principal Environmental Consultant, with over 10 years' experience in environmental consultancy. Her expertise lies in conducting Strategic Environmental Assessments and Sustainability Appraisals of local and national government planning policy; EIA coordination for agricultural and renewable energy developments; green infrastructure planning; and ecosystem service assessments. Helen holds a BSc in Economics (Warwick), an MSc in Environmental Assessment & Management (Brighton), and is close to completing a PhD in Environmental Economics (Southampton).

Table 1.3: Structure of the Environmental Statement and Project Team

ES Volume I: Written Statement	Competent Expert(s)
Chapter 1: Introduction	Marcus Wood, BA(Hons), MRTPI Jenny Warhurst, MEnvSci (Hons) MCIWM Helen Hedworth, BSc (Hons) MSc Mem.MBA
Chapter 2: Consideration of Alternatives	
Chapter 3: Description of the Scheme	
Chapter 4: Approach to the EIA	
Chapter 5: Consultation	
Chapter 6: Air Quality	Claire Lucas, PhD MIAQM MIEnvSc
Chapter 7: Noise and Vibration	Robin Brown, BSc (Hons) MIOA
Chapter 8: Nature Conservation	Ian Ellis, BSc (Hons) MRes MCIEEM

ES Volume I: Written Statement	Competent Expert(s)
Chapter 9: Cultural Heritage	Alexandra Grassam, BA MSc
Chapter 10: Townscape and Visual Impacts	Peter Metcalfe, BSc (Hons) MA CMLI Christopher Rance, BSc (Hons) MA MA(LM) CMLI
Chapter 11: Road Drainage and The Water Environment	Surface Water: Claire Storer, MEng CEng MICE and Sheena Cheng, BSc(Hons) MSc AMICE Groundwater: Melanie Cross, MESci (Hons) FGS and Alex Gallagher, BSc (Hons) CGeol FGS
Chapter 12: Flood Risk	Julia Hunt, BSc (Hons) MCIWEM C.WEM CEnv CSci
Chapter 13: Climate Change	Caroline Jones, BSc (Hons) PIEMA
Chapter 14: People and Communities	Lowri McCann, BSc (Hons) MSc PIEMA
Chapter 15: Materials	Jean-Louis Bartlett, BSc MSc PIEMA Alice Berry, BSc (Hons) MSc GradIEMA
Chapter 16: Geology and Soils	Neil Balderstone, BSc MSc
Chapter 17: Traffic and Transport	Amanda Fogg, BEng (Hons) MSc CMILT Iñaki Gaspar-Erburu, MEng MTPS
Chapter 18: Major Accidents and Disasters	Jerome Kreule MEnvSci GradIEMA
Chapter 19: Cumulative Effects	Anna Hagan, BSc MSc Jerome Kreule MEnvSci GradIEMA

1.5.15 The technical appendices and figures provided within Volumes II and III are listed in Table 1.4 and Table 1.5, respectively. Where images are embedded in the text these have been included as plates.

Table 1.4: Technical Appendices that Support the ES

Appendix Number	Appendix Title
Chapter 1: Introduction	
No appendices included.	
Chapter 2: Description of the Scheme	
No appendices included.	

Appendix Number	Appendix Title
Chapter 3: Consideration of Alternatives	
Appendix 3A	Options Assessment Report
Appendix 3B	Final Options Assessment Report
Appendix 3C	Environmental Options Appraisal Report
Chapter 4: Approach to EIA	
Appendix 4A	Regulation 32 Transboundary Screening
Chapter 5: Consultation	
No appendices included.	
Chapter 6: Air Quality	
Appendix 6A	Legislation, Policy and Guidance
Appendix 6B	Construction Phase Assessment Methodology
Appendix 6C	Local Air Quality Modelling and Model Verification
Appendix 6D	Compliance Risk Assessment
Appendix 6E	Scheme Specific Air Quality Monitoring
Appendix 6F	Wind Rose
Appendix 6G	Ecological Assessment – Detailed Results and Impacts
Chapter 7: Noise and Vibration	
Appendix 7A	Legislation, Policy and Guidance
Appendix 7B	Acoustic Glossary
Appendix 7C	Noise and Vibration Activities and Plant Items
Appendix 7D	Operation Phase Results Tables
Appendix 7E	Operation Phase Predicted Noise Levels - Residential
Appendix 7F	Operation Phase Predicted Noise Levels – Non-residential
Chapter 8: Nature Consultation	
Appendix 8A	Legislation, Policy and Guidance
Appendix 8B	Preliminary Ecological Appraisal
Appendix 8C	Preliminary Ecological Appraisal Update Report
Appendix 8D	Bird Survey Report
Appendix 8E	Protected Species Survey Report

Appendix Number	Appendix Title
Appendix 8F	Water Vole Survey Report
Appendix 8G	Preliminary Bat Roost Report
Appendix 8H	Detailed Arboricultural Report
Appendix 8I	Benthic and Fish Ecology Report
Chapter 9: Cultural Heritage	
Appendix 9A	Legislation, Policy and Guidance
Appendix 9B	Cultural Heritage Desk Based Assessment
Appendix 9C	Borehole Log Review and Deposit Modelling Report
Chapter 10: Townscape and Visual	
Appendix 10A	Legislation, Policy and Guidance
Appendix 10B	Photomontage Production Methodology
Chapter 11: Road Drainage and The Water Environment	
Appendix 11A	Legislation, Policy and Guidance
Appendix 11B	Impact Assessment Criteria for Surface Water and Ground Water
Appendix 11C	Sediment Transport Assessment
Appendix 11D	HAWRAT Assessment
Appendix 11E	Water Framework Directive Assessment
Appendix 11F	Groundwater Modelling Study of the Bascule Pit Groundwater Control System
Chapter 12: Flood Risk	
Appendix 12A	Legislation, Policy and Guidance
Appendix 12B	Flood Risk Assessment
Appendix 12C	Drainage Strategy
Chapter 13: Climate Change	
Appendix 13A	Legislation, Policy and Guidance
Appendix 13B	Vulnerability Assessment
Appendix 13C	Climate Change Risk Assessment
Chapter 14: People and Communities	
Appendix 14A	Legislation, Policy and Guidance
Appendix 14B	(appendix not used)

Appendix Number	Appendix Title
Appendix 14C	Community Facilities
Appendix 14D	Recreational Facilities
Appendix 14E	Driver Stress Analysis
Chapter 15: Materials	
Appendix 15A	Legislation, Policy and Guidance
Appendix 15B	Material Application
Appendix 15C	Waste Arisings
Chapter 16: Geology and Soils	
Appendix 16A	Legislation, Policy and Guidance
Appendix 16B	Interpretive Environmental Desk Study Report
Appendix 16C	Interpretative Environmental Ground Investigation Report
Appendix 16D	Piling Works Risk Assessment
Chapter 17: Traffic and Transport	
Appendix 17A	Legislation, Policy and Guidance
Appendix 17B	Changes to Degree of Hazard
Chapter 18: Major Accidents and Disasters	
Appendix 18A	Legislation, Policy and Guidance
Chapter 19: Cumulative Effects	
Appendix 19A	Legislation, Policy and Guidance
Appendix 19B	In-Combination Assessment - Stage 1 Supporting Information
Appendix 19C	In-Combination Assessment - Stage 3 Information Gathered

Table 1.5: Figures that Support the ES

Number	Figure Title	Location
Chapter 1: Introduction		
Figure 1.1	Site Location Plan	Volume: III
Figure 1.2	Strategic Location Plan	Volume: III
Chapter 2: Description of the Scheme		
No figures included.		

Number	Figure Title	Location
Chapter 3: Consideration of Alternatives		
Figure 3.1	Bridge and Tunnel Corridors Options Considered	Volume: III
Chapter 4: Approach to EIA		
No figures included.		
Chapter 5: Consultation		
No figures included.		
Chapter 6: Air Quality		
Figure 6.1	Air Quality Background Pollutant Concentrations	Volume: III
Figure 6.2	Air Quality Operational Assessment Study Area	Volume: III
Figure 6.3	Construction Dust Assessment Study Area	Volume: III
Figure 6.4	Air Quality Regional Assessment Study Area	Volume: III
Figure 6.5	Air Quality Operational Assessment NO_2 Results 2017 Base Year Scenario	Volume: III
Figure 6.6	Air Quality Operational Assessment PM_{10} Results 2017 Base Year Scenario	Volume: III
Figure 6.7	Air Quality Operational Assessment $PM_{2.5}$ Results 2017 Base Year Scenario	Volume: III
Figure 6.8	Air Quality Operational Assessment NO_2 Results 2023 Opening Year Do Minimum Scenario	Volume: III
Figure 6.9	Air Quality Operational Assessment PM_{10} Results 2023 Opening Year Do Minimum Scenario	Volume: III
Figure 6.10	Air Quality Operational Assessment $PM_{2.5}$ Results 2023 Opening Year Do Minimum Scenario	Volume: III
Figure 6.11	Air Quality Operational Assessment NO_2 Results 2023 Opening Year Do Something Scenario	Volume: III
Figure 6.12	Air Quality Operational Assessment PM_{10} Results 2023 Opening Year Do Something Scenario	Volume: III
Figure 6.13	Air Quality Operational Assessment $PM_{2.5}$ Results 2023 Opening Year Do Something Scenario	Volume: III
Figure 6.14	Air Quality Operational Assessment NO_2 Results Change Between the Do Minimum and Do Something Scenario 2023 Opening Year	Volume: III

Number	Figure Title	Location
Figure 6.15	Air Quality Operational Assessment PM_{10} Results Change Between the Do Minimum and Do Something Scenario 2023 Opening Year	Volume: III
Figure 6.16	Air Quality Operational Assessment $PM_{2.5}$ Results Change Between the Do Minimum and Do Something Scenario 2023 Opening Year	Volume: III
Figure 6.17	Air Quality Monitoring Locations used in the Model Verification Procedure	Volume: III
Figure 6.18	Ecological Assessment Do Something NO_x Results	Volume: III
Figure 6.19	Ecological Assessment Do Something N-Deposition Results	Volume: III
Figure 6.20	Compliance Risk Assessment Study Area	Volume: III
Chapter 7: Noise and Vibration		
Figure 7.1	Operation Phase Noise Study Area	Volume: III
Figure 7.2	Noise Monitoring Locations	Volume: III
Figure 7.3	Short-term Noise Change Contours	Volume: III
Figure 7.4	Long-term Noise Change Contours	Volume: III
Figure 7.5	Night-time Noise Change Contours	Volume: III
Chapter 8: Nature Consultation		
Figure 8.1	Main and Broad Study Areas	Volume: III
Figure 8.2	Extended Study Area	Volume: III
Figure 8.3	Bat Survey Area	Volume: III
Figure 8.4	Water Vole Survey Area	Volume: III
Figure 8.5	Bird Survey Area	Volume: III
Figure 8.6	Statutory Designations	Volume: III
Figure 8.7	Water Vole Survey Results	Volume: III
Figure 8B.1	Phase 1 Habitat Map	Volume: III
Figure 8C.1	Survey Area	Volume: III
Figure 8F.1	Water Vole Survey Area	Volume: III
Figure 8F.2	Water Vole Survey Results	Volume: III
Figure 8H.1	Arial Photograph of the Principal Application Site	Volume: III

Number	Figure Title	Location
Figure 8H.2	Plan Showing Location of the Principal and Satellite Application Sites	Volume: III
Figure 8H.3 – 8H.10	Tree Protection Plans	Volume: III
Chapter 9: Cultural Heritage		
Figure 9.1	Designated Heritage Assets	Volume: III
Figure 9.2	Non-Designated Heritage Assets	Volume: III
Chapter 10: Landscape and Visual		
Figure 10.1	Study Area and Viewpoint Location Plan	Volume: III
Figure 10.2	Zone of Theoretical Visibility Plan Based on LIDAR (0.25M Spacing) DSM	Volume: III
Figure 10.3	Townscape Constraints Plan	Volume: III
Figure 10.4	Photosheets	Volume: III
Figure 10.5	Isolux Contour Plan	Volume: III
Chapter 11: Road Drainage and The Water Environment		
Figure 11.1	Water Environment Study Area	Volume: III
Figure 11.2	Simulated Extent of Groundwater Drawdown due to Proposed Dewatering	Volume: III
Figure 11.3	Drainage Plan for Waveney, Lower Yare and Lothingland Internal Drainage Board	Volume: III
Chapter 12: Flood Risk		
Figure 12.1	Flood Risk Study Area	Volume: III
Figure 12.2	Environment Agency Flood Map for Planning	Volume: III
Figure 12.3	Baseline Present Day Modelled Flood Extents	Volume: III
Figure 12.4	River Yare Comparison Points	Volume: III
Figure 12.5	Scheme – Baseline Comparison, 0.5% AEP Present Day Event	Volume: III
Figure 12.6	Flood Hazard Rating, Baseline 0.5% AEP Present Day Event	Volume: III
Figure 12.7	Flood Hazard Rating, Scheme 0.5% AEP Present Day Event	Volume: III
Figure 12.8	Baseline Climate Change Modelled Flood Extents	Volume: III

Number	Figure Title	Location
Figure 12.9	Scheme – Baseline Comparison, 0.5% AEP Climate Change Event	Volume: III
Figure 12.10	Flood Hazard Rating, Baseline 0.5% AEP Climate Change Event	Volume: III
Figure 12.11	Flood Hazard Rating, Scheme 0.5% AEP Climate Change Event	Volume: III
Figure 12.12	Baseline H++ Modelled Flood Extents	Volume: III
Figure 12.13	Scheme – Baseline Comparison, 0.5% AEP H++ Event	Volume: III
Figure 12.14	Flood Hazard Rating, Baseline 0.5% AEP H++ Event	Volume: III
Figure 12.15	Flood Hazard Rating, Scheme 0.5% AEP H++ Event	Volume: III
Figure 12B.1	Flood Risk Receptors Identified Within Assessment Study Area	Volume: III
Figure 12B.2	Borehole Groundwater Monitoring Locations	Volume: III
Figure 12B.3	Closest Reservoir to Great Yarmouth	Volume: III
Figure 12B.4	Existing Model 2D Domain Halcrow 2011	Volume: III
Figure 12B.5	Model Domain	Volume: III
Figure 12B.6	Peel Ports Great Yarmouth Bathymetric Survey Coverage in River Yare	Volume: III
Figure 12B.7	Model Boundary Conditions	Volume: III
Figure 12B.8	Comparison of Increased Roughness Model with Environment Agency Historic Flood Map	Volume: III
Figure 12C.1 – 2	Drainage Sheets	Volume: III
Chapter 13: Climate Change		
No figures included.		
Chapter 14: People and Communities		
Figure 14.1	Existing Land Uses	Volume: III
Figure 14.2	People and Communities Sensitive Receptors	Volume: III
Figure 14.3	Public Rights of Way and NMU Facilities	Volume: III
Figure 14.4	Properties to be Demolished	Volume: III
Chapter 15: Materials		
No figures included.		

Number	Figure Title	Location
Chapter 16: Geology and Soils		
Figure 16.1	Interpretive Environment Desk Study – Study Area Boundary	Volume: III
Figure 16.2	Exploratory Hole Locations	Volume: III
Chapter 17: Traffic and Transport		
Figure 17.1	Town Centre Masterplan Investment Area	Volume: III
Figure 17.2	Microsimulation Model Area	Volume: III
Figure 17.3	Main Roads Around the Scheme	Volume: III
Figure 17.4	Public Transport Network	Volume: III
Figure 17.5	Key Cycle Routes	Volume: III
Figure 17.6	Accident Severity	Volume: III
Figure 17.7	Change in Walking Times	Volume: III
Figure 17.8	Change in Cycling Times	Volume: III
Figure 17.9	Walking and Cycling Routes Current and During Construction	Volume: III
Chapter 18: Major Accidents and Disasters		
No figures included.		
Chapter 19: Cumulative Effects		
Figure 19.1	Committed Developments Short List	Volume: III
Figure 19.2	Zone of Influence	Volume: III

Structure of Technical Chapters

1.5.16 A common structure has been adopted for the reporting of the assessments undertaken for each of the environmental aspects investigated in Chapters 6-18 of this ES, under the following headings:

- Introduction;
- Competent Expert;
- Legislative, Policy and Guidance Summary;
- Scope, Methodology and Significance Criteria;
- Baseline Conditions;
- Sensitive Receptors;

- Establishing the Scenario for Assessment;
- Assessment of Effects, Mitigation and Residual Effects;
- Limitations and Assumptions;
- Summary; and
- References.

Supporting Documents

1.5.17 The ES suite of documents includes a number of supporting documents (contained within Section 6 of the DCO Application Document suite) as well as figures and appendices to the ES Chapters. Table 1.6 sets out the other supporting documents that are referred to and should be read in conjunction with the ES.

Table 1.6: ES Supporting Documents

Number	Document Description
6.4A	Natural Environmental Constraints Plan
6.4B	Water Bodies in a 'River Basin Management Plan' Plan
6.5	Environmental Statement (Non-Technical Summary)
6.6	EIA Scoping Report
6.7	EIA Scoping Opinion
6.8	Assessment of Nature Conservation
6.9	Archaeological Written Scheme of Investigation
6.10	Statutory Nuisance Statement
6.11	Habitats Regulations Assessment
6.12	Photomontages
6.13	Mitigation Schedule
6.14	Preliminary Navigational Risk Assessment
6.15	Equalities Impact Assessment
6.16	Outline Code of Construction Practice

Other Regulatory Regimes

1.5.18 The DCO includes or disapplies the need for a number of consents that deal with other regulatory regimes, such as a Deemed Marine Licence and flood risk activity permits. An explanation of which consents are relevant to the Scheme, and the status of discussions as to those consents that are not

included in the DCO, are set out in the Consent and Agreements Position Statement (document reference 7.3) and are also discussed in greater detail in the specific environmental aspects covered in this ES, where appropriate.

1.6 References

Ref 1.1: The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

Ref 1.2: The Planning Act 2008.

Ref 1.3: Department for Communities and Local Government (2006), Environmental Impact Assessment: A Guide to Good Practice and Procedures.

Ref 1.4: Department for Transport (2014), National Policy Statement for National Networks.

Ref 1.5: Department for Transport (2012), National Policy Statement for Ports.

2 Description of the Scheme

2.1 Introduction

2.1.1 This chapter presents the description of the Great Yarmouth Third River Crossing (hereafter referred to as "the Scheme"). Any other descriptions presented within this ES (document reference 6.1) represent a summary of, or are subsidiary to, this chapter. This chapter, including Figures 1.1 and 1.2 (document reference 6.3), reflects the draft DCO and other DCO documents including:

- Location Plan (document reference 2.1);
- General Arrangement Plans (document reference 2.2);
- Works Plans (document reference 2.6);
- Landscaping Plans (document reference 2.9); and
- Engineering Plans, Drawings and Sections (document reference 2.10).

2.1.2 The Application Site for the Scheme is shown by a red line on the Works Plans (document reference 2.6).

2.2 Scheme Location

2.2.1 DCO document reference 2.1 (Location Plan) shows the location of the Scheme. Great Yarmouth is located at the mouth of the River Yare, one of the main waterways providing access to the Norfolk Broads. The river bisects Great Yarmouth, with the town centre, seafront, industrial areas and outer harbour being located on the narrow, 4km long, South Denes peninsula, which lies between the river and the sea, isolated from the rest of the town. To the south of the River Yare, Gorleston-on-Sea is just a few hundred metres away from the South Denes peninsula as the crow flies, but by road it is over 7km distant.

2.2.2 The Application Site indicated on Figure 1.2 shows the location of the Scheme in the context of the administrative area of the Borough of Great Yarmouth. Other noteworthy areas in the vicinity of the Scheme are also shown on Figure 1.2, namely:

- South Denes Enterprise Zone – part of the wider New Anglia Enterprise Zone where energy-related businesses benefit from simplified planning, superfast broadband and rate relief for five years;

- South Denes Local Development Order – an order adopted in 2012 by Great Yarmouth Borough Council covering an area of 136.3ha of which 58.8ha is Enterprise Zone, to simplify the planning process for businesses in energy, offshore engineering, port and logistics sectors;
- Great Yarmouth Energy Park – a 20.2ha site near to the river port and outer harbour created to ensure that businesses related to the offshore energy sector have suitable land available so that the area is best placed to capture anticipated future jobs, investment, economic growth and regeneration opportunities; and
- South Denes Business Park – providing easy access to the river port and outer harbour.

2.3 Environmental Designations

2.3.1 There are a number of area designations affecting the Scheme. Section 4 within each of the technical chapters (Chapters 6-18) provides full details of the baseline environment within which the Scheme will be constructed and operated. Key designations and features within the topic study areas include, but are not limited to, the following:

- European Designation:
  - The Outer Thames Estuary Special Protection Area (SPA);
  - Breydon Water SPA and Ramsar Site[1]; and
  - Great Yarmouth North Denes SPA.
- National Statutory Designation:
  - Breydon Water Site of Special Scientific Interest (SSSI);
  - Great Yarmouth North Denes SSSI; and
  - The Broads National Park[2].

[1] It is a matter of Government policy (notably NPPF Paragraph 176) that sites designated under the Ramsar Convention (1971) for their internationally important wetlands (commonly known as 'Ramsar sites') and potential SPAs are considered in the same way as European designations such as SPAs.

[2] "Broads National Park" is the term used by the Broads Authority to refer to the Broads for branding and marketing purposes. Whilst the Broads is not a statutory national park, being governed principally by the Norfolk and Suffolk Broads Act 1988, it shares many of the statutory characteristics of a national park and is treated by Government policy as a member of the national park family.

- Heritage Designations:
  - Four Scheduled Monuments;
  - Listed Buildings (Grades I, II* and II); and
  - Six Conservation Areas.

2.4 Main Design Considerations

The Scheme

2.4.1 The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. The Scheme consists of a new dual carriageway road, including a road bridge across the river, linking the A47 at Harfrey's Roundabout on the western side of the river to the A1243 South Denes Road on the eastern side. The Scheme would feature an opening span double leaf bascule (lifting) bridge across the river, involving the construction of two new 'knuckles' extending the quay wall into the river to support the bridge. The Scheme would include a bridge span over the existing Southtown Road on the western side of the river, and a bridge span on the eastern side of the river to provide an underpass for existing businesses, enabling the new dual carriageway road to rise westwards towards the crest of the new crossing.

2.4.2 If constructed, the Scheme would comprise the following principal elements:

- A new dual carriageway road, crossing the River Yare in an east-west orientation, comprising of:
  - A new double-leaf bascule bridge providing an opening span to facilitate vessel movement within the river. This would include structures to support and accommodate the operational requirements of the bridge-opening mechanism, including counterweights below the level of the bridge deck. The bridge would be supported on driven piles;
  - New substructures, supported by driven piles, to support the double leaf bascule bridge within the existing quays either side of the river and within the river itself, requiring new permanent 'knuckle' walls, creating cofferdams in the waterway to accommodate their construction;
  - A new five-arm roundabout connecting the new dual carriageway road with Suffolk Road, William Adams Way and the western end of Queen

Anne's Road. Sections of the new five-arm roundabout would be supported on driven piles where deep soft ground is encountered;

- A single-span bridge over Southtown Road, with reinforced earth embankments joining that bridge to the new roundabout at William Adams Way. Southtown Road bridge and the reinforced earth embankments would be supported on driven piles;
- A single-span bridge to provide an underpass on the eastern side of the river, with reinforced earth embankments joining that single span bridge to South Denes Road. The underpass and reinforced earth embankments would be supported on driven piles; and
- A new signalised junction connecting the new road with A1243 South Denes Road.

- The closure of Queen Anne's Road, at its junction with Suffolk Road, and the opening of a new junction onto Southtown Road providing vehicular and pedestrian access to residential properties and the MIND Centre and Grounds at the eastern end of Queen Anne's Road;
- Revised access arrangements for existing businesses onto the local highway network;
- Dedicated provision for cyclists and pedestrians which ties into existing networks;
- Implementation of part of a flood defence scheme along Bollard Quay that is proposed to be promoted by the Environment Agency, and works to integrate with the remainder of the flood defence scheme;
- A control tower structure located immediately south of the crossing on the western side of the river. The control tower would facilitate the 24/7 operation of the opening span of the new double-leaf bascule bridge;
- A plant room located on the eastern side of the river for the operation of the opening span of the new double-leaf bascule bridge;
- The demolition of an existing footbridge on William Adams Way;
- Associated changes, modifications and/or improvements to the existing local highway network;

- Additional signage, including Variable Message Signs (VMS) at discrete locations, to assist the movement of traffic in response to network conditions and the openings / closings of the double-leaf bascule bridge[3];
- The relocation of existing allotments to compensate for an area to be lost as a result of the Scheme and other accommodation works, including those at the MIND Centre and Grounds; and
- New public realm, landscape, ecology and sustainable drainage measures.

2.4.3 The Scheme also included works to facilitate the construction, operation and maintenance of the above elements including:

- Creation of temporary construction sites and accesses from the public highway;
- Provision of new utilities and services and the diversion of existing utilities;
- Provision of drainage infrastructure, lighting and landscaping;
- Demolition of a number of existing residential and commercial / business properties; and
- Provision of vessel waiting facilities to the north and south of the new crossing, either as floating pontoons or additional fendering to the existing berths, including any dredging and quay strengthening works that may be required.

Parameters of Environmental Assessment

2.4.4 The 'Rochdale Envelope' provides for robust environmental assessment of NSIPs within 'clearly defined parameters' relating to the design of the Scheme. PINS Advice Note 9 provides guidance on the use of the 'Rochdale Envelope'; a term used to describe those elements of a Scheme that have not yet been finalised but yet can be constrained within certain parameters hence allowing a determination of likely significant effects to be presented in the ES. This Advice Note sets out that, when using the 'Rochdale Envelope' to allow for flexibility within a DCO application, the Applicant should use a worst-case approach to identifying likely significant effects and should incorporate

[3] The VMS locations are referred to throughout the ES as Satellite Application Sites.

mitigation accordingly within the parameters of the Scheme being considered. The parameters of assessment for this Scheme are identified in Table 2.1 below.

2.4.5 The assessments within this ES have been based upon a Scheme design that has been sufficiently developed to allow an assessment to be undertaken within the parameters of assessment identified in Table 2.1 below. These parameters of assessment, together with limits of deviation specified in the draft DCO, have been used for EIA purposes to ensure that potentially significant environmental effects associated with the Scheme have been adequately assessed. The limits of deviation (i.e. the horizontal and vertical limits of deviation) within which the authorised development (as set out in Schedule 1 to the draft DCO) would be delivered, are set out in article 6 of the draft DCO (document reference 3.1).

Table 2.1: Parameters of Environmental Assessment

Item	Parameter
Control tower	A maximum height of 20m above Ordnance datum (AOD).
Road gradient	A maximum of 5%.
Finished road level tolerance	The finished road level has a tolerance of +1.0m and -0.5m from that shown on the Engineering Plans, Drawings and Sections (document reference 2.10).
Double leaf bascule bridge clearance over water	A minimum of 5.36m AOD to the underside of the double-leaf bascule bridge when lowered. Unlimited headroom (air draught) to be provided when the bascule bridge is raised.
Navigable channel width	A minimum navigable channel width of 50m.
Southtown Road bridge	Minimum clearance of 5.3m above finished road level for traffic in accordance with the Design Manual for Roads and Bridges (DMRB).
Underpass (eastern side of river)	Minimum clearance of 4.9m above finished road level.

Highway Design Standards and Cross Sections

2.4.6 The highway aspects of the Scheme have been designed with reference to the DMRB and are based on a 30mph (50kph) design speed (Ref 2.2). DMRB (Ref 2.2) standards provide for minimum widths of elements such as carriageways, central reserves, footways and cycle tracks. These design standards, together with the limits of deviation provided for in the DCO, have informed the parameters within which the potential environmental impacts of these elements of the Scheme have been assessed.

2.4.7 The highway elements of the Scheme (including footways and cycle tracks) are shown on the General Arrangement Plans (document reference 2.2). The relevant limits of deviation, as set out in article 6 of the draft DCO, relate to the Works Plans (document reference 2.6), which show horizontal / lateral limits of deviation, and to the Engineering Plans, Drawings and Sections (document reference 2.10), which provide the points of reference against which vertical limits of deviation (upwards and downwards) are secured.

Structures and Earthworks

2.4.8 The opening elements of the double-leaf bascule bridge across the River Yare would comprise a steel superstructure, with counterweights, which would be installed below deck level, and which would require two bascule chambers in order to accommodate their movement. The bascule cofferdams would form the knuckle walls that would extend into the River Yare from the quays along both banks (as shown on the Engineering Section Drawings (document reference 2.18) and Plate 2.1 below).

2.4.9 Southtown Road bridge would be located immediately to the west of the western bascule abutment and would consist of concrete beams and in-situ slab supported on driven piles. To the east of the eastern bascule abutment there would be an underpass, also consisting of concrete beams and in-situ concrete slab supported on driven piles.

2.4.10 When in the closed position, the bridge would have a clearance of not less than 5.36 AOD, which would enable smaller boats to pass under the bridge (as shown on Plate 2.1).

2.4.11 The new five-arm roundabout connecting the new dual carriageway road with Suffolk Road, William Adams Way and the western end of Queen Anne's Road would be supported driven piles where deep soft ground is encountered. Supporting retaining walls and culverts would also be required.

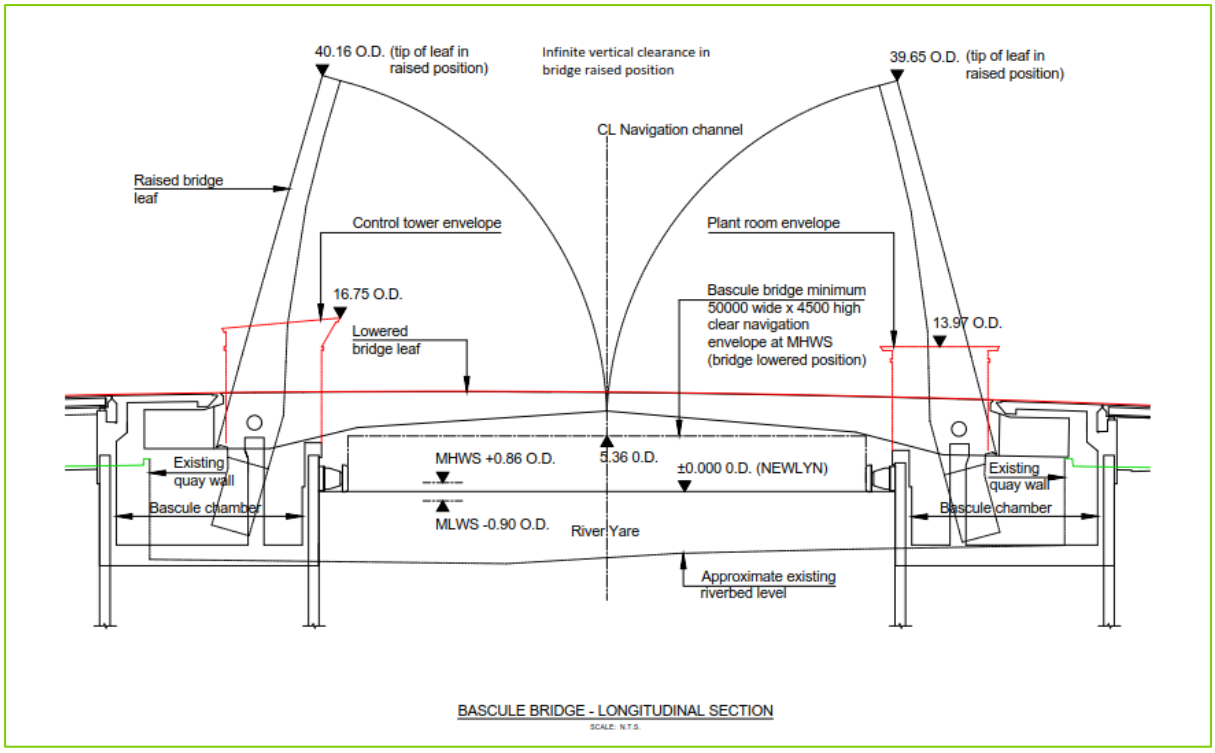


Plate 2.1: Longitudinal Profile of the Bascule Bridge in The Lowered Position

2.4.12 A vessel impact protection system would be provided to the knuckles, which would provide a level of protection to vessels and the double-leaf bascule bridge structure in the event of a collision. The proposed clear navigation width is of at least 50m between the vessel impact protection systems provided at each of the knuckles. This is shown on Plate 2.1 and discussed in greater detail in this ES. Plate 2.1 also shows infinite air draught would be provided for the full distance between the vessel impact protection systems when the bridge is raised and open to vessels.

2.4.13 In consultation with Great Yarmouth Port Company (GYPC), vessel simulation modelling has been undertaken to confirm the effects of setting the navigation channel width at a minimum of 50m between the vessel impact protection systems.

2.4.14 The new double-leaf bascule bridge would require a control tower with a maximum height of 20m AOD, as shown on the General Arrangement Plans (document reference 2.2) and the Engineering Plans, Drawings and Sections (document reference 2.10).

Main Junction Arrangements

2.4.15 Presented in the General Arrangement Plans (document reference 2.2) are new roundabout arrangements on the western side of the Scheme and a new signalised junction on the eastern side of the Scheme.

The Western Roundabout

2.4.16 On the western side of the River Yare, the new crossing over the river would connect into the existing highway network by means of a new five-arm roundabout. The existing William Adams Way dual carriageway would be realigned to form two of the five arms of the new roundabout. The William Adams Way western arm of the roundabout would form a short link connecting into the existing A47 Harfrey's roundabout. The William Adams Way eastern arm of the roundabout would form a link to the existing signalised junction of William Adams Way and Southtown Road. The other two arms of the new roundabout would form connections with the western end of Queen Anne's Road, where the Kings Centre and premises occupied by the Haven Veterinary Surgeons are located, and Suffolk Road. The fifth arm of the new roundabout would form the western approach to the new crossing.

2.4.17 Signal-controlled pedestrian and cycle crossing facilities would be provided across the William Adams Way eastern arm of the roundabout and across the arm connecting the new crossing to the roundabout. In addition, a signal-controlled crossing for pedestrians would be provided on the Suffolk Road arm of the roundabout.

The Eastern Signalised Junction

2.4.18 At its eastern end, the new crossing over the river would connect into a new signalised junction with South Denes Road. The existing direction of one-way operation of Sutton Road and Swanston's Road would be reversed to ensure efficient operation of the new signalised junction. Signal-controlled crossing facilities would be incorporated into the new signalised junction.

Access

2.4.19 On the western side of the river, a new junction on Southtown Road would provide vehicular and pedestrian access to the residential properties and MIND Centre and Grounds at the eastern end of Queen Anne's Road. In addition, a new private access would be provided north of the new public realm on Bollard Quay for vehicles to exit Bollard Quay and join the southbound carriageway of Southtown Road.

2.4.20 On the eastern side of the river, new private access arrangements would be provided including a new underpass to allow vehicular and pedestrian access between land north and south of the new road.

Drainage

2.4.21 The proposed drainage strategy for the Scheme is detailed within the Flood Risk Assessment, presented as Appendix 12B (document reference 6.2), and the Drainage Strategy, presented as Appendix 12C (document reference 6.2).

2.4.22 The proposed drainage for the Scheme would be secured by a requirement in the DCO for drainage to be implemented in accordance with details which accord with the drainage strategy and have been approved by the county planning authority prior to commencement of the authorised development.

2.5 Other Design Elements

Highway Lighting

2.5.1 The proposed lighting strategy for the Scheme is outlined with Appendix D to the Design Report (document reference 7.4).

2.5.2 The proposed highway lighting for the Scheme would be secured by a requirement in the DCO. This would require a highway lighting scheme to be implemented. The highway lighting scheme would be required to be in accordance with the lighting strategy and approved by the county planning authority prior to the commencement of the authorised development.

Other Lighting

2.5.3 The Scheme includes provision for public realm lighting, security lighting and interior lighting to the control tower, plant room and bridge.

2.5.4 The Scheme includes provision for marine navigation lighting in accordance with the requirements of navigational safety.

Technology

2.5.5 Six VMS would be provided at discrete locations around Great Yarmouth as part of the Scheme to assist the movement of traffic depending on whether the double-leaf bascule bridge is open or closed. The VMS locations are based on a review of the Great Yarmouth road network and the traffic model for the Scheme to identify locations where signage (advising of bridge opening/closing) would have the greatest potential to influence route choice and reduce congestion on the approach to the crossing and across the wider local highway network.

Road Restraint

2.5.6 Vehicle parapets would be provided across both sides of the bascule bridge, Southtown Road bridge, above the eastern underpass and on part of the western and eastern approach embankments. The parapets would terminate before the signalised crossings near the new roundabout with William Adams Way and the new junction with South Denes Road.

2.5.7 Separate rising barriers would be provided on the carriageway and on the footway / cycle track, at either end of the lifting section of the bascule bridge, to optimise the bridge lifting sequence and minimise delay.

2.5.8 A pedestrian guardrail would be provided at the back of the footway / cycle track, on both sides of the crossing.

Landscaping

2.5.9 The Scheme would incorporate hard and soft landscaping so that it is fully integrated into the wider townscape. The general approach is set out in the landscaping plans (document reference 2.9) and the Approach to Detailed Design presented in Appendix A of the Design Report (document reference 7.4) to ensure that a high quality of public realm is achieved, and that required mitigation identified by the technical chapters (Chapters 6-18) is secured.

2.5.10 The western approach to the crossing would feature walking and cycling routes north and south of the embankment structures, to provide connectivity between Southtown Road and destinations west of this area including Suffolk Road, the allotments on Queen Anne's Road and Southtown Common.

2.5.11 The planting strategy would be diverse with native species to reflect the surrounding Norfolk County area and to benefit biodiversity. A mix of native and ornamental planting would attract wildlife and visually enhance these areas. The choice of species would reflect the need to simplify maintenance and management regimes.

2.5.12 To replace the allotments affected by the Scheme, a plot has been allocated north of Queen Anne's Road, to ensure this amenity remains within the vicinity of its current location. This replacement allotment area is of a comparable size to the current provision and would include four individual plots. The MIND Centre and Grounds would be reinstated within a smaller footprint adjacent to the base of the embankment of the widened and elevated William Adams Way. The relocated allotments, and the MIND Centre and Grounds, would be accessible from the walking and cycling route to the south of the crossing, and also from Queen Anne's Road for vehicles.

2.5.13 Implementation of a detailed landscaping scheme, including provision for maintenance, would be secured by a requirement in the DCO. The Scheme would be required to accord with the landscaping plans (document reference 2.9) and the Approach to Detailed Design (Appendix A of document reference 7.4) and would have to be approved by the county planning authority prior to commencement of the authorised development.

2.6 Construction

Constructability Advice

2.6.1 Constructability advice has been sought from the Applicant's appointed Contractor on the approach to the construction of the Scheme, on a basis which allows for the parameters of assessment which have informed this ES.

Construction Programme

2.6.2 Subject to Development Consent being granted, it is anticipated that construction of the Scheme would commence in late 2020 and would take approximately two years to complete.

2.6.3 An approximate preliminary construction programme, based upon a construction period starting in Q4 2020 and ending in W4 2022, which shows the main construction activities from mobilisation through to Scheme opening, is provided in Table 2.2 below.

Table 2.2: Preliminary Construction Programme

Key Construction Activity	Indicative Timing	Indicative Duration
Mobilisation and Site Establishment	27 weeks	Q4 2020 – Q2 2021
Western Approach Retaining Structures	57 weeks	Q1 2021 – Q2 2022
Eastern Approach Retaining Structures	55 weeks	Q2 2021 – Q2 2022
Southtown Road Bridge	25 weeks	Q2 2021 – Q4 2021
Underpass	20 weeks	Q4 2021 – Q2 2022
Double-leaf Bascule Bridge	87 weeks	Q1 2021 – Q4 2022
Vessel Waiting Facilities	6 weeks	Q3 2021 – Q4 2021
Western Roundabout, Eastern Signalised Junction, and other ancillary works (e.g. surfacing, landscaping)	86 weeks	Q4 2020 – Q3 2022

Site Clearance

2.6.4 Site clearance to facilitate construction and the establishment of construction compounds would include the breaking of hard standing, the demolition of buildings, the clearance of trees and vegetation and the removal of unsuitable material. Site clearance would be undertaken as one of the first operations,

running in parallel with the establishment of site compounds and welfare facilities.

Construction Compounds, Access and Storage

2.6.5 Two main construction compounds, that would incorporate car parking, mess and welfare facilities, stores and laydown areas, would be required for the construction of the Scheme. The compounds are located within the Order Limits.

2.6.6 On the east side of the river a construction compound would be located on land between the River Yare and South Denes Road, immediately north of the new crossing. Access to this compound from the trunk road network is likely to be via Acle New Road, North Quay, South Quay South Denes Road and Fish Wharf, a side road opposite Barrack Road, in accordance with the Framework Construction Traffic Management Plan (appended to the Outline Code of Construction Practice (Outline CoCP) (document reference 6.16)).

2.6.7 On the west side of the river a construction compound would be located on land between William Adams Way and Queen Anne's Road, immediately west of Suffolk Road. Access to this compound from the trunk road network is likely to be via William Adams Way, Suffolk Road and Queen Anne's Road, in accordance with the Framework Construction Traffic Management Plan (appended to the Outline CoCP (document reference 6.16)). Following the construction of the Scheme, areas used temporarily for construction compounds would be restored to their previous condition, unless otherwise agreed with the landowner.

Construction Staffing and Transport

2.6.8 The Applicant has considered the delivery profile of staff and construction materials as well as an estimate of the number of staff likely to be employed during the construction phase to inform the likely construction traffic movements.

2.6.9 An indicative profile of numbers of staff employed on site on a daily basis is included in Plate 2.2 below. As shown, the peak in staff numbers is anticipated about halfway through the construction period, with approximately 185 full-time equivalents working on site each day.

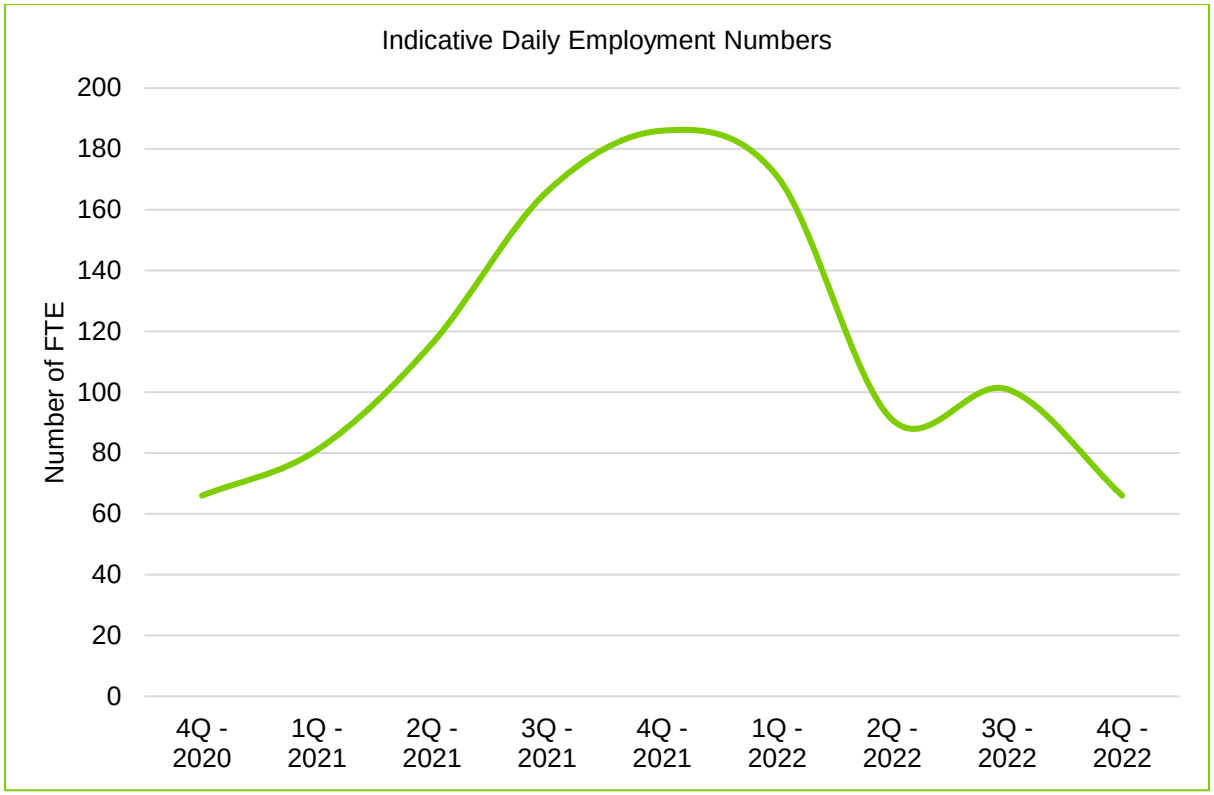


Plate 2.2: Indicative Daily Employment Numbers

2.6.10 A profile of predicted weekly HGV movements over the construction period is shown in Plate 2.3 below. It can be seen that HGV movements peak at 360 per week, or 72 per day assuming a five-day week. The information presented in Plate 2.3 shows one-way movements, where a one-way movement is a single access to or egress from a site.

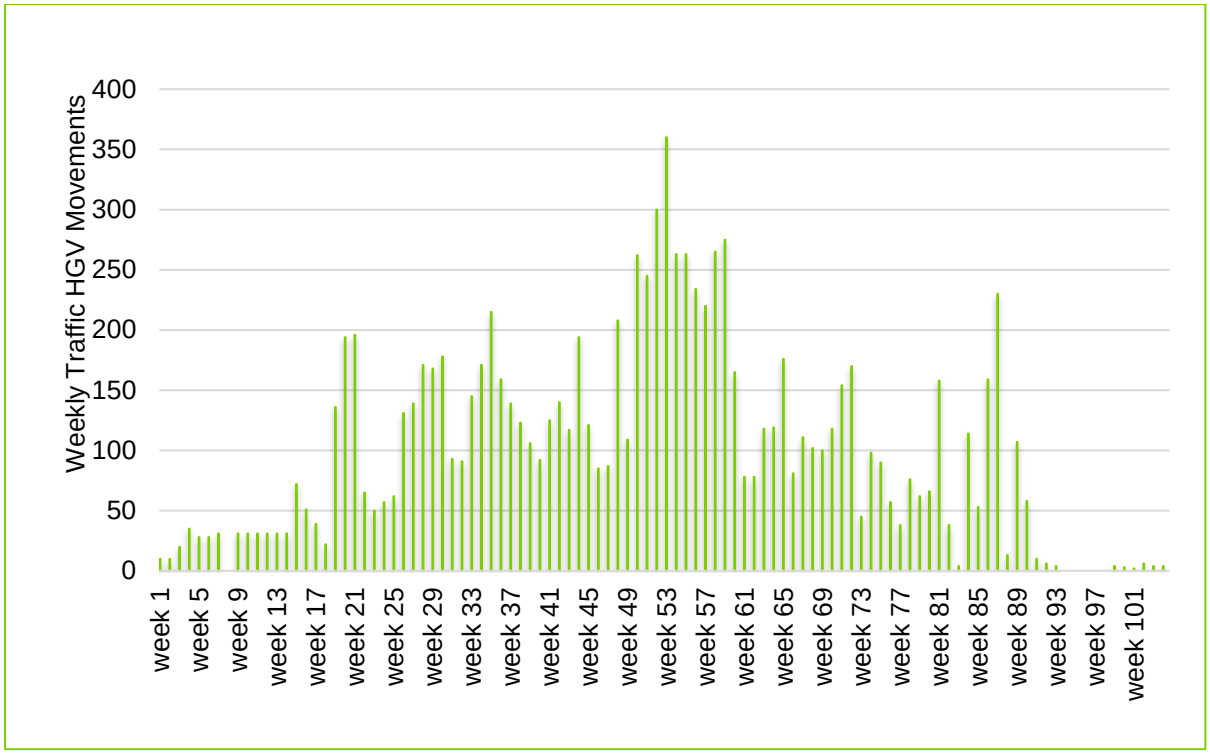


Plate 2.3: Indicative Weekly HGV Movements

Code of Construction Practice

2.6.11 Works would be carried out in accordance with the Outline CoCP (document reference 6.16).

Access Arrangements during Construction

2.6.12 The Contractor will ensure the works are planned to enable them to be delivered safely and in a manner which minimises congestion and disruption for all road users

2.6.13 The approach to minimise disruption to the highway will be underpinned by a signage and communication strategy that will be developed with the Applicant and key stakeholders. Key aspects of this strategy are set out in the Framework Construction Traffic Management Plan (appended to the Outline CoCP (document reference 6.16)).

Construction Access to Footpaths and Public Rights of Way

2.6.14 Temporary closures of some footpaths and public rights of way are likely to be necessary at certain points during the construction of the Scheme. Where this is the case, temporary diversion routes will be provided, key aspects of which are set out in the Framework Construction Traffic Management Plan (appended to the Outline CoCP (document reference 6.16)).

Summary of Core Working Hours

2.6.15 Table 2.3 below summarises the core working hours during the construction period.

Table 2.3: Preliminary Construction Programme

Day Period	Time Period
Weekday	07:00 – 19:00
Saturday	07:00 – 13:00
Sunday / Bank Holiday	None

2.6.16 Limited 24-hour construction works would be required and have been considered in the assessment of night-time construction noise in Chapter 7: Noise and Vibration.

Task Lighting

2.6.17 Task lighting would be employed to minimise the lighting impacts on the overall site. Where practicable, the task lighting would face away from nearby properties. The type of task lighting employed for different tasks would vary depending on the nature of those tasks and be commensurate with the works being undertaken.

2.7 Operation and Maintenance

2.7.1 Operation of the double-leaf bascule bridge would be the responsibility of the Applicant, as the Highway Authority. It is intended that the proposed double-leaf bascule bridge would be operated on demand for commercial vessels and by agreement for recreational vessels at set times when requested in advance. The double-leaf bascule bridge is expected to be operational 24 hours per day and 365 days per year.

2.7.2 It is anticipated that the bridge would open on average 15 times per day on a typical weekday. Individual opening durations would vary, however, traffic modelling undertaken for the Scheme has assumed that each opening will take on average approximately 5.5 minutes including vessel passage time, meaning that the crossing would be closed to traffic for approximately 82 minutes on a typical day.

2.7.3 Maintenance of the Scheme would be the responsibility of the Applicant, as the Highway Authority, and would involve routine, planned maintenance and system checks, as well as reactive maintenance and repairs. It is likely that the maintenance regime of the bascule bridge would require the following which has informed the assessment within this ES:

- High pressure hose replacement on a seven-year basis;
- Low pressure hose replacement on a ten-year basis;
- Major hydraulic components (e.g hydraulic cylinders and pumps) on a 50-year basis;
- Minor hydraulic components replacement (e.g. valves) on a 15-year basis;
- Mechanical components replacement (e.g. span locks) on a 25-year basis; and
- Electrical and control systems (e.g. programmable logic controllers) on a 15-year basis.

2.7.4 It is considered that maintenance operations would all fall within the environmental envelope related to the initial construction phase, as they would involve similar or lesser activities than those required for construction.

2.7.5 Maintenance activities would be planned to enable them to be delivered safely and in a manner which minimises congestion and disruption for all river and road users and would not require the need for excessively noise plant or equipment.

2.8 Decommissioning

2.8.1 The Scheme bascule bridge will be designed to have a life of at least 120 years in accordance with the requirements of BS EN 1990:2002 Eurocode – Basis of Structural Design (Ref 2.3).

2.8.2 Any decommissioning would be likely to be completed in less time than the construction of the Scheme and, whilst the Applicant has no plans to decommission and remove the Scheme, were it to be removed, it would be likely to require a similar degree of plant, equipment and disturbance within the navigation channel to that predicted during construction.

2.8.3 Given that the Applicant has no plans to decommission the Scheme, and as the environmental constraints in the mid-22nd Century cannot be reasonably predicted, further consideration of decommissioning is not considered appropriate (although please refer to Chapter 15: Materials, where greater information is included on the nature of the materials used in construction and how their suitability will be assessed).

2.9 References

Ref 2.1: PINS (2018), Advice Note Nine: Rochdale Envelope.

Ref 2.2: Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland (various dates), Design Manual for Roads and Bridges.

Ref 2.3: British Standards Institution (2002), BS EN 1990:2002 Basis of Structural Design.

3 Consideration of Alternatives

3.1 Introduction

3.1.1 This chapter describes the alternatives to the Scheme that have been considered by the Applicant during the design and pre-application process, taking account of consultation responses received during the statutory consultation period.

3.1.2 Consultation responses received throughout the design and pre-application process were used to help develop options for the Scheme and, subsequently, in refinement of the Scheme. For greater detail on the consultation process undertaken, see Chapter 5 of this ES and for details around the consultation responses, see the Consultation Report (document reference 5.1).

3.1.3 The 2017 EIA Regulations, in Schedule 4, Paragraph 2, state that an ES must include:

"A description of the reasonable alternatives (for example, in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects."

3.1.4 To accord with the above, the consideration of alternatives in the development of the Scheme has covered the following broad issues:

- Alternative sites - the broad area of interest for the Scheme, i.e. a northern, central or southern crossing of the River Yare; and
- Design alternatives.

3.1.5 The Scheme has also undergone a Habitat Regulations Assessment (HRA) (document reference 6.11). This concluded that the Scheme, alone or in combination with any other plan or proposal, would not affect the integrity of any European site. The HRA also concludes that no further consideration of alternatives from a HRA perspective is required. Further discussion of alternatives in the HRA context is, therefore, not required.

3.1.6 A Water Framework Directive Assessment (presented as Appendix 11E (document reference 6.2)) has been carried out to assess effects of the Scheme on the water environment. The assessment has concluded that, whilst the Scheme may have some localised effects on watercourses directly affected by the Scheme, and the local groundwater aquifer, these are not considered sufficient to lead to any detriment in status or ability to meet the

objectives of the respective waterbodies, in accordance with those set out in the Anglian River Basin Management Plan (RBMP). Further discussion of alternatives in the WFD context is, therefore, not required.

3.1.7 Since the outset, the Scheme's overall purpose has been to relieve existing congestion on the wider highway network. The Scheme objectives detailed in Chapter 1: Introduction are an evolution of those prepared at the Outline Business Case (OBC) stage. The OBC presented the strategic, specific and operational objectives. Alternative options have since been considered through the development process for the Scheme, in order to best meet the overall purpose and objectives of the Scheme.

3.1.8 This chapter is informed by the OBC and its supporting documents, which were submitted to the DfT in March 2017 to facilitate funding of the Scheme. The OBC was produced in accordance with published DfT guidance, which requires that alternatives are considered and presented. It also explained why the Scheme should receive support, providing a clear audit trail for the purposes of public accountability. More than just a bid for financial support, however, the OBC presented five separate business cases:

- The strategic case;
- The economic case;
- The financial case;
- The commercial case; and
- The management case.

3.1.9 This chapter has also been informed by the following documents, which were developed prior to, and informed, the OBC:

- Stage 1 Scheme Assessment Report (SAR) (2007) (Ref 3.1):
  - The Stage 1 SAR detailed the initial sifting exercise undertaken to identify the environmental, engineering, economic, and traffic advantages, disadvantages and constraints associated with broadly defined improvement strategies. The Stage 1 SAR identified the preferred alignment for the Scheme and the feasible engineering options.
- Stage 2 SAR (2009) (Ref 3.2):
  - The Stage 2 SAR refined the Stage 1 assessment by (i) assessing potential design solutions for bridge and tunnel structures; (ii) refining the alignment option for these solutions; (iii) identifying

three preferred options for the Scheme and (iv) assessing and comparing the performance of the three preferred options.

- Options Assessment Report (OAR) (2016) (Appendix 3A (document reference 6.2)):
  - The 2016 OAR presented the findings (i) of the Stage 1 and Stage 2 SAR; and (ii) the preferred route announced by NCC's Cabinet in 2009.
- Final OAR (2017) (Appendix 3B (document reference 6.2)):
  - The 2017 OAR details the preferred design solution for the Scheme based on a bascule bridge at the preferred route between Harfrey's Roundabout and South Denes Road, as identified in the Stage 1 and Stage 2 SARs (Ref 3.1 and Ref 3.2).
- Environmental Options Appraisal Report (EOAR) (2017) (Appendix 3C (document reference 6.2)):
  - The purpose of the EOAR was to provide an evaluation of environmental topic related constraints for the three final Scheme options, identified within the 2017 Final OAR. For each option, the EOAR presents the required environmental impact appraisal inclusive of the WebTAG worksheets.

3.2 Option Development: Stage 1 SAR: Initial Sifting (2007)

3.2.1 A Stage 1 SAR was commissioned by the Applicant in 2007 (Ref 3.1), in order to understand the existing constraints to, and potential engineering solutions for, a crossing of the River Yare in Great Yarmouth. The report, prepared by consultants Mott Macdonald in March 2007, followed the methodology prescribed in the Design Manual for Roads and Bridges Volume 5, Section 1, Part 2, TD36/93 (Scheme Assessment Reporting). Stage 1 identifies the environmental, engineering, economic, and traffic advantages, disadvantages and constraints associated with broadly defined improvement strategies. The Stage 1 SAR was supported by a Stage 1 Traffic and Economic Assessment.

3.2.2 In the 2007 SAR, a broad area of interest was identified. This was determined through consideration of the following:

- The predicted number of bridge openings at various points on the river, calculated from detailed data on commercial vessel movements in the inner harbour – the Stage 1 Assessment concluded that an opening structure placed at the southern end of the area of interest would have to open 4,000 times a year for large vessels, with additional openings for

pleasure craft. If the bridge were placed at the northern extremity of the area of interest, this would reduce to 2,000 times a year, with additional openings for pleasure craft.

- The potential impact of a new structure on the navigation of the river – any structure on a curve of the river would require a larger clear span, which would incur greater cost.
- The need to minimise impacts on existing built development.

3.2.3 On this basis the study area was defined. This is shown in Figure 3.1 which presents an extract from the 2007 Scheme Assessment Report. Within the area of interest, three proposed corridors were identified for bridge and tunnel options (also presented in Figure 3.1).

3.2.4 For each of the three route alignments, a high- and low-level bridge option, as well as options for a tunnel, were developed. This produced nine options in total. As described in the Stage 1 SAR, the initial sifting exercise was simplified and focused on five key criteria, inclusive of environmental impacts. The criteria were applied as set out in Table 3.1.

Table 3.1: Stage 1 SAR - Initial Sifting Criteria

Corridor	Type	Cost	Env	Traffic	Benefit-Cost Ratio (BCR)	Accessibility
Northern	High-Level Bridge	●	●	●	●	●
	Low-Level Bridge	●	●	●		
	Tunnel	●	●			
Central	High-Level Bridge		●			
	Low-Level Bridge		●			
	Tunnel		●	●	●	●
Southern	High-Level Bridge	●	●	●	●	●
	Low-Level Bridge	●	●	●		
	Tunnel	●	●			

Stage 1 SAR: Environmental Assessment

3.2.5 In addition, an Environmental Assessment was undertaken at Stage 1, as described in the SAR, which considered all nine route options. It reported that the Scheme would have the potential for a range of impacts on the local environment, some beneficial and some adverse. For example, each of the

routes was predicted to have a minor adverse impact on air quality. The report found that there were many aspects of construction that could cause disruption to aspects of the natural environment, most notably impacts of noise and vibration, with effects on water quality, drainage and ecology. A summary of the findings of the assessment are reproduced in Table 3.2: below.

Table 3.2: Summary of Stage 1 SAR Environmental Assessment

Topic	Conclusion
Local Air Quality	All routes were predicted to have a minor adverse impact locally. Options in the central corridor would affect fewer properties; the southern corridor would affect more. All would lead to improved air quality in the town centre due to reduced traffic.
Cultural Heritage	Minor impacts only locally with all routes. Potential benefits in the town centre due to reduced traffic.
Construction Impacts	Impacts due to noise, vibration, air quality, water quality, drainage, ecology and nature conservation. Partial mitigation of these impacts expected to be possible.
Landscape and Townscape	High level bridge likely to have greatest impact, though not out of place in an industrial townscape. A tunnel would mean less visual intrusion from traffic, but approach ramps could affect residential areas more than the bridge options.
Land Use	Adverse impacts due to demolition of buildings. All routes would have a similar impact.

Stage 1 SAR: Transport Assessment

3.2.6 The options identified at Stage 1 were tested using the Great Yarmouth SATURN[1] model:

(i) northern alignment opening bridge;
(ii) central alignment tunnel; and
(iii) southern alignment opening bridge.

3.2.7 These options were tested in 2007 using the 2003 Great Yarmouth SATURN model. For the Stage 1 SAR, an opening year of 2015 and a design year of 2030 were assumed. The findings of this assessment are presented in the

[1] SATURN: Simulation and Assignment of Traffic in Urban Road Networks modelling software, developed by the University of Leeds and Atkins.

2007 Stage 1 Traffic and Economic Appraisal Report. A summary of the Traffic Impacts of each of the options tested is reproduced in Table 3.3.

Table 3.3 Traffic Assessment of Options

Two-way Traffic Flow	Do Minimum 2030 AADT	Northern bridge 2030 AADT	Southern bridge 2030 AADT	Central tunnel 2030 AADT
Breydon Bridge	35,400	32,200	33,000	32,600
Haven Bridge	35,000	20,500	24,100	26,500
Third River Crossing	-	28,300	24,400	18,900
Total	**70,400**	**81,000**	**81,500**	**78,000**

3.2.8 The key findings showed that any of the bridge options would carry more traffic (and hence provide more traffic relief) than the tunnel option.

Stage 1 SAR: Accident Assessment

3.2.9 Based on the forecast traffic flows, accidents and casualties in the study area were predicted over a 60-year assessment period using COBA[2]. Expected reductions set out in the Stage 1 SAR are set out in Table 3.4.

Table 3.4: Accident Impacts of Options

Accidents / Casualties	Total	Change Over 60 Years		
	Base	Northern Bridge	Southern Bridge	Central Tunnel
Accidents	44,398	-2,260	-2,644	-2,385
Casualties	61,270	-3,092	-3,619	-3,230

3.2.10 The stage 1 SAR concluded that all of the options would produce savings in accidents and casualties, and little difference was found between them. By a small margin, the southern bridge option was found to produce the greatest accident savings.

[2] COBA: Department for Transport Cost Benefit Analysis.

Stage 1 SAR: Economic Assessment

3.2.11 An economic assessment was also undertaken using TUBA[3], with accident benefits calculated using COBA. All the options tested show a positive BCR:

- Bridge (northern location): 4.3;
- Bridge (southern location): 4.9; and
- Tunnel (central location): 2.2.

3.2.12 A summary of the findings of the economic assessment are reproduced in Table 3.5 below.

Table 3.5: Stage 1 SAR Benefit-Cost Ratio

Benefits / Dis-Benefits / Costs	Northern bridge £,000	Southern bridge £,000	Central tunnel £,000
Consumer user benefits	112,727	121,295	78,468
Business user benefits	110,153	117,174	83,266
Private sector provider impacts	0	0	0
Carbon benefits	1,501	1,696	987
Accident benefits	85,611	96,844	88,551
Present value of benefits (PVB)	309,992	337,009	251,272
Investment costs	61,674	57,544	109,971
Indirect tax revenue	10,189	11,475	6,714
Present Value of Costs (PVC)	71,863	69,019	116,685
BCR	4.3	4.9	2.2

3.2.13 A bridge in the southern corridor was found to offer the greatest monetised benefits and, because it was also likely to be the least expensive option, generated the highest BCR. The representative tunnel option tested produced significantly lower monetised benefits and, being considerably more expensive than either of the bridge options, produced a BCR that, although still positive, was much less than what could be achieved with a bridge.

[3] TUBA: Transport Users Benefit Analysis modelling tool.

Stage 1 SAR: Assessment Conclusions

3.2.14 The Stage 1 SAR showed that a third river crossing would be feasible, and that either a bridge or a tunnel could produce benefits in excess of its costs. The assessment showed that a bridge would be less expensive and therefore produce a significantly better BCR than a tunnel.

3.2.15 The Stage 1 SAR determined that the exact route alignment would depend on the cost of the alignment. The 'cost' in this context relates not only to the economic cost, i.e. the capital cost associated with construction, but also to adverse / beneficial environmental and social effects. The Stage 1 SAR concluded that, due to the existing trunk road layout and physical constraints placed by surrounding development, the only economically viable tie-in with the trunk road network for all three corridors was at the Harfrey's Roundabout on the A47.

3.2.16 For this alignment, the Stage 1 SAR concluded that a high-level opening bridge, low-level opening bridge and immersed tube tunnel should be included at the start of the Stage 2 scheme assessment process.

3.3 Option Development: Stage 2 SAR (2009)

3.3.1 A Stage 2 SAR was commissioned by the Applicant in 2009, in order to develop options further. The report, prepared by consultants Mott Macdonald, included engineering and environmental assessment and further analysis of shipping information to determine the most appropriate location for a bridge crossing. Further investigation was undertaken into a range of different forms of crossing, including: (i) fixed bridge; (ii) swing bridge; (iii) lifting bridge; (iv) bascule bridge; and (v) tunnel.

Stage 2 SAR: Assessment of Bridge Structures

3.3.2 Using the Harfrey's Roundabout corridor on the western side of River Yare, a detailed investigation of the potential bridge was undertaken, as described in a Structural Options working paper (2009) (Ref 3.3) which informed the Stage 2 SAR. This investigation led to the rejection of the fixed bridge, swing bridge and lift bridge options on grounds including construction and maintenance costs, visual impact, and risks from collision by ships. A summary of the conclusions of the Structural Options working paper is presented in Table 3.6 below.

Table 3.6 Summary of the Conclusions of the Structural Options Working Paper

Crossing Option	Conclusion
Fixed Bridge	The paper investigated six crossings for fixed bridge alignments. It

Crossing Option	Conclusion
	was concluded that it was not possible to devise any fixed bridge option high enough to not obstruct some existing shipping movements. The fixed bridge options were assessed as costing significantly more than a movable bridge and having a significant adverse environmental impact. For these reasons, the idea of providing a fixed bridge was rejected.
Swing Bridge	A swing bridge option was considered but rejected. The superstructure would be vulnerable to damage from ship collision and the cost of protecting against this would be prohibitive.
Lifting Bridge	A lifting bridge option was considered but rejected. The towers would need to be at least 40m high, with a high adverse visual impact, and the maintenance cost would be higher than with a bascule bridge.
Bascule	It was concluded that a bascule bridge was the most appropriate type for this location. It would be less expensive than the other types of bridge considered, have a lower visual impact, especially when closed, and would allow passage of vessels of any height when opened.

Optimising Bridge Location

3.3.3 Having confirmed that a bascule bridge was likely to be the best type of bridge, the Stage 2 Assessment gave further consideration to the options which had emerged from the initial sift (Stage 1 Assessment). A navigation simulation was undertaken to determine the scope for reducing the opening spans of a bascule bridge to reduce the overall cost, and to optimise the alignment of the bridge.

3.3.4 Detailed data on commercial vessel movements within the inner harbour was used to determine the likely number of bridge openings required for different locations. It concluded that a bridge on the shortest route across the river, from the A47 Harfrey's Roundabout would require about six openings each day. Further south, the number of openings would be greater. Further north, the openings would be fewer cost of construction would be higher, attributed to the requirement for more land and longer approach roads.

Stage 2 SAR: Assessment of Tunnel Solution

3.3.5 The Stage 2 Assessment confirmed, through ground investigation, that only an immersed tube tunnel, or a tunnel cast in situ into the river bed would be feasible due to the poor ground conditions. The Stage 2 SAR confirmed that the overall length of the tunnel scheme would be longer than the bridge options as the road level of the scheme would need to change from ground

level to c. 16m below ground level, whereas the bridge options only require a c. 9.5m level change.

3.3.6 The Stage 2 SAR stated that the tunnel option would require mechanical and electrical systems for ventilation, drainage and fire protection. It would be difficult to prevent flood waters from entering the tunnel so a temporary closure of the tunnel due to inundation must be considered a possibility. The assessment concluded that a tunnel would take approximately three years to construct and would have a material impact on the current commercial operation of the inner harbour during construction.

Optimising Tunnel Location

3.3.7 Taking account of the findings of the Stage 1 Assessment, an improved tunnel alignment was identified, running generally from SW to NE. It was found that this alignment would attract about 35% more traffic than a NW to SE alignment. Technically, the only feasible form of construction would be an immersed tube tunnel, or a tunnel cast in situ on the river bed, due to poor ground conditions. It would have a significant physical impact on the operation of the harbour during construction.

Stage 2 SAR: Shortlisted Options

3.3.8 Based on the initial findings of the Stage 2 SAR, the following three crossing options were shortlisted for further assessment:

- Bridge Option 1: Bascule bridge with roundabout on Southtown Road:
  - This option would provide a dual carriageway bascule bridge between the A12 (now A47)[4] Harfrey's Roundabout over Southtown Road and the River Yare to a new three-arm roundabout on South Denes Road between Sutton Road and Swanston's Road. This would give a headroom clearance of 5.3m on Southtown Road and 7.5m clearance to mean high tide level when closed.
  - Other changes to the road network would also be necessary to accommodate the bridge. Beccles Road would be stopped up at its junction with Southtown Road, whilst Queen Anne's Road would also be closed from its junction with Suffolk Road. A new roundabout

[4] Note: On Wednesday 1st March 2017, the A12 between Great Yarmouth and Lowestoft became part of the A47. The work ensures that the A47 is a continuous trunk road between Peterborough and Lowestoft, while the A12 is a continuous trunk road between Ipswich and London.

would be provided on Southtown Road beneath the bridge and slip roads would be provided from this junction into the link to Harfrey's Roundabout.

- Bridge option 2: Bascule Bridge with T-junction on Southtown Road:
  - This option would provide a dual carriageway bascule bridge between Harfrey's Roundabout over Southtown Road and the River Yare to a new three-arm roundabout on South Denes Road between Sutton Road and Swanston's Road. This would give a headroom clearance of 5.3m on Southtown Road and 7.5m clearance to mean high tide level when closed.
  - Beccles Road would remain open from its junction with Southtown Road, but would provide a westbound one-way link towards the A12 (now A47). Queen Anne's Road would be closed to vehicle traffic from its junction with Suffolk Road. An eastbound off-slip would be provided from the bridge into Southtown Road
- Tunnel option: Tunnel from A12 (now A47) onto Southgates Road:
  - This option would provide a dual carriageway tunnel between the A12 (now A47) south of the existing Harfrey's Roundabout and a new three arm roundabout at the junction of South Quay, Queens Road and Southgates Road. It would also provide improvements to Southgates Road and South Denes Road between Queens Road and Sutton Road. The existing access into the Fish Wharf would be replaced and the northbound carriageway of South Denes Road would run through the area. The tunnel portal would be located between Barrack Street and Newcastle Road.
  - A replacement roundabout to the south of the existing Harfrey's Roundabout would be provided with diversions to the existing Beccles Road and Harfrey's Road to link into the new junction. The existing roundabout would be removed. On and off-slips would be provided onto Southtown Road to retain access to the trunk road
  - There would be no pedestrian provision through the tunnel, but cyclists could use the tunnel by travelling on-carriageway with other traffic.

3.3.9 Plate 3.1, overleaf, presents an extract from the Stage 2 SAR and shows the three crossing options assessed (as described above).

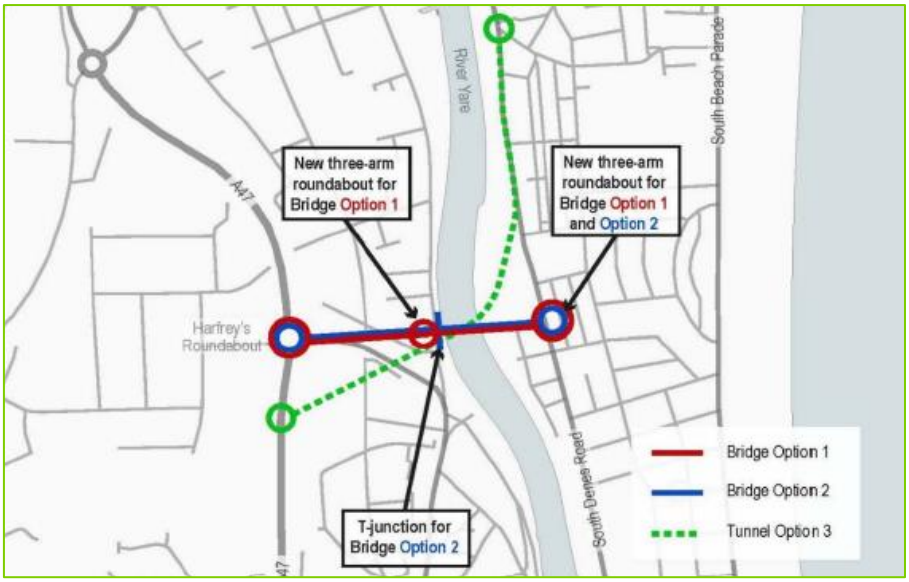


Plate 3.1: Three Shortlisted Crossing Options Assessed within the Stage 2 SAR

3.3.10 Results from the economic assessment carried out in the OAR stage showed that, although the economic benefits of the tunnel option would be nearly as high as those for the bridge options, its cost would be much higher at three times that of the bridge. The resulting BCR was less than 2.0, confirming that a tunnel option offers significantly lower value for money. Both bridge options have a BCR of greater than 4, offering very high value for money as depicted in Table 3.7.

Table 3.7: Cost and BCR of Options

Option	Bridge Option 1	Bridge Option 2	Tunnel
Cost (2015)	£121.676 million	£112.301 million	£375.828 million
BCR	4.5	4.8	1.5

3.3.11 The Stage 2 SAR found that a bridge in the southern corridor would offer the greatest monetised benefits and, because it was also likely to be the least expensive option, would generate the highest BCR. Further to this, detailed data on commercial vessel movements within the inner harbour were used to determine the likely number of bridge openings required for different locations. It was concluded that a bridge on the shortest route across the river, would require about six openings each day. Further south, the number of openings would be greater. Further north, the cost of construction would be higher.

Stage 2 SAR: Simple Environmental Assessment

3.3.12 The Stage 2 SAR was supported by a Stage 2 Simple Environmental Assessment Report (Ref 3.4). This assessment was commissioned by the Applicant to evaluate the existing environmental constraints relating to the three options for a new crossing. The findings key findings from the SAR are summarised below:

Air Quality

3.3.13 For all three of the options a number of areas were predicted to experience changes in annual mean NO_2 concentrations as a result of changes in traffic flows across the road network. Modelling predicted that all changes in particulate matter (PM_{10}) concentrations would be negligible at all receptors for all three proposed options.

3.3.14 The overall effects on air quality as a result of the three proposed options were found to be similar. Within Great Yarmouth as a whole, it was considered that the beneficial air quality effects caused by any of the proposed options compared to the Do-Minimum scenario would outweigh the adverse effects.

Cultural Heritage

3.3.15 Archaeology: The assessment predicted that overall there would be negligible adverse effects on recorded archaeological sites, except for the possible buried shoreline on the east side of the river. It was concluded that the most significant of the recorded archaeological remains in the vicinity was likely to be the buried shore and any associated deposits, although the proposed crossing alignment was not expected to affect it.

3.3.16 Historic buildings: The number and significance of historic buildings considered likely to be affected by the options were assessed as being low, and the options were assessed as having a neutral to slight adverse effect on the majority of these. However, both bridge options required the demolition of 19th century buildings for which there is no effective mitigation option. One listed building (The Dolphin Inn) was judged to be affected to a moderate/large degree, and it was considered that appropriate mitigation measures would help to reduce the significance of this effect.

3.3.17 Historic Landscape: The historic landscape likely to be affected by the options was considered to have been extensively eroded, with little evidence of pre-20th century land use. The options were therefore considered to have a neutral to slight adverse effect. The assessment identified the slight possibility of uncovering evidence of earlier land use, particularly within the Fish Wharf area and mitigation measures should be put in place to provide appropriate recording for any historic features which might be revealed.

Ecology and Nature Conservation

3.3.18 The impacts of ecological assets in the area, both terrestrial and marine, were assessed following specific site surveys. Both construction and operational phases were considered for the three options.

3.3.19 The assessment identified that the construction impacts of bridge options 1 and 2 include loss of terrestrial habitats e.g. garden allotments, broadleaved trees and drainage ditches, direct loss of aquatic habitat, indirect disturbance to aquatic habitats caused by the disturbance of silts etc, and light and noise pollution, affecting some fauna known to exist locally. Several protected species were known to exist locally, including water voles, several species of bats, and grass snakes, all of which are likely to be affected by construction. No direct effects were considered likely on Breydon Water during construction.

3.3.20 The construction impacts of the tunnel option were considered to be similar to the two bridge options, but to a greater extent, as the areas of land take would be greater, and in more sensitive areas. It was considered that a large portion of Southtown Common would be lost to this option, and the impacts on the river bed would be far greater due to the requirement to excavate a trench across the width of the river.

3.3.21 The operational impacts of the two bridge options increased light pollution, with associated impacts on bats and birds, and the possible flight pattern disruption caused by the structure itself. It was considered likely that indirect impacts caused by the increased traffic would have some detrimental effects on ecological assets adjacent to the new traffic corridor but could also provide improvements to ecological assets within the areas of Great Yarmouth and Gorleston which would experience a reduction in traffic and congestion.

3.3.22 The assessment considered that the operational impacts associated with the tunnel option would be likely to be less significant compared to the other options although the assessment concluded that impacts associated with lighting would still occur, as would indirect effects associated with elevated traffic levels and any control building.

Landscape and Townscape

3.3.23 The landscape effects resulting from the proposed works were assessed, in terms of both impacts on the surrounding landscape and on visual intrusion on the local community.

3.3.24 The main impact of the bridge options was assessed as being the presence of traffic and the bulk of the structure within the view of nearby houses, and the presence of the bridge structure across the open river. The assessment considered that the tunnel option would largely remove traffic impacts across

the river, but the extensive areas required for the approach ramps would have greater impacts on residential areas than either of the bridge options.

3.3.25 The assessment concluded that for all three options, construction impacts were likely to be significant but once completed, a bridge structure could be considered as a visually striking iconic gateway feature, with potentially beneficial landscape and visual effects.

Community and Private Assets

3.3.26 The assessment considered the impacts of the shortlisted options on (i) private and commercial assets and land used by the community; (ii) existing patterns of land use and the areas of land lost; and (iii) the resultant impact on land use.

3.3.27 Bridge option 1 was found to require (i) the demolition of up to 42 private properties, both residential and commercial; and (ii) the provision of suitable exchange land for community allotments.

3.3.28 Bridge option 2 was found to require (i) the demolition of up to 25 properties; and (ii) provision of land to compensate for the loss of the community allotments as required by bridge option 1.

3.3.29 The assessment considered that the tunnel option would require the demolition of approximately 24 private properties. However, with much larger overall footprint; the assessment found that the tunnel option would also require provision of land for a small area of community used allotments and an area of recreation ground. It was assessed that the recreation ground would be split in two by the tunnel alignment and would thereby be rendered unfit for purpose as a playing field necessitating a requirement to replace this facility. The assessment concluded that there was no practicable mitigation for the reinstatement of the entire recreation ground, therefore of the three shortlisted options considered, the tunnel option was considered to have the most significant effects in terms of loss to communities and private assets.

3.3.30 Bridge option 2 represents the design with the least impacts when compared with bridge option 1 and the tunnel option.

Noise and Vibration

3.3.31 The impacts on the local environment caused by noise and vibration were assessed for each option. The assessment included an assessment of both construction phase and operational phase impacts.

3.3.32 In general, impacts on people were quantified, although detailed impacts associated with construction were not carried out as a detailed construction strategy was not available. The assessment comprised a simple quantitative

assessment. Mitigation was not considered as too many parameters associated with each option were unknown.

3.3.33 During the construction phase, all three options were assessed as being likely to result in adverse noise and vibration impacts at nearby receptors, although no marked differences in their respective impacts were identified. The assessment concluded that bridge options 1 and 2 were likely to result in nearly identical construction impacts given their similar scheme extents. The assessment considered that bridge options 1 and 2 would have lesser construction impacts as they would take approximately 12 months less time to construct than the tunnel option.

3.3.34 The assessment considered short-term or long-term impacts for all three options. The assessment concluded that in the short term, based on current traffic model predictions:

- Bridge option 2 would produce a third fewer adverse noise impacts and a few more beneficial impacts than bridge option 1.
- The tunnel option would result in more than twice as many receptors experiencing a significant adverse noise impact than bridge option 1, and an even greater number of receptors experiencing adverse noise impacts than bridge option 2.

3.3.35 The assessment concluded that, in the long term, based on current traffic model predictions:

- Bridge option 2 would produce a quarter fewer adverse noise impacts and the same number of significant beneficial impacts than bridge option 1.
- The tunnel option would result in five times as many receptors experiencing adverse noise impacts as bridge option 1, and seven times as many receptors experiencing adverse noise impacts as bridge option 2.
- The tunnel option would result in almost twice as many receptors experiencing beneficial noise impacts as either bridge option.

3.3.36 Overall, the assessment determined that all shortlisted options would result in similar beneficial effects. However, it found that bridge options 1 and 2 would produce fewer adverse impacts in than the tunnel option. The assessment concluded that both bridge options meet their aims of reducing traffic noise in Great Yarmouth town centre, but the tunnel option did not.

Pedestrians, Cyclists and Equestrians

3.3.37 The Stage 2 SAR environmental assessment determined that during construction, pedestrians and cyclists would experience minor adverse impacts, as routes would be closed off and diversions put in place. It considered that the works were likely to be phased, both spatially and temporally, reducing the potential impacts of the construction process. The construction of the tunnel option was considered to last for approximately twice as long as the bridge options, therefore the impacts associated with the tunnel option would be felt over a longer period.

3.3.38 The assessment considered that, once completed, the bridge options would have beneficial impacts for both pedestrians and cyclists by offering relief from the existing severance that the River Yare creates in the absence of any crossing. The assessment considered that shared use footways and cycle tracks would be provided in both directions over the crossing and that existing routes would generally experience negligible impacts.

3.3.39 The tunnel option was also perceived to have benefit by offering relief from the existing severance created by the river, although only for cyclists as pedestrians would not be allowed to use the tunnel on safety grounds. However, it was considered likely that the pedestrians would benefit indirectly as public transport routes would be provided to take advantage of the new crossing.

Vehicular Travellers

3.3.40 Two aspects affecting vehicular travellers were included within the assessment; (i) the view from the road; and (ii) driver stress.

3.3.41 The view from the road along the existing route between Harfrey's roundabout and South Denes Road, for comparison to that of the crossing options, was found to fluctuate between an intermittent view and no view, with the exception of Haven Bridge where the view is a lot more open. This was also considered to be the case during construction of each of the options, except where the features of the construction site itself reduce the view.

3.3.42 The assessment determined that the two bridge options would have a benefit by permitting an open view for most of their lengths due to the height of the structure. The tunnel option was found to have an overall minor adverse impact, as the route would have no view for the majority of its length.

3.3.43 Driver stress along the existing route between Harfrey's roundabout and South Denes Road was considered to be moderate to high. Using the simple criteria presented in the DMRB, the assessment concluded that each of the

three options would also have high driver stress levels, in both the opening year and design year.

3.3.44 The assessment concluded that overall, driver stress levels would be reduced because of the much shorter distance travelled, improved traffic capacity, junctions, surfacing and pedestrian and cycle facilities. Potential disbenefits in for both bridge options would arise when the bridge is open to navigation, meaning vehicular travellers would have to either wait and queue or use the original route.

Road Drainage and the Water Environment

3.3.45 The assessment determined that, during construction, the tunnel option would have a greater negative effect on surface and ground water quality compared to the bridge options, due to the footprint and longer duration of dredging works within the River Yare. The assessment also considered that the release of contaminated sediments could have a negative impact on the ecologically sensitive receptors at Breydon Water. The assessment determined that during operation, the tunnel option could also have larger negative impacts on groundwater flow (quantity) due to the size and length of the structure within the groundwater table.

3.3.46 During operational activities, the tunnel option was considered to have neutral impacts on surface water quality, while the two bridge options would have slight adverse impacts. The neutral effect of the tunnel option was due to the dilution capacity of the River Yare in respect of the additional road runoff. The slight adverse impacts were due to the localised restriction of river water flow, and increased river bed scour expected from the pier foundations associated with the bridge solutions.

3.3.47 All options were assessed as being within a high flood risk area. Both bridge options were deemed preferable to the tunnel in terms of flood risk, as they would facilitate the passage of flood flows beneath the approach ramps. The assessment considered that the embankments associated with the Scheme would offer no greater obstruction to flood flows than the existing structures.

3.3.48 It was not possible for the assessment to determine the exact effect of flood waters on any of the options as the revised strategic flood risk assessment for the Great Yarmouth area had not been made publicly available at the time of assessment. The assessment concluded that it was difficult to see how the tunnel option would meet the Scheme objective of providing an essential infrastructure link to the peninsula in times of inundation.

Geology and Soils

3.3.49 The assessment did not anticipate any adverse impacts on geology and soils (including terrestrial soils and river sediments) as no sensitive receptors that would be affected by construction or operation of any of the options had

been identified. For the three shortlisted options assessed, the removal of existing contaminated material from site was considered to be potentially beneficial. The tunnel option was assessed as having the potential to lead to the removal of more contaminated material than the two bridge options. Both bridge options were considered to remove comparable volumes of material.

3.3.50 The assessment determined that the disturbance of contaminated soils had the potential to affect ecology, surface water, groundwater and pedestrians, cyclists and equestrians. It concluded that the tunnel option had the potential for the greatest disturbance of contaminated soils, therefore it was assessed as having the greatest adverse effect in this respect.

3.3.51 The assessment considered that the disturbance of potentially contaminated soils could also lead to impacts on construction workers. However, assuming use of appropriate Personal Protective Equipment (PPE) and implementation of a construction environmental management plan (or similar), the consequence of contact with contaminated land was assessed as low and the risk to human health was also concluded to be to be low.

3.3.52 The impacts caused by the disturbance of any contaminated river sediments were assessed and the potential for adverse effects upon ecological and surface water receptors were highlighted. Of the three shortlisted options, the assessment considered that the tunnel option would likely to lead to the greatest disturbance of contaminated sediments.

Stage 2 SAR: Traffic Assessment

3.3.53 The three shortlisted options were tested using the Great Yarmouth SATURN model. The Stage 2 Traffic and Economic Assessment Report describes the development and use of the model.

3.3.54 The model is based on detailed surveys in 2003 and updated in 2008 to take account of major developments during that period. The assessment years are 2015 and 2030, with growth constrained to TEMPRO. It was recognised that this model would need to be fully updated if the scheme progresses to the next stage of appraisal.

3.3.55 All of the options were found to produce a big reduction in traffic over Haven Bridge and a smaller reduction in traffic over Breydon Bridge. The bridge options were more effective than the tunnel option in reducing traffic on Haven Bridge (by more than 30%), but the tunnel option produces the biggest reductions on Breydon Bridge (more than 9%) at this level of detail.

3.3.56 All three options produce a net increase in traffic crossing the River Yare (up to 17%). This is because the new crossing enables traffic from South Denes to the west and north to bypass the town centre using the Western Bypass and Breydon Bridge.

Stage 2 SAR: Assessment of Journey Times

3.3.57 The Stage 2 Traffic and Economic Appraisal Report gives details of forecast journey time savings on seven routes in the study area. All three options produced significant savings in journey times on existing routes over a wide area. In addition, a third crossing was considered to produce significant distance journey time savings for journeys transferring to the new route, especially journeys between the peninsula and the A47 (south).

Stage 2 SAR: Economic Assessment

3.3.58 An economic assessment was undertaken using TUBA. All of the options tested show a positive benefit-cost ratio.

Table 3.8 Benefits, Disbenefits and Costs of Three Options

Benefits/ Disbenefits/ Costs	Bridge Option 1 £,000	Bridge Option 2 £,000	Tunnel £,000
Present Value of Benefits (PVB)	£474,450	£472,841	£441,726
Present Value of Costs (PVC)	£105,256	£98,042	£301,578
Net Present Value (NPV)	£369,194	£374,799	£140,148
BCR (PVB/PVC)	4.508	4.823	1.465

3.3.59 Although the economic benefits of the tunnel option were nearly as high as those for the bridge options, the cost of this option was assessed as being much higher. This resulted in a BCR less than 2.0 which would be poor value for money and much lower than either of the bridge options.

3.3.60 There is little difference between the benefits of the two bridge options, however option 2 was assessed as being a less expensive solution, thereby producing the highest BCR. Both of the bridge options have a BCR of greater than 4.0. Based on the criteria in DfT guidance (Ref 3.5), they were therefore considered to offer very high value for money.

3.4 Option Selection: Preferred Route (2009)

3.4.1 In December 2009, NCC's Cabinet (Ref 3.6) considered the findings of the technical studies and the public and stakeholder consultation (detailed in Chapter 5: Consultation) and decided to adopt a preferred route for the bridge option. This preferred route is illustrated in an extract from the 2016 OAR, presented in Plate 3.2 overleaf.

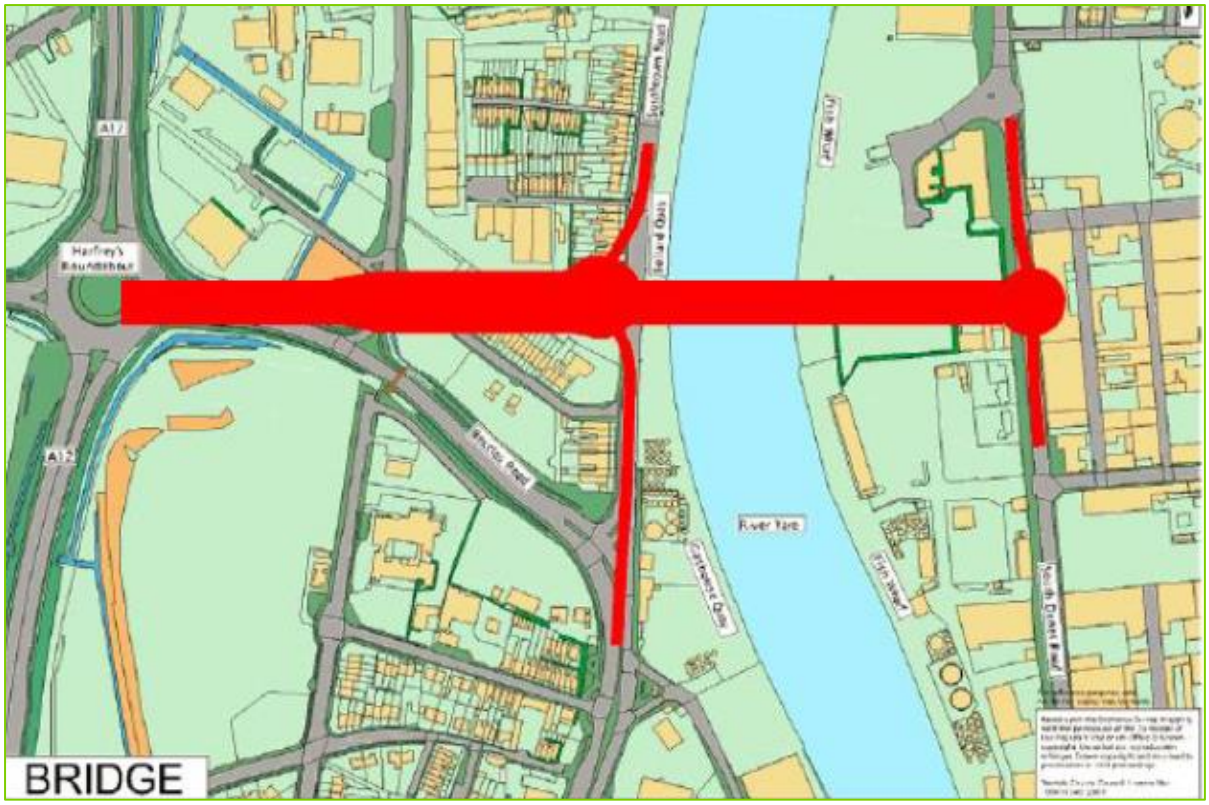


Plate 3.2: Preferred Route Adopted by NCC, November 2009, as Presented in the 2016 OAR

3.4.2 The 2016 OAR states that the Cabinet's conclusion was that:

"Evidence from all of the technical work to date and the results from the public consultation indicate that the bridge option with a dual carriageway link utilising a 50m span bascule bridge over the river is the best option for a preferred route.

The decision on whether the bridge scheme has a roundabout or a T-junction on Southtown Road can be decided during the detailed design."

3.4.3 The Cabinet also authorised the purchase of properties subject to blight notices and agreed to investigate funding options for the Scheme.

3.5 Option Selection: 2017 OAR

3.5.1 Based on preferred scheme location, presented in Plate 3.2, a long list of 40 options was produced based on different criteria including the location, form and geometry of the western and eastern tie-ins to the local road network, bridge height and carriageway standard.

3.5.2 As described in the 2017 OAR, these 40 options were predominantly variants at three different tie-in locations. These tie in locations are illustrated in an extract from the 2017 OAR, presented in Plate 3.3 below.

Plate 3.3: Three Tie in Locations Considered

2017 OAR: Sifting Process

3.5.3 As described in the OAR, the 40 identified options were put through an initial sift in order to narrow down to a selection of preferred options. This approach quickly reduced the initial list of options by removing those that a) did not make significant contributions to meeting the defined objectives; b) did not resolve the identified problems; or c) were not deliverable or feasible.

3.5.4 For each objective and identified problem, a score was allocated based on the anticipated impact of the option being assessed. The total score for each option was then calculated by summing the individual scores for each function, thus enabling a comparison between options.

3.5.5 The long list then became nine primary options (listed in Table 3.9) following the initial sift, which were variants of three different western tie-in forms and locations outlined in the OAR.

2017 OAR: Early Assessment Sifting Tool

3.5.6 DfT's Early Assessment Sifting Tool (EAST) is a decision support tool developed to quickly summarise and present evidence on options in a clear and consistent format. It provides decision makers with relevant, high-level information to help them form an early view of how options perform and compare.

3.5.7 EAST has been designed to be consistent with Transport Business Case principles and follows the same five cases as the DfT Business Case model.

3.5.8 The nine options (listed in Table 3.9), which successfully met the evaluation criteria within the initial sifting process, were taken forward to the final stage of sifting, using the EAST decision support tool. This assessment identified the high-level economic, environmental and social impacts of all nine options based on DfT's five case model approach. Reviewing the scheme's performance across all of the cases is the preferred approach, and therefore a red/amber/green (RAG) score was applied to each of the nine options to provide a visual guide (Table 3.9).

Table 3.9: Preferred Options Table

Option	Width	Tie in Location (West)	Tie in Form (West)	Tie in Location (East)	Tie in Form (East)	Cost (£M)
4	Single Carriageway	A12 (now A47) Harfrey's Roundabout tie-in	Existing four-arm roundabout	South Denes	T-junction	£65
5	Dual Carriageway	A12 (now A47) Harfrey's Roundabout tie-in	Existing four-arm roundabout	South Denes	T-junction	£102
6	Three-lane Carriageway	A12 (now A47) Harfrey's Roundabout tie-in	Existing four-arm roundabout	South Denes	T-junction	£87
31	Single Carriageway	Suffolk Road	New four-arm roundabout	South Denes	T-junction	£62
32	Dual Carriageway	Suffolk Road	New four-arm roundabout	South Denes	T-junction	£97
33	Three-lane Carriageway	Suffolk Road	New four-arm roundabout	South Denes	T-junction	£83
37	Single Carriageway	Southtown Road tie-in	At grade junction	South Denes	T-junction	£62
38	Dual Carriageway	Southtown Road tie-in	At grade junction	South Denes	T-junction	£95
39	Three-lane	Southtown	At grade	South	T-	£81

Option	Width	Tie in Location (West)	Tie in Form (West)	Tie in Location (East)	Tie in Form (East)	Cost (£M)
	Carriageway	Road tie-in	junction	Denes	junction	

2017 OAR: Discounting of Initial Options

3.5.9 Having selected nine options, it was necessary to identify which ones did not represent realistic solutions. The need for the selected scheme to perform well across economic, environmental and social indicators required a process of sifting and discarding of options to ensure that final options made a significant contribution to achieving the Scheme objectives.

3.5.10 The DfT EAST was applied to reduce nine options down to the final three. The shortlisted options were subjected to preliminary operational testing using the Mott MacDonald 2008 SATURN model, with adjustments to the network coding to reflect the alternative bridge tie-in arrangements on either side of the river, and Paramics[5] Discovery model platforms. Of the nine options, the following text outlines the preliminary findings from the sifting assessments:

- Following the option assessment and findings from the preliminary operational performance testing, Options 32, 33 and 37 were recommended to be carried forward to next stage for further appraisal.
- Both options 32 and 33 met all specific, intermediate and operational objectives of the Scheme. Option 37, a two-lane low bridge option that tied in at-grade to Southtown Road, was to be carried forward as the low-cost option. Testing showed that all key indicators suggest that Option 32 performed better than either Option 33 or 37.
- Option 39 would be expected to experience comparable over-capacity queuing issued at the AM and PM peak traffic time, and was therefore discarded.
- SATURN model outputs for Option 38 indicated that, whilst the travel time and distance would likely be reduced in comparison to the 'do nothing' scenario, significant over-capacity queuing issues may arise.

[5] Paramics refers to the traffic microsimulation software developed by Quadstone Paramics.

- Structurally, low-level bridge options (38 and 39) involved complicated construction methods that were deemed to be relatively expensive.
- Options 4, 5 and 6 had tie-ins at Harfrey's roundabout and were ruled out because of significant drawbacks to the wider road network, notably associated with queuing traffic on the A47.
- Despite performing well during the junction assessment, Option 31 was not taken forward because the four- and three-lane variants (Options 32 and 33) that tie into the same location on Suffolk Road are expected to deliver better resilience to the network and to provide more benefits to the local road network as opposed to a two-lane carriageway standard.

2017 OAR: Final Options Assessment

3.5.11 Following the discounting of options stage, three final design options were identified as:

- Preferred Option 32 - Suffolk Road tie-in to the west (four-lane high-level bridge, roundabout as west tie-in and traffic signals to the east at South Denes Road);
- Alternative Option 33 - Suffolk Road tie-in to the west (three-lane high-level bridge, roundabout as west tie-in and traffic signals to the east at South Denes Road); and
- Alternative Option 37 - Southtown Road tie-in to the west (Single Carriageway two-lane low-level bridge with traffic signal junctions to the west and the east at South Denes Road).

3.5.12 A summary of further appraisal work undertaken for Options 32, 33 and 37 are outlined in the following sections. This included a summary of the environmental assessment, as outlined in the EOAR (Appendix 3C).

Saturn Model Updates

3.5.13 Saturn Model outputs relating to overall journey times, distance travelled, queuing and total trips on the network for morning, evening and inter-peak (the time period between peak periods, from 10:00 to 16:00) periods for 2030 are summarised in Table 3.10.

3.5.14 The results show that Option 32 has a marginal benefit overall in respect of the total distance travelled in the modelled road network.

Table 3.10: Do Minimum Options 32, 33 and 37 (2030) Forecast Year

Period	Scenario	Total Distance Travelled (pcukm)	Total Travel Time (pcuhr)	Total Trips on the Network (pcu*)
AM	**Do Minimum**			
	Option 32	44920.6	1387.6	14809.5
	Option 33	44988.9	1380.9	14809.5
	Option 37	44857.4	1407.7	14809.5
IP	**Do Minimum**			
	Option 32	49019.8	1676.7	17208.2
	Option 33	48129.3	1746.7	17208.2
	Option 37	48271.5	1869.4	17208.2
PM	**Do Minimum**			
	Option 32	51424.8	1851.1	17401
	Option 33	51484.5	1853.4	17401
	Option 37	51490.1	2198.2	17401

*pcu: passenger car units.

Queueing Lengths

3.5.15 Table 3.11 shows the predicted maximum queue lengths for the three options. All key indicators suggest that Option 32 performs better than either Option 33 or 37.

Table 3.11: 2023 Max Queue (m) for Average Case Scenario and Worst-Case Scenario

ACS 2023	Option 32	Option 33	Option 37	WCS2023	Option 32	Option 33	Option 37
Western Side	154	341	407	Western Side	296	329	424
Eastern Side	189	182	397	Eastern Side	245	249	445

3.5.16 Table 3.12 shows the forecast journey time and distance savings for 2023 (opening year).

Table 3.12: Forecast Journey Time and Distance Savings 2023

2023	Vehicles	Total Distance (m)	Reduction (m)	Total Journey Time (s)	Reduction (s)
Do Minimum	109,170	284,144,403	-	30,656,804	-
Option 32	109,267	277,221,279	6,923,124	29,375,070	1,281,734
Option 33	109,281	277,366,867	6,777,536	29,400,413	1,256,391
Option 37	109,246	276,572,017	7,572,386	30,231,789	425,016

3.5.17 Table 3.13 shows the forecast journey times and distance savings for 2038, the future design year given in this report.

Table 3.13: Forecast Journey Time and Distance Savings 2038

2038	Vehicles	Total Distance (m)	Reduction (m)	Total Journey Time (s)	Reduction (s)
Do Minimum	121,984	319,680,152	-	40,219,537	-
Option 32	122,756	313,060,558	6,619,593	35,786,851	4,432,686
Option 33	122,738	312,980,112	6,700,039	35,872,101	4,347,436
Option 37	122,424	312,103,104	7,577,048	38,090,568	2,128,968

Cost

3.5.18 Table 3.14 outlines the predicted costs for each option.

Table 3.14: Estimated Scheme Cost

Option	Estimated Cost
32	£96,538,000
33	£82,604,665
37	£61,513,841

Environmental Options Appraisal Report

3.5.19 The OBC was also supported by an Environmental Options Appraisal Report (EOAR), prepared in 2017. While the OBC discussed the area of impact, the engineering and the financial case, the primary objective of the EOAR was to assess the impacts on the environment for Options 32, 33 and 37.

3.5.20 The methodology adopted for the environmental impact appraisal was informed by the guidance provided in the relevant chapters of TAG Unit A3 (WebTAG guidance for Environmental Impact Appraisals). Additionally, some assessment of the potential environmental impact and effect of the options used guidance contained within the Design Manual for Roads and Bridges (DMRB) Volume 11.

3.5.21 To inform the EOAR, a desk study was undertaken for each of the environmental disciplines; noise, air quality, greenhouse gases, landscape, townscape, biodiversity, historic environment and the water environment. It is noted that contaminated land, human health and population were not assessed within the report. A preliminary ecology survey was undertaken to inform the scope of ecology surveys. Due to the absence of appropriate traffic data for the options, a proportionate air quality and noise assessment was undertaken to inform the appraisal. This comprised a qualitative analysis of the likely effects using available information, such as potential number of sensitive receptors (e.g. properties and sensitive areas).

3.5.22 The findings of the assessments are summarised below. The appraisal scoped out the need for assessing impacts on greenhouse gases as it was deemed that this would not present a material change on the optioneering process. Given the urban nature of the options, it was concluded that the townscape sub-discipline adequately considered the potential impacts in relation to the setting and that the landscape sub-discipline would not be directly relevant to the decision-making process. Accordingly, the landscape sub-discipline was scoped out of the overall appraisal.

Noise

3.5.23 For all options, there are 663 sensitive receptor buildings and no Noise Important Areas within the 300m study area.

3.5.24 The EOAR concluded, overall, that receptors close to all three options would experience an increase in noise as a result of increased traffic flow. Option 37 was located marginally further away from sensitive receptors and therefore could be expected to result in the lowest impact of the proposed options.

Air Quality

3.5.25 The appraisal indicated that Options 32 and 33 would have a greater number of potentially sensitive receptors situated within 200m of their design footprint than Option 37. Due to the predicted reduction in traffic on the existing road links around the existing bridge, along with the absence of an Air Quality Management Area (AQMA) in the vicinity, an overall neutral local air quality impact was considered most likely for each option.

Townscape

3.5.26 The majority of townscape impacts were predicted to have a neutral effect for all options. The bridge in its temporary open position, however, would be an evident feature of Great Yarmouth's contextual townscape as a skyline feature. The assessment concluded that this would not fundamentally change the associated character of the river corridor, or how the town is perceived in context with its surrounding landscape.

Biodiversity

3.5.27 All options passed through several areas of habitat that are suitable for breeding birds, as well as several buildings which may have suitable bat roosts within them that have the potential to be affected. The appraisal determined that, once suitable mitigation has been implemented, the effect of all options on biodiversity should not exceed slight adverse.

Historic Environment

3.5.28 The EOAR deemed that all options would have a moderate adverse effect upon the setting of two listed buildings due to their proximity to the options. Additionally, the construction of all options would have a major adverse effect upon any unknown sub-surface archaeological remains.

Water Environment

3.5.29 All three of the options were located entirely within floodplain cited as Flood Zone 3 and were deemed to be a significant adverse effect upon the water environment as a result of impacts to the floodplain. However, no effects on the permeability of surrounding land and aquifer recharge were anticipated. The overall effect of all options on the water environment was deemed to be moderate adverse.

Preferred Option

3.5.30 The EOAR considered the three options and their potential effects on six different environmental disciplines. For Noise and Air Quality, a smaller number of potentially sensitive receptors, and therefore a lower impact, would be anticipated for Option 37. However, on balance with other considerations detailed in the option selection process, Option 32 was chosen as the Preferred Option for the Scheme. Option 32 was forecast to provide the greatest potential benefit in terms of total travel distance and time saved across the modelled road network. In addition, Option 32 was also forecast to present the best operational performance at the junctions adjacent to the bridge, with the lowest levels of queueing and most efficient dissipation of these queues once the bridge re-opens for vehicular traffic.

3.6 Strategic Option Design

3.6.1 Following submission of the OBC, specimen designs for the Scheme were produced. These were used to inform the Section 42, 47 and 48 consultations, in accordance with the requirements of the Planning Act 2008.

Statutory Consultation

3.6.2 While the Scheme design was well progressed, and further assessment work was undertaken, in line with the finding the 2017 OAR, a degree of flexibility was retained within the limits of deviation and, in particular, the design of the lifting mechanism for the twin-leaf bascule bridge. This degree of flexibility allowed for the finalisation of the Scheme design by the Scheme contractor, who was appointed during the pre-application stage of the project. This approach was undertaken in line with the Planning Inspectorate's Advice Note 9: Using the Rochdale Envelope, and the Applicant determined that this degree of flexibility could be applied without compromising the consultation process. Details of the consultation process are included in Chapter 5: Consultation. Below are some of the features into which flexibility was retained for consultation.

Counterweight Design

3.6.3 In order to retain a degree of flexibility, a working envelope for the proposed lifting bridge was progressed and presented during consultation (details of the consultation process can be found in Chapter 5: Consultation) and within the PEIR (submitted to PINS in August 2018 and presented in Appendix G of the Consultation Report (document reference 5.2)).

3.6.4 Two indicative specimen designs for the lifting bridge were presented in the PEIR to identify ends of a range within which a working design envelope had been defined, with confirmation that these designs did not reflect an 'either / or' scenario. It was noted that the final design of the opening mechanism would be made by the Applicant within that working envelope, taking into account a number of issues, including contractor innovation and construction cost. To ensure that the opening mechanism was adequately assessed in the PEIR, the impact assessments presented in the PEIR considered the 'worst-case' of both illustrative designs when combined.

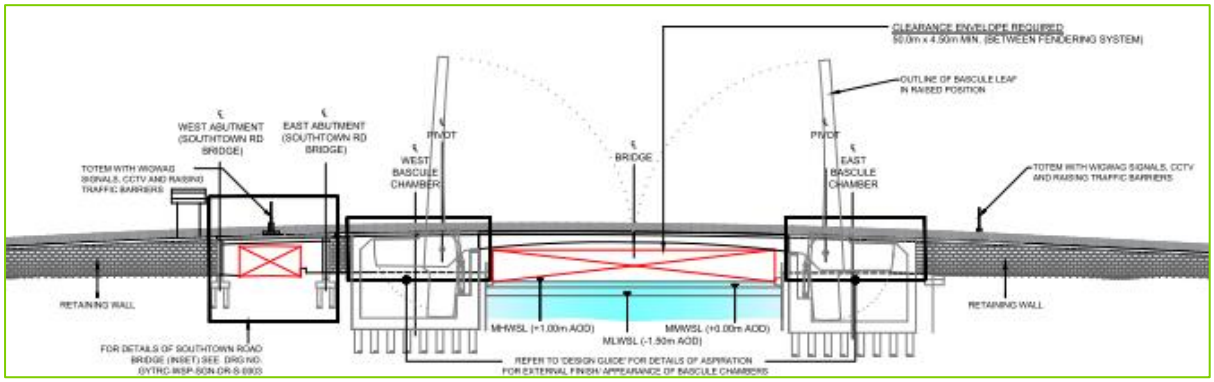
3.6.5 The working envelope presented consultees with below-deck and above-deck counterweight options. These are illustrated in Plates 3.4 and 3.5, respectively. When describing these options, the PEIR stated that:

"If counterweights are installed at or below deck level, the proposed double leaf bascule bridge may require two bascule chambers in order to accommodate their movement. If required, these will be accommodated within steel sheet-piled knuckle walls, extending into the River Yare from the

quays along both banks. The requirement for, and exact shape, form and design of these knuckle walls will be subject to further confirmation and design and will be presented in the Environmental Statement.

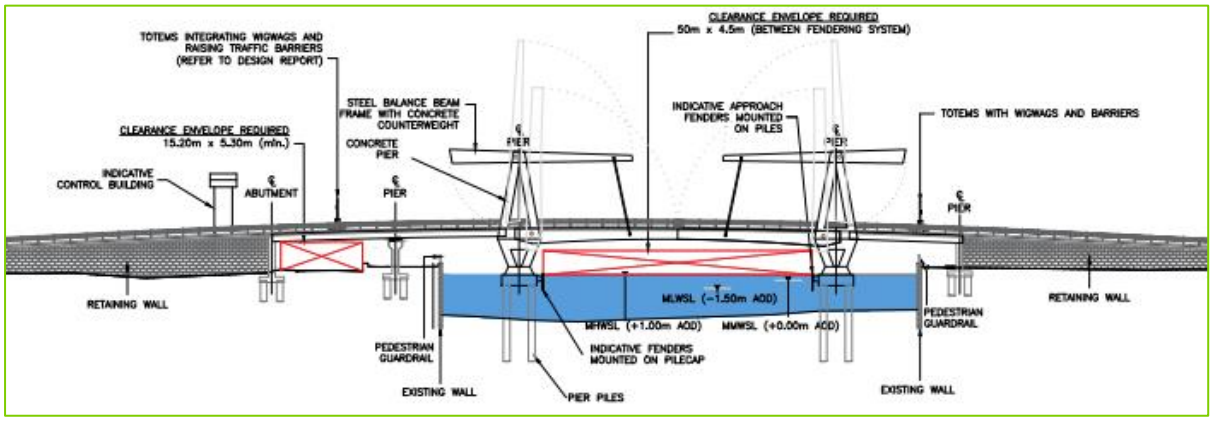
If counterweights are installed above the deck level, chambers and permanent 'knuckles' may not be required as there would be sufficient space to accommodate their movement above ground. However, temporary sheet piled cofferdams may still be required to enable the construction of the piers within the River Yare."

Plate 3.4: Indicative Profile of the Proposed Bascule Bridge in the Lowered Position (counterweights at or below bridge deck level, as presented in the PEIR)



Note the profile of the bridge when it is raised is shown in dashed grey outline.

Plate 3.5: Indicative Profile of the Proposed Bascule Bridge in the Lowered Position (counterweights above bridge deck level, as presented in the PEIR)



Note the profile of the bridge when it is raised is shown in dashed grey outline.

3.6.6 As part of design process undertaken post submission of the PEIR a selection process was undertaken for the two counterweight design options, notably in relation to:

- Capital and whole-life costs;

- Maintenance requirements;
- Operability; and
- Appearance.

3.6.7 Although the above bridge deck level counterweight option offered advantages regarding smaller bascule piers (size and depth), reduced excavation depths and removing the need for pumping to keep water out of the bascule these were outweighed by the advantages offered by the counterweights at or below bridge deck level. Such advantages included:

- Lower capital costs and anticipated lower inspection/ maintenance costs;
- Increased reliability;
- Greater protection from vandalism and extreme weather events;
- Machinery would be below the deck level and thus maintenance activities would not require road closures, which is inherently safer;
- Improved visual aesthetics given the machinery would sit below the level deck level; and
- Reduced risk of lubricants and other maintenance substances entering the River Yare.

3.6.8 Based on the above bullet points the below bridge deck level counterweight design was taken forward into the Scheme design.

Control Tower

3.6.9 The double-leaf bascule bridge would require a Control Tower to facilitate 24/7 operation. The Control Tower would need to contain a room for a bridge operator, a room to house the control equipment, and suitable welfare facilities.

3.6.10 In the PEIR, the Control Tower was reported to be planned for the vicinity of the crossing, on the western side of the River Yare at a maximum height of 20m AOD. Figure 2.5 of the PEIR presented three provisional locations for Control Tower:

- Option A: To the north of the proposed crossing at the junction of Cromwell Road and Southtown Road;
- Option B: To the north of the proposed crossing adjacent to the River Yare; or

- Option C: To the south of the proposed crossing adjacent to the River Yare.

3.6.11 As part of design process undertaken post submission of the PEIR a selection process was undertaken based on the three locations described above. The process primarily considered the sightlines between the proposed locations and river traffic and bridge users (motorised and non-motorised).

3.6.12 To summarise, Option A was discounted by the design team due to inadequate visibility of river traffic, this was also supported by feedback from Peel Ports during the statutory consultation process. Option A was also discounted on the basis of requiring additional land take and being in close proximity to residential properties, when compared to Options B and C.

3.6.13 Between Options B and C, Option C was taken forward into the Scheme design as it was determined that this option provided more space for vehicles to access the Control Tower during maintenance activities (as outlined in Chapter 2: Description of the Scheme).

Western and Eastern Approach Embankment Construction

3.6.14 Approach embankments would carry the single-span bridge over Southtown Road on the western bank, to join the bridge to a new roundabout at William Adams Way, and would connect the bridge to South Denes Road on the eastern bank. In the PEIR the western and eastern approach embankment construction method was kept flexible. As part of the design process undertaken post submission of the PEIR an appraisal process was undertaken in respect of the most suitable construction method for the approach embankments with regards to:

- Integration with the surrounding areas;
- Environmental impacts; and
- Risks associated with contaminated soils.

3.6.15 The following construction methods were considered:

- Option A: Pile-supported reinforced earth embankments;
- Option B: Tied embedded sheet pile embankment with excavate and replace;
- Option C: Approach viaduct;
- Option D: Vertical drains ground improvement; and

- Option E: Rolling dynamic compaction ground improvement.

3.6.16 Options D and E were found to be unsuitable at an early stage due to programme implications. Table 3.15 presents the key advantages and disadvantages Option A, B and C.

Table 3.15. Western and Eastern Approach Embankment Construction Method Appraisal

Option	Advantages	Disadvantages
A	• In addition to supporting the road above, the reinforced earth structures support the parapet system and its associated reinforced concrete parapet beam and base slab, thereby providing an additional function. • Highly durable.	• Noise and vibration risks, although the risk can be reduced by selecting appropriate driving heads and vibratory plant.
B	• Reduced footprint of the embankment. • Fast and simple construction process.	• Reduced aesthetics due to exposed sheet pile, although, painting and cladding could be used to improve the aesthetics. • Noise and vibration risks, although the risk can be reduced by selecting appropriate driving heads and vibratory plant. • Large excavation requirements, thereby increasing vehicle movements.
C	• Reduced excavation requirements, thereby offering reductions in vehicle movements.	• Enclosure panels could result in excessive maintenance costs due to the increased risks associated with anti-social activity, and ingress of birds / vermin.

3.6.17 Based on the findings of the appraisal process Option A was taken forward into the Scheme design on the basis of the advantages outweighing those associated with Option B and C.

Further Consultation

3.6.18 Further design refinement was undertaken following the statutory consultation process, notability in relation to:

- Removal of the large commercial vessel waiting facility; and
- Changes to the Scheme to minimise the impact of the proposed Scheme on the MIND Centre and Grounds.

3.6.19 The Applicant undertook localised consultations between February 2019 and March 2019 with those parties with an interest in land on, or nearby, to the land plots where each change occurred.

3.6.20 A summary of the changes is provided in the following sections. Further details can be found in Chapter 11 of the Consultation Report (document reference 5.2).

Large Vessel Waiting Facility

The statutory consultation documents explained that consideration had been given to a potential large commercial vessel waiting facility, for use in the event that the proposed bridge fails to operate. The documents also explained that the need for this facility would be confirmed in the Application for a DCO. An assessment of the risk levels of a bridge failure during a large vessel movement concluded that the risk rating for these larger vessels would be low and would be considered acceptable under the processes laid out in the Port Marine Safety Code: Marine Safety Management System (Ref 3.7). It was therefore concluded that the risks to large commercial vessels associated with a bridge failure do not warrant the provision of this large vessel waiting facility.

MIND Centre and Grounds

3.6.21 Following design refinement, changes were proposed to the MIND Centre and Grounds in order to reduce the effects of the Scheme presented during statutory consultation. As part of the statutory consultation process the Applicant held a series of meetings with representatives of the MIND Centre and Grounds to describe the effects of the Scheme and identify measures to further minimise such effects. Further details on the consultation, including responses and outcomes, can be found in Appendix Q-3 of the Consultation Report (document reference 5.2). Key concerns were related to a reduction in the size of the MIND Centre and Grounds. As a result, additional consultation on the MIND Centre and Grounds took place which resulted in further evolution of the design to minimise effects. The progression of the design as a result of the further consultations included:

- Removal of the drainage ditch proposed on the south side of the MIND Centre and Grounds and replacement with a stone-filled drainage trench to reduce the amount of land required for this drainage feature;
- Changes to the position of the vehicle turning head at the end of Queen Anne's Road to enable the extension of the MIND Centre and Grounds further to the west, thereby increasing the amount of land available for the MIND Centre and Grounds;
- Changes to the terraced embankment slope between William Adams Way and the MIND Centre and Grounds to enable the slope to be planted, thereby providing aesthetic benefits to users; and
- Changes to the public realm and other proposals, which would provide additional areas to accommodate some of the features that are currently on the MIND Centre and Grounds site, inclusive of:
  - The relocation of the labyrinth that currently occupies an area of the MIND Centre and Grounds site; and
  - Relocation of the proposed footway closer to the roundabout to provide a separate area for the orchard and individual planting areas that are currently on the MIND Centre and Grounds site. This option would include provision of a retaining feature on the eastern side of the roundabout to enable the provision of ramp and step access.

3.6.22 Table 3.16 below provides an estimate of the area changes of the MIND Centre and Grounds, as a result of the above changes.

Table 3.16. MIND Centre and Grounds Changes as a Result of Further Consultation

MIND Centre and Grounds	Approximate Area
Current Area of MIND Centre and Grounds	**4,450m^2**
Remaining area of MIND Centre and Grounds following construction of the Scheme (as presented during the statutory consultation process)	1,800m^2
Removal of the drainage ditch proposed	3,200m^2
Changes to the position of the vehicle turning head	
Changes to terraced slope	300m^2
Use of an area of public realm for the relocation of the Labyrinth feature	250m^2
Relocation of the proposed footway closer to the roundabout to provide a separate area for the orchard and individual planting	450m^2

MIND Centre and Grounds	Approximate Area
areas	
Proposed area of MIND Centre and Grounds*	3,950m^2
***Note: The relocation of the Labyrinth feature is excluded from this figure** as it is being relocated/reconstructed in an area of public realm outside of **MIND Centre and Grounds.**	

3.6.23 Following further consultation on the MIND Centre and Grounds changes presented above all have been taken forward into the Scheme design.

3.7 Final Design Selection

3.7.1 For this ES, the Scheme has now been confirmed as an opening span, double-leaf bascule bridge with counterweights in the below-deck position. This would involve the construction of two new 'knuckles', extending the quay wall into the river to support the bridge.

3.7.2 A full description of the Scheme can be found in Chapter 2: Description of the Scheme, in this ES.

3.8 References

Ref 3.1: Mott Macdonald for Norfolk County Council, Great Yarmouth Third River Crossing, 2007, Stage 1 Scheme Assessment Report.

Ref 3.2: Mott Macdonald for Norfolk County Council, Great Yarmouth Third River Crossing, 2009, Stage 1 Scheme Assessment Report.

Ref 3.3: Mott MacDonald for Norfolk County Council, Great Yarmouth Third River Crossing, 2009, Structural Options Working Paper.

Ref 3.4: Mott MacDonald for Norfolk County Council, Great Yarmouth Third River Crossing, 2009, Stage 2 Environmental Assessment Report.

Ref 3.5: Department for Transport, 2013, Value for Money Assessment: Advice Note for Local Transport Decision Makers.

Ref 3.6: Norfolk County Council Cabinet, Great Yarmouth Third River Crossing Preferred Route, 2009.

Ref 3.7: Peel Ports Group, Port Marine Safety Code: Marine Safety Management System, 2017.

4 Approach to EIA

4.1 Introduction

4.1.1 This chapter outlines the approach to the EIA for the Scheme, the objectives and the EIA strategy which was formally consulted on through the EIA scoping process. Scoping has been an ongoing process and is documented within this chapter alongside the evidence base associated with the insignificant topics.

4.1.2 The approach to consultation is outlined in this chapter (and detailed in Chapter 5: Consultation), together with the approach to the assessment including the assessment criteria and the methodology for assessing cumulative effects.

4.1.3 The EIA has been undertaken in accordance with the EIA Regulations (Ref. 4.1) and the National Planning Practice Guidance (Ref. 4.2).

4.1.4 An overview of the Application Site's status in relation to relevant planning policy is discussed within the Case for the Scheme (including Planning Statement) (document reference 7.1).

4.2 Objectives of the EIA

4.2.1 EIA is a process that identifies the likely significant environmental effects of a proposed development. It ensures that effects are properly considered as part of the design development process and that adverse effects are adequately mitigated. EIA assists in decision-making so that environmental factors can be given due weight. EIA also helps the Applicant to avoid, minimise and compensate for adverse environmental effects. EIA provides an opportunity for iterative feedback throughout the design process, providing a mechanism to take into account environmental effects within the design process.

4.2.2 The key objectives of the EIA are as follows:

- Set the legal framework;
- Document the consultation process;
- Consider the alternatives to the Scheme;
- Establish baseline environmental conditions at the Application Site and within the surrounding area;

- Establish the future baseline conditions at the Application Site and within the surrounding area;
- Identify likely significant effects during the design process so that some effects can be mitigated prior to the assessments within the ES (i.e. demonstrating an iterative approach to EIA);
- Identify, predict and assess the significance of environmental effects associated with the Scheme including its embedded mitigation: positive and negative; permanent and temporary; direct and indirect and short / medium / long term. These include environmental effects associated with the following topic areas:

  (i) Air Quality;
  (ii) Noise and Vibration;
  (iii) Nature Conservation;
  (iv) Cultural Heritage;
  (v) Townscape and Visual;
  (vi) Road Drainage and the Water Environment;
  (vii) Flood Risk;
  (viii) Climate Change;
  (ix) People and Communities;
  (x) Materials;
  (xi) Geology and Soils;
  (xii) Traffic and Transport;
  (xiii) Major Accidents and Disasters; and
  (xiv) Cumulative Effects.

- Identify, predict and qualitatively assess the synergistic and cumulative effects of the Scheme including those associated with the other identified committed developments; and
- Identify suitable additional mitigation, enhancement and monitoring measures to prevent, reduce or offset significant negative environmental effects and identify the residual effects following the implementation of these measures.

4.3 EIA Regulations and Guidance

EIA Regulations

4.3.1 This ES is being submitted with an application for development consent under the Planning Act 2008 and has been prepared in compliance with the EIA Regulations.

4.3.2 The Scheme is considered to be EIA development, in accordance with the definition in the EIA Regulations. To enable the decision-maker to understand the likely significant environmental effects of the Scheme, the ES provides environmental information in accordance with Schedule 4 of the EIA Regulations, which sets out the information that must be included within an ES. The ES provides sufficient information to inform stakeholders, including the local community, of the main environmental effects that are likely to arise as a result of the Scheme.

4.3.3 Regulation 5, Regulation 14 and Schedule 4 of the EIA Regulations highlight the information to be included in an ES. These requirements are set out in Table 1.1 which also provides a confirmation of where the information is provided within this ES.

EIA Guidance

4.3.4 As well as legislative requirements, various guidance documents have been developed by decision-makers, developers and professional institutions to guide the EIA process and preparation of the ES. The approach taken to individual technical assessments is presented in Section 3 of Chapters 6 to 19, and any relevant topic-specific technical assessment guidelines are detailed within these chapters, as appropriate.

4.3.5 In addition, PINS has published a number of Advice Notes to help guide applicants through the application process, the PINS Advice Notes directly relevant to the EIA are as follows:

- PINS (2017 – Version 7). Advice Note Three: EIA Consultation and Notification;
- PINS (2016 – Version 7). Advice Note Six: Preparation and submission of application documents;
- PINS (2017 – Version 6). Advice Note Seven: Environmental Impact Assessment: Preliminary Environmental Information, Screening and Scoping;
- PINS (2018 – Version 3). Advice Note Nine: Rochdale Envelope;

- PINS (2017 – Version 8). Advice Note Ten: Habitat Regulations Assessment relevant to Nationally Significant Infrastructure Projects;
- PINS (2018 – Version 5). Advice Note Twelve: Transboundary Impacts and Process;
- PINS (2015 – Version 1). Advice Note Seventeen: Cumulative Effects Assessment; and
- PINS (2017 – Version 1). Advice Note Eighteen: The Water Framework Directive.

4.3.6 In addition, the DMRB (Ref. 4.3) provides guidance for all aspects of the planning, design and assessment of major road schemes. The guidance in Volume 11 specifically addresses environmental assessment and identifies impacts and effects, which can be anticipated where a major road scheme is being introduced into the environment, although it is acknowledged that the DMRB (Ref. 4.3) predates the current EIA Regulations. The guidance has been used, where relevant, to assist the assessment team in establishing which impacts and effects could potentially occur, and the specific nature of them for the Scheme. Where it is concluded that assessment is required, there is a description of the assessment considered appropriate and methods of assessment which have been adopted.

4.4 Overview of the EIA Process

4.4.1 The following steps form the development process of an EIA:

- Proposal Identification: the need or opportunity for development is identified, alternatives are considered, and draft plans are drawn up, which generally include the potential location, proposed land use and initial design concepts.
- Screening: in order to determine whether an EIA is needed for a given project it is 'screened' by the relevant consenting authority. The regulations require that some projects are always subject to EIA whilst others may be subject to an EIA where there is the likelihood for significant environmental impacts.
- Scoping: where an EIA is required, scoping focuses the assessment onto the key environmental issues that the assessment will consider in further detail. Technical stakeholders are engaged in the process. The scoping stage ensures that only aspects of the environment likely to be significantly affected are included in the later stages of the assessment.
- Iterations of: Design > Assessment > Alteration, Mitigation and Enhancement: to predict the likely environmental effects of a proposed

development the assessment must consider the current condition of the environment and likely future changes to it without the development, the changes the development would have on this and the significance of such effects. A Preliminary Environmental Information Report (PEIR) is produced which provides documentation similar to an early-stage Environmental Statement (ES), in order to facilitate consultation. A period of consultation gathers views from stakeholders and members of the public. Feedback from the consultation process is incorporated into the ES. Negative environmental effects predicted to result from the development are reduced through alterations to design or through the inclusion of mitigation measures. At this stage opportunities to enhance the environment should also be identified. The assessment also considers the interaction of environmental effects caused by the development, in order to identify secondary, cumulative and synergistic effects that may occur as a result of taking action to reduce negative environmental effects.

- Environmental Statement (ES): this is the document which communicates the results of the EIA to the decision-maker and other stakeholders. Criteria for what must be included are set out in the regulations, with the Non-Technical Summary (NTS) being the most widely distributed component of the document.

- Submission: the ES is submitted for consideration by the decision maker.

- Decision-Making: at this point all the application information is reviewed and the decision whether to grant development consent is taken. The views expressed during the public consultation process and the EIA's findings contained in the ES must be considered in making the decision.

4.4.2 Post-consent: if the development is granted consent, mitigation measures should be implemented, and the environmental effects of construction and operation may be monitored, in accordance with the terms of (in this case) the Outline Code of Construction Practice (OCoCP) (document reference 6.16) and the DCO. Key steps in the process and how they have been applied to the EIA of the Scheme are described below.

Screening

4.4.3 On 3rd April 2018, the Applicant notified the SoS that it proposed to provide an ES in relation to the Scheme. The effect of this notification was to determine for the purposes of the EIA Regulations (Regulations 6(1),6(2)(a) and 8(1)(b)) that the Scheme is to be an 'EIA Development'.

Scoping

4.4.4 The EIA scoping process aims to assist the preparation of the ES by providing an opinion as to the scope of the information to be provided in the

ES and the level of detail. The process of scoping helps to ensure that the topics covered, the baseline information used, and the methods of assessment, are appropriate, and have taken into account the views of decision-makers, and consultees where appropriate.

4.4.5 There are two main stages in the scoping process. Firstly, the undertaker compiles information to inform their view as to the scope of issues that should be covered in the main ES; this usually takes the form of an EIA Scoping Report and is based on initial consultation, data searches and baseline surveys. The EIA Scoping Report is submitted to the decision-maker with a request for a Scoping Opinion. The second stage in the scoping process is for the decision-maker to issue a Scoping Opinion, outlining what they expect to be covered in the ES, having consulted a range of statutory bodies and taken into account the information provided by the applicant in their EIA Scoping Report.

4.4.6 The EIA Scoping Report (document reference 6.6) was received by the PINS on 5th of April 2018. Following receipt of the Scoping Opinion (document reference 6.7) it was considered that the Scheme has the potential to result in likely significant effects on the environment associated with the following topic areas:

- Air Quality (Chapter 6);
- Noise and Vibration (Chapter 7);
- Nature Conservation (Chapter 8);
- Cultural Heritage (Chapter 9);
- Townscape and Visual (Chapter 10);
- Road Drainage and the Water Environment (Chapter 11);
- Flood Risk (Chapter 12);
- Climate Change (Chapter 13);
- People and Communities (Chapter 14);
- Materials (Chapter 15);
- Geology and Soils (Chapter 16);
- Traffic and Transport (Chapter 17);
- Major Accidents and Disasters (Chapter 18); and

- Cumulative Effects (Chapter 19).

4.4.7 These topics and their associated likely significant effects have been assessed within the ES. They are presented in Chapters 6-19 accordingly.

4.4.8 As part of the EIA Scoping process, a number of sub-topics were considered 'scoped out' of the EIA process. These topics can be found in part 4 of the Scoping Opinion (document reference 6.7).

4.4.9 A Scoping Opinion (document reference 6.7) was received from the SoS on 16 May 2018. The Scoping Opinion (document reference 6.7) provided comments from the SoS on the proposed scope of the EIA and included copies of responses from the Consultation Bodies (see Appendix 2 of the Scoping Opinion (document reference 6.7), for a full list of the statutory Consultation Bodies, as prescribed in Schedule 1 of The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009). A number of late responses to the Scoping Report were received, all of which were given consideration by the Applicant. After receipt of the Scoping Opinion (document reference 6.7) the Applicant met with PINS to discuss it.

4.4.10 In Section 3 of each of the technical chapters (Chapters 6-19) presented in this ES, a table is provided which includes extracts from the Scoping Opinion that relate specifically to the technical chapter, including comments from consultation bodies, and information is provided to explain how and where the issue is addressed in the ES.

4.4.11 Each technical chapter (Chapters 6-19) describes the technical scope of works undertaken. The proposed technical scope for each of the EIA topics was detailed in the EIA Scoping Report. Each technical chapter provides a table which includes extracts from the Scoping Opinion that relate specifically to the technical chapter, and information is provided to explain how and where the issue is addressed in the ES have been addressed as part of the assessment.

4.4.12 In order to satisfy the requirements of the EIA Regulations and the Scoping Opinion, the ES considers (i) Risks of Major Accidents and/or Disasters; (ii) Transboundary Effects; (iii) Residues and Emissions.

4.4.13 The Applicant considers that, particularly in light of the Section 35 status of the Scheme and given that the roads affected by the Scheme are local roads, not the strategic road network, no aspect of the Scheme has the potential to be an additional NSIP. Nonetheless, each technical chapter considers effects arising from those aspects of the works that directly impact upon relevant receptors.

Human Health

4.4.14 As part of EIA Scoping, an initial health screening and scoping assessment was completed using the London Healthy Urban Development Unit (HUDU) screening tool (Ref 4.4). This was undertaken so that the potential health effects could be identified and considered early on in project development. The exercise identified potentially affected populations, including vulnerable groups, in addition to aspects of the project which may give rise to effects on health.

4.4.15 It was concluded a stand-alone human health chapter would be scoped out of the EIA as potential impacts were determined to be either positive, unlikely to be significant or were already being assessed within other environmental topic chapters.

4.4.16 Within the Scoping Opinion (document reference 6.7), PINS agreed that a stand-alone Health aspect chapter is not required, however it stated that for clarity the ES should contain a table which provides a clear cross-reference to where the relevant information and assessment of human health is located in the ES. This is presented in Table 4.1 below.

4.4.17 It was determined that impacts on landscape and nature conservation are unlikely to affect human health given the existing urban nature of the environment and retention of open space.

Table 4.1: Location of Assessment of Effects upon the Human Health

Health Assessment	Location within ES
Human health effects associated with air quality.	Chapter 6: Air Quality
Human health effects associated with noise and vibration.	Chapter 7: Noise and Vibration
Potential effects associated with community severance, loss of property, economic aspects and community facilities.	Chapter 14: People and Communities
Human health effects associated with contaminated land.	Chapter 16: Geology and Soils
Combined effects upon human health.	Chapter 19: Cumulative Effects

4.4.18 PINS stated that the Applicant should ensure the survey methodologies and study area relevant to human health effects are clearly defined in the relevant aspect chapters. The relevant chapters of this ES explain how

health effects form part of the considerations within each assessment This includes in the identification of sensitive receptors through the survey methodologies and study areas undertaken within these assessments. The effects of each of these topics in relation to human health is then considered in combination in Chapter 19: Cumulative Effects.

Risks of Major Accidents and/or Disasters

4.4.19 Chapter 18: Major Accidents and Disasters addresses the potential vulnerability of the Scheme to major accidents and/or disasters as required by the EIA Regulations.

4.4.20 Schedule 4 of the EIA Regulations 2017 states that the ES must include the following:

"A description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned…. Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies."

4.4.21 Chapter 18: Major Accidents and Disasters includes a description and assessment (where relevant) of the likely significant effects resulting from accidents and disasters applicable to the Scheme. The chapter:

- Evaluates the potential occurrence and the Scheme's susceptibility to major accidents and disasters outlined in the Cabinet Office's UK National Risk Register to occur in relation to the Scheme, which may give rise to significant adverse effects on the environment;
- Considers the vulnerability of the Scheme to a potential major accident or disaster, which may give rise to significant adverse effects on the environment; and
- Considers the Scheme's potential to cause an accident or disaster, which may give rise to significant adverse effects on the environment.

4.4.22 Where specific technical chapters describe major accidents and disasters Chapter 18 evaluates the potential for significant effects along with signposting to the appropriate technical chapter.

Transboundary Effects

4.4.23 On the 28th of June 2018, transboundary screening was undertaken by PINS on behalf of the SoS for the purposes of Regulation 32 of EIA Regulations. This is presented in Appendix 4A (document reference 6.2).

4.4.24 This screening exercise considered the information presented within the EIA Scoping Report (document reference 6.6) and gave regard to the location of the Scheme, its characteristics, and the environmental importance of the receiving environment.

4.4.25 As part of the screening exercise PINS identified and considered the likely impact of the Scheme, including consideration of potential pathways and the extent, magnitude, probability, duration, frequency and reversibility of the effects. The transboundary screening (Appendix 4A (document reference 6.2)) concluded that the Scheme is unlikely to have a significant effect either alone or cumulatively on the environment in another European Economic Area State.

4.4.26 PINS considered that the likelihood of transboundary effects resulting from the Scheme was so low that it did not warrant completion of a formal transboundary screening matrix. PINS noted that the position should remain under review and regard given to any new or materially different information coming to light which may alter the decision. It is the Applicant's conclusion that Scheme design iterations have not changed the position since the transboundary screening was completed on 28th June 2018.

Residues and Emissions

4.4.27 In accordance with the requirements of the EIA Regulations, Chapter 13: Climate Change, specifies the residues and emissions that are likely to arise as a result of the Scheme. This includes an estimate, by type and quantity, of expected residues and emissions. In addition, chapters of the ES specifically reference aspects of residues and emissions relating to water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation and quantities, and types of waste produced during the construction and operation phases, where relevant. These assessments are presented in the appropriate chapters.

4.4.28 The ES is supported by a Statutory Nuisance Statement (document reference 6.10). This Statement has been prepared and submitted pursuant to Regulation 5(2)(f) of the APFP Regulations and in accordance with the Department for Communities and Local Government titled 'Planning Act 2008: Application Form Guidance' (Ref 4.5), and PINS Advice Note Six titled 'Preparation and submission of Application Documents' (Ref 4.6). It is required in order to identify any possible sources of statutory nuisance as defined in Section 79(1) of the Environmental Protection Act 1990, and if so, the proposals for mitigation or means of limiting such nuisance.

Effects on Maritime Activities

4.4.29 The scope of the EIA includes assessments of the potential impact of the Scheme on maritime activities. Table 4.2 provides a list of the assessments

that have been undertaken and signposts where this information is presented.

Table 4.2: Scope of Assessment of Maritime Effects

Assessment	Chapter
Impacts of lighting: A stand-alone lighting report has been produced to support the DCO application (document reference 7.4d). This report has been used to assess the impacts of the proposed artificial lighting, including the risk of light spill on the navigation channel.	Chapter 10: Townscape and Visual impacts
Hydromorphological assessment: A hydromorphological assessment has been undertaken and includes sediment transport modelling of the Scheme to understand the impact of the presence of the bridge infrastructure on the hydromorphology of the River Yare. It discusses the potential effects on river bed scour / erosion and sediment deposition patterns.	Chapter 11: Water Environment (notably the Sediment Transport Assessment presented in Appendix 11C (document reference 6.2)).
Generation of employment opportunities: Once operational, the Scheme is anticipated to lead to an increase in economic activity due to the greater connectivity afforded. An assessment of employment opportunities has been undertaken and considers the potential effects on enhanced access for local businesses, including port activities.	Chapter 14: People and Communities
Land-take, severance and disruption to marine businesses and associated activities: The assessment of effects on marine commercial businesses and activities focuses on land-take, severance and disruption to operations within the River Yare and Port operations, including the potential for negative impacts of the bridge as a barrier to the river port north of the new bridge location. Initial Vessel Simulation Modelling has been undertaken that allows a virtual navigation of a vessel through the River Yare to test how the Scheme interacts with Port operations. Further development of the Vessel Simulation Modelling will be undertaken as the design progresses. The Vessel Simulation Report which summarises the Vessel Simulation Modelling is included as Appendix C to the Navigational Risk Assessment (Document reference 6.14).	Chapter 14: People and Communities

4.4.30 The assessment of combined effects on maritime activities is presented in Chapter 19: Cumulative Effects.

Consultation

4.4.31 A number of consultation stages have been undertaken throughout the development of the Scheme. In addition to the formal consultation undertaken in conjunction with the scoping process, statutory consultation has been undertaken. The PEIR, presented as an appendix to the Consultation Report (document reference 5.2) was published as part of the statutory consultation material to inform the public and other consultees and obtain effective feedback. This is summarised in Chapter 5: Consultation.

4.4.32 Under Part 5, Chapter 2 of the Planning Act 2008, the Applicant has a duty to undertake pre-application consultation on its proposed application for a DCO for the Scheme. The Applicant has undertaken three stages of consultation for the Scheme since 2016, as discussed in Chapter 5: Consultation. Stages 1 and 2 were undertaken to invite views on congestion in Great Yarmouth and to share emerging proposals for the Scheme. Stage 3 formed the statutory stage of consultation which was completed in accordance with the requirements of Sections 42, 47 and 48 of the Planning Act 2008. This consultation ran between August 2018 and December 2018. The purpose of Stage 3 consultation was to provide updated details on the Scheme and to invite and assess views on it, before an application for development consent is submitted. Considering the consultation responses received from the Stage 3 statutory consultation, the Applicant undertook further localised consultations on proposed changes to the Scheme with stakeholders likely to be affected. Further details of the consultation process are described in Chapter 5: Consultation.

4.4.33 As part of the EIA process, technical consultation with a range of statutory and non-statutory consultees has been ongoing. Details of the technical consultation undertaken for each topic area is provided in the respective chapters (Chapters 6 – 19).

4.4.34 Consultation has informed the development of the Scheme from the OBC options considered to the final development of the Scheme. Each consultation stage is referred to as part of the Scheme in Chapter 3: Consideration of Alternatives. Please refer to the Consultation Report (document reference 5.1) for further information on these stages of consultation, consultation feedback provided and how the Applicant had regard to the responses received.

Baseline Scenario

4.4.35 Baseline information (environmental characteristics and conditions) has been collated for the Scheme, based on surveys undertaken and information available at the time of the assessment. Technical Chapters 6 to 19 provide

details of the baseline information (and the timeline for the data collection to inform this baseline) for the Application Site and a summary is provided in Chapter 2: Description of the Scheme.

4.4.36 The baseline year for the purpose of the ES is generally 2018. There are slight variances across the ES depending on the use of existing data obtained through other sources and also the dates when surveys were undertaken, which represent baseline scenarios earlier or later than 2018. This has been clearly outlined within technical Chapters 6 to 19.

4.4.37 The dates of surveys and the dates when data sources have been accessed are provided within technical Chapters 6 to 19.

4.4.38 For some technical chapters, the baseline situation during the construction period or operational years is unlikely to be any different from the existing baseline, as studied during the EIA process (2017-2018). However, for other topics the baseline will not be static, and it is important to include a forecast of changes to the baseline, if that baseline is expected to be different from the existing one, both as a result of committed development and from any 'natural' changes from the baseline. The 'do nothing' / 'do minimum' scenario, in effect the evolution of the baseline environment were the Scheme not to be constructed, is included where appropriate within the assessments in Chapters 6 to 19, and Table 4.3 explains the need for baseline forecasting for each technical chapter. Natural Changes from the baseline scenario, as referred to in Schedule 4 (Paragraph 3) of the EIA Regulations, have been considered within Table 4.3.

Table 4.3: How Future Baseline is Considered

Chapter	How Future Baseline is Considered
Chapter 6: Air Quality	The do-nothing scenario is an intrinsic requirement of the assessment of road traffic during the operational phase in so far that the change in the future with and without the Scheme in place is the measure of the environmental effect caused by the Scheme. This has taken account of Defra's Emissions Factors Toolkit and related tools, which include predicted changes from the baseline scenario.
Chapter 7: Noise and Vibration	Similarly, to air quality the assessment of change in road traffic noise with and without the Scheme in place is a fundamental part of the assessment.
Chapter 8: Nature Conservation	No forecasting required. Climate change could alter the distribution of certain species, and changes to rainfall patterns could alter the hydrology of habitats; however, these changes cannot be predicted with any certainty.
Chapter 9: Historic Environment	The assessment of historic environment has considered the potential impacts of the Scheme on the setting of Heritage

Chapter	How Future Baseline is Considered
	Assets.
Chapter 10: Townscape and Visual	An assessment of the Great Yarmouth Future Townscape is included within the ES, which, whilst not strictly the do-nothing scenario, does present how the local townscape is expected to develop and the townscape character change in the absence of the Scheme (see Paragraph 10.4.45).
Chapter 11: Road Drainage and the Water Environment	No forecasting required as it is not anticipated that the baseline has potential to change substantially over the Scheme timescales.
Chapter 12: Flood Risk	The Flood Risk Assessment (Appendix 12B (document reference 6.2) identifies the change in flood level that will be experienced should the Scheme be constructed, above the do-nothing scenario in that time period.
Chapter 13: Climate Change	The climate change chapter considers measures that have been built into the Scheme design to take account of climate change factors.
Chapter 14: People and Communities	Where the assessment of effects has drawn on the results of other technical assessments, any forecasting undertaken for those assessments applies. The assessment considers the effects of the Scheme on development land and the increased pressures on local services / open space arising from the construction of committed developments.
Chapter: 15 Materials	No forecasting required as it is not anticipated that the baseline has potential to change substantially over the Scheme timescales.
Chapter 16: Geology and Soils	No forecasting required as it is not anticipated that the baseline has potential to change substantially over the lifetime of the Scheme.
Chapter 17: Traffic and Transport	The traffic and transport chapter identifies and considers committed developments in the construction and operational phases of the Scheme in considering the changes to traffic on the highway network, including junctions.
Chapter 18: Major Accidents and Disasters	The major accidents and disasters chapter considers measures that have been built into the Scheme design to take manage the potential for major accidents and/or disasters during construction and in the operational phase of the Scheme.
Chapter 19: Cumulative Effects	The cumulative effects chapter identifies and considers committed developments in the construction and operational phases of the Scheme in considering in-combination effects.

Study Area

4.4.39 The study area for each of the technical assessments varies according to the specific assessment and is described in each of the individual technical chapters (Chapters 6-19) as the study area will vary for each discipline and is driven by the nature of the existing environmental baseline.

4.4.40 It is also recognised that some effects only impact on a defined area, for example direct impacts on buried archaeology, whereas other effects are more widespread, for example considering the potential effects on landscape character.

4.4.41 Furthermore, some technical assessments relate only to the Principal Application Site only whilst others consider the Application Site in its entirety (i.e. including the Satellite Application Sites). Justification for the extent of the Application Site considered are included in each technical chapter (Chapters 6-19).

Timing and Duration of Works

4.4.42 The high-level construction programme is provided in Chapter 2: Description of the Scheme.

4.4.43 The timescales adopted for the assessments vary according to the environmental aspect being considered. For environmental aspects related to traffic (i.e. noise and air quality), the DMRB (Ref. 4.3) calls for an assessment based on predicted changes during construction, as the Scheme will be opened to use (the Opening Year) and 15 years subsequent to the Opening Year (the Design Year). The latter represents the period adopted for forecasting the volumes of traffic using the road and within parts of the wider road network as the basis for designing the Scheme. The specific timescale for each assessment is described in each technical Chapters 6-19.

4.4.44 This ES considers the timing of the effects as well as the duration over which likely significant effects may occur. It addresses effects arising from the construction, temporary and permanent land take and operation of the scheme as follows:

- Construction effects that may arise directly from construction activities (e.g. piling) and from the temporary use of land (e.g. construction sites), or from associated changes in traffic movements (e.g. diversions); and
- Operational effects that may arise from the new infrastructure and traffic flows.

4.4.45 Any decommissioning would be likely to be completed in less time than the construction of the Scheme and, whilst the Applicant has no plans to

decommission and remove the Scheme, were it to be removed, it would be likely to require a similar degree of plant, equipment and disturbance within the navigation channel to that predicted during construction. Given that the Applicant has no plans to decommission the Scheme, and as the environmental constraints in the mid-22nd Century cannot be reasonably predicted, further consideration of decommissioning is not considered appropriate.

4.4.46 As noted in Paragraph 4.4.36 for the purposes of the EIA, the base year for assessments is generally 2018, with an opening year of 2023. Considering the limited change expected in the baseline conditions in the time period between assessment and the submission of the DCO Application, 2018 is considered to be an appropriate base year. The temporal scope may vary for specific disciplines but will generally extend from commencement of construction works to 15 years after the opening of the Scheme.

Approach to the Assessment

4.4.47 The significance level attributed to each effect identified has been assessed based on the magnitude of change due to the Scheme and the sensitivity of the affected receptor or receiving environment to change, as well as a number of other factors that are outlined in more detail below. The determination of the significance of residual effects has been assessed with regard to the extent to which mitigation and enhancement measures will reduce or reverse negative effects or enhance positive effects.

4.4.48 The assessment of likely effects for each of the technical topics are presented in technical Chapters 6-19 and have taken into account a number of criteria to determine whether or not the likely effects are 'significant'. Wherever possible and appropriate, the effects have been assessed quantitatively. The following criteria has been taken into account when determining the significance of the potential effects:

- Relevant legislation and planning policy;
- International, national, regional and local standards;
- Likelihood of occurrence of the potential effect;
- Geographical extent of potential effect;
- Sensitivity and value of the receiving environment or receptor;
- Magnitude and complexity of effect;
- Whether the effect is temporary or permanent;

- Duration (short-, medium- or long-term), frequency and reversibility of effect;
- Inter-relationship between different effects (both cumulatively and in terms of potential effect interactions);
- The outcomes of consultations; and
- Sensitivity of receptors.

4.4.49 The sensitive receptors considered within the ES are identified within technical Chapters 6-19, the associated figures presented in Volume III (document reference 6.3), and also illustrated on the Natural Environment Constraints Plan (document reference 6.4A), and the Water bodies in a River Basin Management Plan (document reference 6.4B). The sensitivity of the receptors or receiving environments to change is also defined within technical Chapters 6-18 and has been determined by quantifiable data (where available), the consideration of existing designations, topic specific guidelines published by government departments or professional institutions, and professional judgement based on experience of similar schemes. Whenever professional judgement is applied, this has been qualified, giving an explanation as to how it has been applied.

Mitigation and Monitoring

4.4.50 The ES evaluates the measures required to avoid, minimise or offset the significant adverse effects of the Scheme. Where measures are integral to the design and the applicant has committed to their implementation, mitigation has been termed “embedded mitigation”.

4.4.51 Embedding mitigation during the design process, has been crucial in avoiding or reducing the number and extent of potential environmental effects. During this time, environmental constraints have been addressed and design options informed by iterative environmental assessment. A summary of the design iterations has been provided in the Design Report (document reference 7.4) and Chapter 3: Consideration of Alternatives.

4.4.52 Where the design of the Scheme has been unable to resolve potentially significant effects, control and management mitigation measures have been identified that would need to be implemented and embedded within the Scheme proposals, such as measures to control silt laden runoff during construction etc. These control and management mitigation measures describe actions that would be undertaken to meet other existing legislative requirements, or actions that are considered to be standard practices used to manage commonly occurring environmental effects. These measures are captured for the post-consent period in the event that the development is granted consent.

4.4.53 These mitigation measures would be implemented, and the environmental effects of construction and operation monitored, in accordance with the OCoCP (document reference 6.16) which incorporates a Framework Construction Traffic Management Plan (Framework CTMP) and a Framework Construction Worker Travel Plan (Framework CWTP) and the requirements of the DCO. The supporting control and management plans would form a live document to be passed to the contractor for development throughout the detailed design and construction phases of the Scheme. Compliance with the OCoCP (document reference 6.16) is secured through the DCO.

4.4.54 Additional mitigation describes actions, over and above embedded mitigation, that require further activity in order to achieve the anticipated outcome. For example, anything that has been added to the design purely to mitigate an effect such as the preparation of a travel plan, or landscape planting.

4.4.55 Any monitoring needed to confirm that the mitigation measures put in place for the Scheme are working as intended, or to confirm effects where there is uncertainty, or difficulties in assessing effects, is reported within the monitoring section of each of the technical chapters (Chapters 6-19).

4.4.56 Where likely significant effects are identified, each topic chapter explains (i) whether the applicant is proposing monitoring (on the basis of whether likely significant effects have been identified; or (ii) why monitoring would not be necessary or would be inappropriate given the nature of the likely significant effect.

4.4.57 A summary of the mitigation measures identified is presented in the Mitigation Schedule (document reference 6.13).

Residual Effects

4.4.58 Once additional mitigation measures are taken into account it is possible to identify residual environmental effects. These are the effects that would remain likely to occur if the Scheme were implemented and delivered, with all the mitigation measures identified.

Assessing Significance

4.4.59 The ES has the objective of identifying and assessing which potential effects of the Scheme on the environment are likely to be significant, both beneficial and adverse, and irrespective of duration. Direct effects are assessed, together with (where relevant) indirect, secondary, and, in Chapter 19, cumulative effects. Where possible, effects are assessed quantitatively, and mitigating measures and features are considered. The significance of effects is assessed using the following criteria, as appropriate to the effect concerned:

- International, national and local standards;
- Sensitivity of receiving environment;
- Reversibility and duration of effect;
- Inter-relationship between effects and cumulative effects; and
- The results of the consultations.

4.4.60 Where required, the significance of effects reflects the professional judgement of the technical specialist as to (i) the value or sensitivity of the affected receptor(s); and (ii) the nature and magnitude of the predicted changes based on their experience of similar schemes.

4.4.61 The methodology and criteria used for the EIA is generally based on the approach published in Volume 11, Section 2, Part 5 of the DMRB (Ref. 4.3), updated as necessary to take account of the 2017 EIA Regulations. Where individual topics depart from this approach, the alternative methodologies and terminology are provided in the relevant chapter.

4.4.62 Environmental value/sensitivity and impact magnitude detailed within HA 205/08 are reproduced in Table 4.4 and Table 4.5, respectively.

Table 4.4: Environmental Value (or Sensitivity) and Typical Descriptors

Value (Sensitivity)	Typical Description
Very High	Very high importance and rarity, international scale and very limited potential for substitution.
High	High importance and rarity, national scale, and limited potential for substitution.
Medium	High or medium importance and rarity, regional scale, limited potential for substitution.
Low (or lower)	Low or medium importance and rarity, local scale.
Negligible	Very low importance and rarity, local scale.

Table 4.5: Magnitude of Impact and Typical Descriptors

Magnitude of Impact	Typical Criteria Descriptors
Major	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse).
	Large scale or major improvement of resource quality;

Magnitude of Impact	Typical Criteria Descriptors
	extensive restoration or enhancement; major improvement of attribute quality (Beneficial).
Moderate	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse).
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).
Minor	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, key characteristics, features or elements (Adverse).
	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 (Beneficial).
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse).
	Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).
No Change	No change as a result of the Scheme.

4.4.63 The magnitude (scale) of change for each identified effect has been predicted as a deviation from the established baseline conditions, for the construction phase and the operation phase of the Scheme. The magnitude of change identified is based on the peak potential magnitude of change i.e. the greatest likely magnitude of change that may potentially be experienced by a sensitive receptor (existing or proposed) during any one phase.

4.4.64 Using the level of sensitivity (value) and the magnitude of an impact, the significance of an effect can be determined using the Significance Matrix presented in Table 4.6. It should be acknowledged that Table 4.6 presents a common methodology for the determination of significant effects. Table 4.7 includes description of the significance levels; again, these descriptions are based on a common methodology, in this case as published by the DMRB in HA 205/08 (Ref 4.3).

4.4.65 Using this approach, it is possible to determine that a major adverse impact on a feature or site of low sensitivity will be of lesser significance than the same magnitude of impact on a feature or site of high sensitivity. Unless otherwise stated in the individual assessment, effects deemed to be of moderate, large or very large significance are deemed to be significant

effects. Whilst effects deemed to be of neutral or slight significance are deemed not to be significant effects.

Table 4.6: Significance of Effect Matrix

		Magnitude of Impact				
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
Importance / Sensitivity / Value	**Very High**	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
	Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
	Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

Table 4.7: Descriptors of the Significance of Effect Categories

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

Significance Category	Typical Descriptors of Effect
	They are unlikely to be critical in the decision-making process but are important in enhancing the subsequent design of the Scheme.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Cumulative Effects

4.4.66 Schedule 4 (Paragraph 5(e)) of the EIA Regulations 2017 states that the ES should include a description of the likely significant effects of the development on the environment resulting as follows.

"…the cumulation of effect with other existing and / or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources."

4.4.67 All technical assessments have considered effect interactions and in-combination effects. The findings of the Cumulative Effects Assessment are presented in Chapter 19: Cumulative Effects. Effect interactions are the combined or synergistic effects caused by the combination of effects of the Scheme on a particular receptor which may collectively cause a more significant effect than individually. An example of an effect interaction would be where a receptor was affected by dust, noise and traffic disruption during the construction of the Scheme, with the result being a greater level of nuisance than each individual effect alone.

4.4.68 In-combination effects are the combined effects of the construction or operation of the Scheme together with 'other developments' within the same study area, which individually might not be significant, but when considered together could create a significant cumulative effect. PINS Advice Note Seventeen (Ref 4.7) provides guidance as to the type and scale of other developments that should be taken into account in the assessment of cumulative effects with 'other developments'.

4.4.69 There is no widely accepted methodology or best practice for assessing cumulative effects although various guidance documents exist. The approach adopted for the assessment of cumulative effects is based on that set out in PINS Advice Note 17 and takes into account previous experience, the types of receptors being assessed, the nature of the Scheme, the reasonably foreseeable or committed developments under consideration and the information available to inform the assessment. Further details regarding the scope and methodology of the assessment of cumulative effects, the identification of relevant committed developments and a description of those

included within the assessment are provided in Chapter 19: Cumulative Effects.

Limitations and Assumptions

4.4.70 Schedule 4 (Paragraph 6) of the EIA Regulations states that an ES should include

"… details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved".

4.4.71 Where there are limitations or assumptions used within the EIA these are clearly identified in this ES.

4.4.72 Assumptions specific to certain topics have been identified in the appropriate Technical Chapters 6-19.

Coordinated Assessment with HRA and WFD

4.4.73 Whilst the over-arching objectives of EIA, HRA and Water Framework Directive (WFD) are similar, their scope, level of detail and terminology vary. As such, these processes have been undertaken separately. However, the assessment presented within the ES has been developed to ensure that the needs of these processes have been considered together to ensure a coordinated assessment compliant with Regulation 26 (for example, the same baseline information being used for the Chapter 8: Nature Conservation and in the Habitats Regulations Assessment (HRA) (document reference 6.11).

4.5 References

Ref 4.1: The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

Ref 4.2: National Planning Practice Guidance.

Ref 4.3: Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland (various dates), Design Manual for Roads and Bridges.

Ref 4.4: London Healthy Urban Development Unit (2017), Rapid Health Impact Assessment Tool Third Edition [online].

Ref 4.5: Department for Communities and Local Government (2013), Planning Act 2008: Application Form Guidance.

Ref 4.6: PINS (2016), Advice Note Six: Preparation and submission of Application Documents.

Ref 4.7: PINS (2015), Advice Note Seventeen: Cumulative Effects Assessment.

5 Consultation

5.1 Introduction

5.1.1 Since 2009, the Applicant has been developing plans for the Scheme. The overall approach to consultation, encompassing Stages 1, 2 and 3, has allowed for public and stakeholder engagement in the design and evolution of the Scheme.

5.1.2 Under Section 50, Chapter 2, Part 5 of the Planning Act, the Applicant has a duty to undertake pre-application consultation on its proposed application for Development Consent for the Scheme. This consultation has been undertaken in accordance with Sections 42, 47 and 48 of the Planning Act, the Planning Inspectorate's (PINS) Advice Note 3 and DCLG Guidance (Ref 5.1).

5.1.3 This chapter summarises the consultation which has been undertaken to inform the Scheme, both statutory and non-statutory, and describes in more detail the consultation that has been relevant to the EIA process, as explained in Chapter 4: Approach to EIA.

5.1.4 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

5.2 Three-Stage Consultation Process

5.2.1 Consultation in relation to the Great Yarmouth and Gorleston Area Transportation Strategy commenced in 2009. This strategy identified a third crossing as a major scheme aimed at overcoming the problem of limited access to the peninsula of Great Yarmouth and the congestion that this causes.

5.2.2 The most recent statutory consultations have followed a three-stage process, as described in the Applicant's Statement of Community Consultation Appendix E-3 presented in of the Consultation Report (document reference 5.1) and illustrated in Plate 5.1, below. Furthermore, following design refinement further localised consultations were undertaken with those parties with an interest in land on, or nearby, to the land plots where each design refinement occurred.

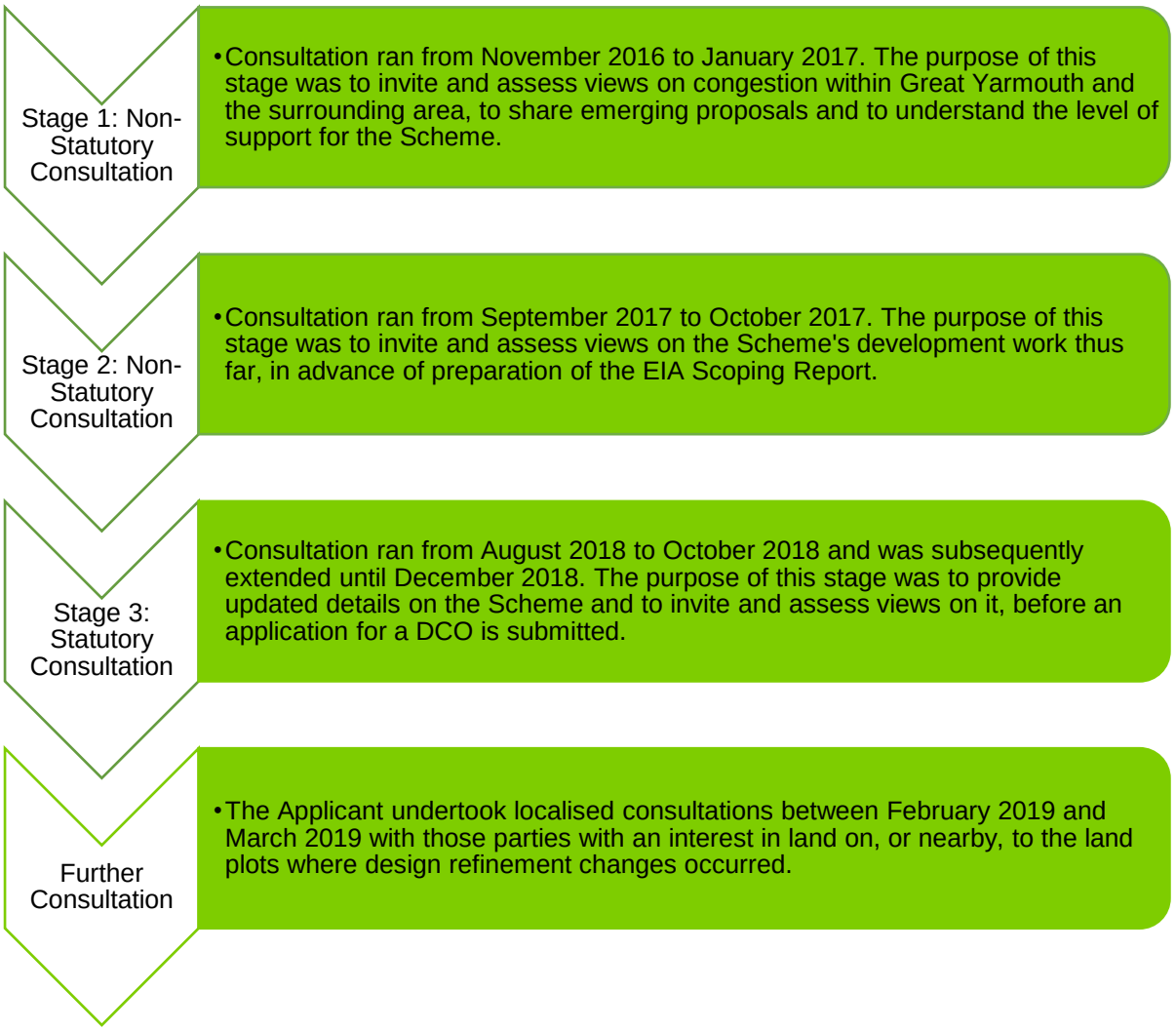


Plate 5.1: Three-stage Consultation Process

5.2.3 Each stage of the consultation process has informed the development of the Scheme. The following sections provide a summary of these consultation stages; please refer to the Consultation Report (Document Refence 5.1) for further information on these stages of consultation, consultation feedback provided and how the Applicant has had regard to the responses received.

Stage 1 and Stage 2 Non-Statutory Consultation

5.2.4 Stages 1 and 2 were non-statutory stages of consultation, in that they were voluntary and additional to the prescribed consultation set out in the Planning Act. Stages 1 and 2 allowed the Applicant to consider the comments from local people and other parties, allowing for development of the proposals.

Stage 1

5.2.5 Between November 2016 and January 2017, the Applicant undertook Stage 1 consultation. The purpose of the Stage 1 consultation was to invite and assess views on congestion within Great Yarmouth and the surrounding area, to share emerging proposals and to understand the level of support for the Scheme. The full list of materials consulted on during Stage 1 is set out in Chapter 5 of the Consultation Report (document reference 5.1).

5.2.6 A consultation leaflet and exhibition boards were prepared to support community engagement. Consultation activity incorporated exhibition displays, meetings, emailed updates, presentations, business breakfasts and special events. Online and paper versions of a questionnaire were made available to record feedback.

5.2.7 During Stage 1, nearly 500 individuals responded, including local residents and business representatives. The feedback received was used to inform the initial Options Assessment Report (OAR) (Appendix 3A), which formed part of the Outline Business Case (OBC).

Stage 2

5.2.8 Between September 2017 and October 2017, the Applicant undertook Stage 2 consultation. The purpose of this stage was to invite and assess views on the Scheme development work undertaken to that point. As part of this process, the Applicant undertook non-statutory consultation in advance of preparation of the EIA Scoping Report. The full list of materials used at Stage 2 is set out in Section 6 of the Consultation Report (document reference 5.1). As well as engaging the community at a series of staffed exhibitions around Great Yarmouth, Stage 2 consultation responses were received from Historic England, Natural England, the Broads Authority and the Environment Agency (EA) in October and November 2017, ahead of undertaking EIA Scoping.

Stage 3 Statutory Consultation

5.2.9 Stage 3 formed the statutory stage of consultation, i.e. consultation completed in accordance with the requirements of Sections 42, 47 and 48 of the Planning Act, and ran between August 2018 and October 2018. The purpose of Stage 3 consultation was to provide updated details on the Scheme (referred to at this stage of the process as the Consultation Scheme) and to invite and assess views on it, before submission of the application for development consent.

5.2.10 Stage 3 consultation included information on the Consultation Scheme and on the options considered throughout the evolution of the Consultation Scheme. This was intended to allow people to provide an opinion on the

overall proposals, comment on any aspect of the design and consider how the proposals may affect them.

5.2.11 Stage 3 consultation was completed in accordance with the Statement of Community Consultation that was consulted on and agreed with the relevant local authorities. In addition to these measures, extra exhibitions were held at the Maritime Festival (see Section 6 of document reference 5.1) and the consultation period was extended to account for resubmission of missing Preliminary Environmental Information Report (PEIR) figures (see Section 7 of document reference 5.1). Stage 3 consultation was also carried out in accordance with Schedule 1 of The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009) (as amended).

5.2.12 More detail on Stage 3 consultation is provided in Chapter 6 of the Consultation Report (document reference 5.1), while a discussion of how the feedback received has been taken into account can be found in Chapter 12: Conclusion of the same document each of the technical chapters of this document (Chapters 6-19).

5.2.13 As part of statutory consultation there is a requirement under Regulation 12 (1) of the EIA Regulations to prepare preliminary environmental information. This was produced in the form of a PEIR for the statutory Stage 3 consultation. The provision of the PEIR was to ensure that those responding to the consultation could have regard to the likely environmental issues and effects from the Consultation Scheme. Feedback received on the PEIR has been used to inform the design of the Scheme, as described in Chapter 3: Scheme and the EIA. Further information on the PEIR is provided in Section 5.3 of this chapter.

Further Consultation

5.2.14 Further design refinement was undertaken following the statutory consultation process, notably in relation to:

- Minor amendments to the Order Limits; and
- Changes to the Scheme to minimise the impact of the Prosed scheme on the MIND Centre and Grounds.

5.2.15 The Applicant undertook localised consultations between February 2019 and March 2019 with those parties with an interest in land on, or nearby, to the land plots where each change occurred.

5.2.16 Further details can be found in Chapter 11 of the Consultation Report (document reference 5.2).

Consultation as Part of the EIA Process

5.2.17 Feedback received from the consultations detailed above has been used to inform the EIA. Several other statutory and non-statutory consultations have been undertaken as part of the EIA for the Scheme. These can be grouped under the following headings:

- EIA Scoping;
- PEIR; and
- Stakeholder meetings.

5.2.18 Sections 2, 3 and 4 of this chapter described how these processes have been used to inform the EIA. Specific details raised during these processes are discussed within sub-section 3 of each of the technical chapters (Chapters 6-19).

5.3 EIA Scoping

5.3.1 The process of scoping helps to ensure that the topics covered, the baseline information used, and the methods of assessment are appropriate, and have taken into account the views of consultees and decision-makers.

5.3.2 There are two main stages in the scoping process. Firstly, the applicant compiles information to inform a view as to the scope of issues that should be covered in the main ES; this usually takes the form of a Scoping Report and is based on initial consultation, data searches and baseline surveys, as appropriate. The second stage in the scoping process is for the Secretary of State (SoS) to issue a Scoping Opinion having consulted a range of statutory bodies and taken into account the information provided by the Applicant in the Scoping Report. The Scoping Opinion outlines what should be covered in the ES.

5.3.3 The Scoping Report (document reference 6.6) was submitted to the Planning Inspectorate on 5th April 2018, under Regulations 6(1),6(2)(a) and 8(1)(b) of the EIA Regulations.

5.3.4 The SoS has a duty under Regulations 10(6) of the EIA Regulations to consult widely before adopting a Scoping Opinion. A full list of the consultation bodies is provided in Appendix 2 of the Scoping Opinion. The list was compiled by the SoS under their duty to notify the Applicant of consultees whom they consider likely to be affected by or have an interest in the development, in accordance with Regulation 11(1)(c). The SoS has considered the responses received in forming the Scoping Opinion.

5.3.5 In response to the Scoping Report, the Scoping Opinion was received by the Applicant on 16th May 2018, which provided comments from the SoS on the

proposed scope of the EIA, and included copies of responses from the consultation, as prescribed by Schedule 1 of the APFP Regulations. In forming the Scoping Opinion, the SoS took account of the requirements of the EIA Regulations, as well as current best practice towards preparation of an ES, and responses received from statutory consultees.

5.3.6 The Scoping Opinion included specific comments on the approach to the ES and topic areas set out in the Scoping Report. Responses from Historic England and Great Yarmouth Borough Council were received after the statutory deadline and were, therefore, not included in the Scoping Opinion. Nevertheless, the scoping responses have also been published on the Planning Inspectorate's website alongside the Scoping Opinion. Section 3 of each of the technical chapters (Chapters 6-19) of this ES detail how these specific comments by PINS and consultees have been considered in the preparation of the individual Chapters.

5.4 Preliminary Environmental Information Report (PEIR)

5.4.1 As part of the EIA Regulations, there is a requirement to prepare preliminary environmental information. This was done in the form of a PEIR. The PEIR provides a snapshot of the environmental information available at the time of writing (in this case at Stage 3 statutory consultation). The type of information required is the same as that required under Schedule 4 of the EIA Regulations and described in Regulations 5 (the environmental impact assessment process) and 14 (environmental statements), albeit that the information is 'preliminary'. The purpose of providing this information is to ensure that those responding to the consultation can develop an informed view of the likely significant effects arising from the Scheme being consulted on.

5.4.2 Notice of the availability of preliminary environmental information was given to consultation bodies to meet Regulation 13 of the EIA Regulations. The Regulation 13 Letter can be found in Appendix L-1 along with the Consultee List as Appendix M-3 of the Consultation Report (document reference 5.1). Notice required under Section 48 of the Act was also given. Section 48 Notices are provided in Appendix J-1 of the Consultation Report (document reference 5.1). The list and letters sent under Section 42 can be viewed in Appendices M-1 through to P-3 of the Consultation Report (document reference 5.1). The information was published to help the stakeholders to understand the likely significant environmental effects of the Scheme. The PEIR consisted of:

- Non-Technical Summary;
- PEIR Written Statement (the main report);
- PEIR Figures; and

- PEIR Appendices.

5.4.3 The PEIR Written Statement comprised environmental information, with a separate chapter for each discipline. Each chapter illustrated the environmental baseline and the potential environmental effects that could be experienced by receptors. The following technical chapters were included:

- Chapter 6: Air Quality;
- Chapter 7: Noise and Vibration;
- Chapter 8: Nature Conservation;
- Chapter 9: Cultural Heritage;
- Chapter 10: Townscape and Visual;
- Chapter 11: Road Drainage and the Water Environment;
- Chapter 12: Flood Risk;
- Chapter 13: Climate Change;
- Chapter 14: People and Communities;
- Chapter 15: Materials;
- Chapter 16: Geology and Soils;
- Chapter 17: Traffic and Transport;
- Chapter 18: Major Accidents and Disasters; and
- Chapter 19: Cumulative Effects.

5.4.4 A full list of the prescribed bodies under section 42 of the Planning Act and the APFP Regulations, and those who responded to the Stage 3 statutory consultation is given in Section 8.3 of the Consultation Report (document reference 5.1). The responses to the PEIR from Section 42 consultees, and how these have been taken into account in the development of the ES are shown in the individual technical chapters of this ES (Chapter 6-19) and a summary is given in Chapter 9 of the Consultation Report (document reference 5.1).

5.5 Stakeholder Engagement

5.5.1 Meetings and discussions with stakeholders have been undertaken to inform the technical assessments presented within this ES. Details of stakeholder engagement undertaken are presented in the relevant technical chapter, with the parties engaged with summarised within Table 5.1, overleaf.

Table 5.1: Stakeholder Consultation Detailed within Technical Chapters

ES Chapter	Stakeholder
Chapter 1: Introduction	PINS
Chapter 2: Consideration of Alternatives	
Chapter 3: Description of the Scheme	
Chapter 4: Approach to the EIA	
Chapter 5: Consultation	
Chapter 6: Air Quality	Great Yarmouth Borough Council Environmental Health Officer PINS
Chapter 7: Noise and Vibration	Great Yarmouth Borough Council Environmental Health Officer PINS
Chapter 8: Nature Conservation	Natural England PINS
Chapter 9: Cultural Heritage	Historic England Norfolk County Council Historic Environment Team PINS
Chapter 10: Townscape and Visual	PINS
Chapter 11: Road Drainage and the Water Environment	Broads and Norfolk Rivers Internal Drainage Board Environment Agency Marine Management Organisation Norfolk County Council Lead Local Flood Authority Pevensey and Cuckmere Water Level Management Board PINS
Chapter 12: Flood Risk	Environment Agency PINS
Chapter 13: Climate Change	PINS
Chapter 14: People and Communities	PINS
Chapter 15: Materials	PINS
Chapter 16: Geology and Soils	Environment Agency

ES Chapter	Stakeholder
	PINS
Chapter 17: Traffic and Transport	Highways England PINS
Chapter 18: Major Accidents and Disasters	PINS
Chapter 19: Cumulative Effects	Great Yarmouth Borough Council Norfolk County Council PINS

5.6 References

Ref 5.1: Department for Communities and Local Government (2016), The DCLG Appraisal Guide.

6 Air Quality

6.1 Introduction

6.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Scheme upon local air quality at receptor locations considered sensitive to changes in air quality, and the impact of the Scheme on regional air quality and national air quality objectives (both exceedances and the ability of zones to comply with them). The effects of both the operation and the construction (e.g. the potential effects of construction dust upon neighbouring properties) of the Scheme are considered.

6.1.2 The level of air pollution adjacent to roads and within urbanised areas is typically a function of vehicle emissions. Emissions of nitrogen oxides (NO_x, including nitrogen dioxide, NO_2), and particulate matter (PM_{10} and $PM_{2.5}$), from vehicles are of greatest concern with respect to human health. Concentrations of these pollutants are subject to air quality standards, established by UK legislation for the protection of human health and ecological resources.

6.1.3 The Air Quality Standards Regulations sets out national air quality objectives and limit values for pollutants as explained in Table 6.2. The assessment presented in this chapter considers the predicted changes to Local and Regional air quality with the Scheme in the context of compliance with the Air Quality Standards Regulations.

6.1.4 There is the potential for impacts to regional emissions, including those of NO_x, PM_{10} and carbon dioxide (CO_2), as a result of changes to vehicle flow characteristics across the roads affected by the Scheme.

6.1.5 The air quality assessment considers likely significant effects associated with the following activities:

- Emissions associated with the construction phase of the Scheme with a focus on construction dust emissions; and
- Emissions associated with the operational phase of the Scheme with a focus on vehicle emissions.

6.1.6 The chapter describes the assessment methodology, the baseline conditions at the Application Site and in the surrounding area, and any embedded and additional mitigation adopted for the purposes of the assessment. It includes a summary of the likely significant effects taking into account national legislation, and describes the further mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

6.1.7 This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES with particular reference to Chapter 8: Nature Conservation and Chapter 17: Traffic and Transport. This chapter is supported by Figures 6.1 to 6.20 and Appendices 6A to 6G.

6.1.8 The Ecological Assessment and the Local Air Quality Assessment results feed into the assessments of effects upon human health which are considered throughout this ES, as signposted in Chapter 4: Approach to EIA.

6.2 Competent Expert

6.2.1 The environment (air quality) lead, Claire Lucas is a Principal Air Quality Consultant who holds membership of the Institute of Air Quality Management, membership of the Institution of Environmental Sciences, a PhD in the Atmospheric Sciences (2012) and an MSci degree in Environmental Geoscience (2006) from the University of London. The air quality lead has significant experience regarding environmental air quality assessment, air quality dispersal modelling, air quality monitoring and the Development Consent Orders process.

6.3 Legislation, Policy and Guidance Summary

6.3.1 Table 6.1 provides a summary of the key legislation, policy and guidance for this assessment.

6.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 6A (document reference 6.2).

Table 6.1: Summary of Key Legislation, Policy and Guidance

Legislation/ Policy/ Guidance	Summary	Chapter Reference
European Ambient Air Quality Directive (2008/50/EC)	The Directive is the primary driver for managing and improving air quality for each member state of the EU. The Directive sets legally binding limit values for concentrations in ambient (outdoor) air of pollutants that can impact public health, including NO_2 and particulates (PM_{10} & $PM_{2.5}$). EU limit values are set for individual pollutants and comprise a concentration value, an averaging time over which it is to be measured, the number of allowed exceedances per year (if any), and a date by which it must be achieved. Some pollutants (e.g. PM_{10}) have more than one limit value covering different averaging	The assessment conforms with the Directive by assessing whether sensitive receptors are predicted to experience pollutant concentrations beyond or within the EU limit values for NO_2, PM_{10}, $PM_{2.5}$ and where

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	times.	applicable NO_x. See Section 6.7 and 6.10.
Air Quality Standards Regulations 2010, as amended in 2016	The European Ambient Air Quality Directive was transposed into English law via the Air Quality Standards Regulations 2010, as amended in 2016.	The assessment conforms with the Regulations by assessing whether sensitive receptors are predicted to experience pollutant concentrations beyond or within the objective values for NO_2, PM_{10}, $PM_{2.5}$ and where applicable NO_x as prescribed in the regulations. See Section 6.7 and 6.10.
National Policy Statement for National Networks (2014)	Paragraph 3.8 of the NPS NN states that *"the impact of road development on aggregate levels of emissions is likely to be very small. Impacts of road development need to be seen against significant projected reductions in carbon emissions and improvements in air quality as a result of current and future policies to meet the Government's legally binding carbon budgets and the European Union's air quality limit values"*. Specifically, regarding air quality, Paragraph 3.8 of the NPS NN also states that *"aggregate air quality impacts from delivering a programme of investment on the Strategic Road Network of the scale envisaged in Investing in Britain's Future are small. Total PM_{10} and NO_x might be expected to increase slightly, but this needs to be seen in the context of projected reductions in emissions over*	The assessment fulfils the policy by considering the impact of the Scheme upon emissions and modelling the dispersal of the emissions and the resulting concentrations at sensitive receptor locations with and without the Scheme. The Opening Year considered in the assessment

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	time. PM_{10} and NO_x are expected to decrease over the next decade or so as a result of tighter vehicle emission standards, then flatten, with further falls over time due to greater levels of electric and other ultra-low emission vehicles". The NPS NN in Paragraph 5.6 states the requirement for ES where *"the impacts of the project (both on and off-scheme) are likely to have significant air quality effects in relation to meeting EIA requirements and / or affect the UKs ability to comply with the Air Quality Directive, the applicant should undertake an assessment of the impacts of the proposed project as part of the environmental statement."* Paragraph 5.7 states that *"The ES should describe:* • *Existing air quality levels*; • *Forecasts of air quality at the time of opening, assuming that the scheme is not built (the future baseline) and taking account of the impact of the scheme; and* • *Any significant air quality effects, their mitigation and any residual effects, distinguishing between the construction and operation stages and taking account of the impact of road traffic generated by the project."* NPS NN Paragraph 5.8 explains that "*The applicant's assessment should be consistent with Defra's published future national projections of air quality based upon evidence of future emissions, traffic and vehicle fleet."* NPS NN Paragraph 5.9 states that *"In addition to information on the likely significant effects of a project in relation to*	represents the worst year in terms of emissions and Local Air Quality. This is because emissions from the national fleet are predicted to improve in time. See Sections 6.7 and 6.10. A judgement of the risk to the UKs compliance with the EU Ambient Air Quality Directive is given in Appendix 6D and Section 6.10.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	EIA, the Secretary of State must be provided with a judgement on the risk as to whether the project would affect the UK's ability to comply with the EU Ambient Air Quality Directive."	
The Air Quality Strategy for England Scotland and Wales	The strategy sets out air quality objectives and policy options to improve air quality in the UK.	See Section 6.3 and 6.10 (document reference 6.1).
United Nations Economic Commission for Europe (UN/ECE) Critical Loads	The United Nations Economic Commission for Europe (UN/ECE) Critical Loads provides critical load values for nutrient nitrogen deposition when undertaking assessment of the effects of changes in air quality upon designated ecological sites.	The assessment predicts the likely impact of the Scheme upon designated ecological sites considered sensitive to changes in air quality during the operational phase and the potential impact of construction dust during the construction phase. See Section 6.4, Section 6.6, Section 6.8 and Appendix 6G (document reference 6.2).

6.3.3 The legislation, policy and guidance that applies to the assessment of the impacts of the scheme upon local and regional air quality; the assessment of impacts upon designated ecological sites considered sensitive to changes in air pollution; and the risk to compliance with the European Ambient Air Quality Directive are defined in Appendix 6A. Policy relating to the air quality objectives considered within this assessment is given in further detail below.

The Air Quality Strategy for England, Scotland and Wales

6.3.4 Local authorities in England are required to review air quality within their jurisdiction, under Part IV of the Environment Act 1995, and designate air

quality management areas (AQMAs) where air quality standards are not being met and/or where air quality improvement is needed. Local authorities are then required to work towards achieving the national Air Quality Strategy objectives and standards as prescribed in the Air Quality Standards Regulations 2016.

6.3.5 Under the Environment Act 1995, the UK Government and the devolved administrations are required to prepare and publish a national Air Quality Strategy. The most recent version of the Strategy was published in 2007 and establishes the UK's air quality standards and objectives, in addition to providing guidance, where needed, on air quality action planning at national, regional and local scales. Air quality standards are concentrations recorded over a given averaging period, which are considered to be acceptable in terms of what is scientifically known about the effects of each pollutants on health and the environment. An objective is the target date on which exceedances of a standard must not exceed a prescribed number.

6.3.6 The national air quality objectives and European Directive limit values that the UK must comply with, specifically for traffic-related pollutants NO_2, PM_{10}, and $PM_{2.5}$, are presented in Table 6.2. The respective UK objectives, and EU limit value concentration standards and averaging periods, are numerically identical for each pollutant, based on air quality standards set for the protection of human health. For NO_x, the objective and limit value is set for the protection of ecosystems and vegetation.

Table 6.2: National (England) Air Quality Objectives and European Directive Limit Values

Pollutant	Objective/ Limit Value Concentration	Concentrations Measured As	Date to be Achieved by:	
			UK Air Quality Strategy Objective	EU Ambient Air Quality Directive
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005	01.01.2010
	40 µg/m^3	Annual mean	31.12.2005	01.01.2010
Particulate Matter (PM_{10})	40 µg/m^3	Annual mean	31.12.2004	01.01.2005
	50 µg/m^3 not to be exceeded more than 18 times a year	24-hour mean	31.12.2004	01.01.2005
Particulate Matter ($PM_{2.5}$)	25µg/m^3	Annual mean	2020	2010
Nitrogen oxides (NO_x)*	30µg/m^3	Annual mean	31.12.2000	19.07.2001

Pollutant	Objective/ Limit Value Concentration	Concentrations Measured As	Date to be Achieved by:	
			UK Air Quality Strategy Objective	EU Ambient Air Quality Directive
*For the protection of ecosystems and vegetation.				

United Nations Economic Commission for Europe Critical Loads

6.3.7 The United Nations Economic Commission for Europe (UNECE) defines the critical load for nitrogen deposition on page 14 of the UNECE report on Empirical Critical Loads for Nitrogen as *"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on sensitive elements of the environment do not occur according to present knowledge".* (Ref 6.1).

6.3.8 The UNECE provides critical load values for nutrient nitrogen deposition as a range based upon the habitat type, the critical load is used as a component of the assessment to identify the ecological impacts of the Scheme.

6.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

6.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

6.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

6.4.3 Table 6.3 and 6.4 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 6.3: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Addressed in the ES
The Scoping Report states that background concentrations of pollutants (NO_2, NO_X, PM_{10} and $PM_{2.5}$) were obtained for the 1x1km grid squares	PINS Reference 4.1, Air Quality ID 2	Background pollutant concentrations are provided in Figure 6.1.

Scoping Opinion Item	Consultee	Addressed in the ES
relative to the Scheme and surrounding area. These should be shown on a figure or plan within the ES or associated Technical Appendix to the ES.		
The Study Area for air quality is not explicitly set out in the Scoping Report. Paragraph 6.2.10 of the Scoping Report states that an initial desk-based review of potentially sensitive receptors to changes in the air quality was undertaken, yet Figure 3 (Environmental Constraints Plan) shows a 2km Study Area for air quality and noise. Table 8 identifies sensitive receptors within 200m of the likely affected road network. Paragraph 6.2.8 states that background pollutant information was obtained for 1x1km grid squares. The ES should clearly set out the Study Area for air quality and use plans or figures to show the Study Area.	PINS Reference 4.1, Air Quality ID 3	The Study Area for the Local Air Quality assessment is presented in Figure 6.2 and also explained in Paragraph 6.4.12. The sensitive receptor locations as defined in Section 6.6 are shown in Figure 6.2. The Study Area for the Construction Dust assessment is presented in Figure 6.3. The Satellite Applications Sites have been considered within the construction dust assessment Study Area. The installation works for the VMS are short in duration and not considered at high risk of creating a substantial impact upon air quality and relevant control measures given in Paragraph 6.8.6 provide mitigation against impacts from this activity. The Regional Air Quality Assessment Study Area is presented in Figure 6.4 and the Compliance Assessment Study Area is presented in Figure 6.20
The Applicant should note that the River Yare Special Protection Area (SPA) has been formally designated	PINS Reference 4.1, Air Quality ID 4	The River Yare area within the Outer Thames Estuary SPA is designated for the Red

Scoping Opinion Item	Consultee	Addressed in the ES
as the Outer Thames Estuary SPA. Table 8 of the Scoping Report states that there are no designated sites within 200m of the proposed scheme alignment; however, the Inspectorate notes that the bridge will be located over/in the Outer Thames Estuary SPA. It is important that inter-related effects across aspects are addressed in the ES. Accordingly, the assessment of air quality should take into account relevant information contained in aspect chapters elsewhere in the ES, including Nature Conservation.		Throated Diver and the Common Tern, the relevant habitat given on UK Air Pollution Information System (APIS) is inshore sublittoral sediment. APIS states that this habitat is not sensitive to NO_x or nutrient Nitrogen deposition and therefore this was not assessed.
It is not clear whether a construction compound(s) will be required and if so where it would be located. The ES should assess whether the location of any compound(s) may impact on any receptors sensitive to air quality.	PINS Reference 4.1, Air Quality ID 5	The Application Site upon which the assessment of potential construction phase impacts has been made includes the construction compounds. The Study Area for the construction phase assessment is given in Figure 6.3.
The Scoping Report states that mitigation measures will be secured through the CEMP. The mitigation measures and CEMP should be detailed in the ES and be suitably secured.	PINS Reference 4.1, Air Quality ID 6	The mitigation measures are described in Paragraph 6.8.6. The recommended measures are to be applied through the Outline CoCP (document reference 6.16), compliance with which is secured through the DCO (document reference 3.1).
The Scoping Report states	PINS Reference 4.1, Air	The ES and associated

Scoping Opinion Item	Consultee	Addressed in the ES
that a detailed local air quality assessment for the operational scheme will be undertaken. The scope, methodology and results of this should be fully reported in the ES and should be accompanied by relevant plans and figures.	Quality ID 7	figures define the scope, methodology and assessment results for the local air quality assessment. The detailed local air quality assessment methodology is defined in Section 6.4 and the assessment results for the detailed local air quality assessment are given in Section 6.7. Figure's 6.5 to 6.16 give the results of the Local Air Quality Assessment.
Forty sites have been identified where diffusion tube monitoring will be undertaken for a six-month period. The Scoping Report states that the location of the tubes has been agreed with Great Yarmouth Borough Council (GYBC). The ES should contain a plan which shows the locations of the diffusion tube monitoring.	PINS Reference 4.1, Air Quality ID 8	The air quality monitoring results are given in Section 6.5 and Table 6.13. The dataset used in the assessment consists of five months monitoring data which meets the requirements of Defra Local Air Quality Technical Guidance (LAQM TG(16)), as the data is sufficiently cross seasonal. The monitoring data presented consists of annualised concentrations from five months sampling and Local Authority diffusion tube monitoring data has been included in the model verification procedure. Figure 6.17 shows the monitoring locations which were used in the model verification procedure.
The Scoping Report states that in the absence of specific $PM_{2.5}$ monitoring,	PINS Reference 4.1, Air Quality ID 9	It was not possible to incorporate PM_{10} data in the verification procedure

Scoping Opinion Item	Consultee	Addressed in the ES
the PM_{10} verification factor will be applied for this fraction of fine particulate matter. Efforts should be made to agree the approach, including any verification factor, with relevant consultation bodies, including the EHO(s) at GYBC. The approach should also be fully explained and justified within the ES.		as the Local Authority continuous monitoring site in Great Yarmouth was shut down in 2017 and a new monitor at a different location was opened within the verification year, meaning there was not suitable data capture at either site to incorporate the data for model verification. The procedure for model verification follows LAQM TG(16) guidance which states that the NO_2 verification procedure can be applied to PM_{10} and $PM_{2.5}$, see Paragraph 6.4.49. The approach to the Air Quality modelling was confirmed with the appropriate Environmental Health Officer (EHO) at GYBC. The approach to modelling and the verification procedure are fully documented within this chapter and the associated technical appendices and have been conducted in accordance with the relevant guidance.

Table 6.4: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Addressed in the ES
As well as residential properties, the PEIR identifies three educational premises and one medical premises within 100m of the works. If development consent is granted, we recommend	Public Health England	The sensitive receptors in relation to the construction phase are given in Paragraph 6.7.7. Recommended mitigation measures for inclusion in the Outline CoCP (document reference

Section 42 Item	Consultee	Addressed in the ES
that the promoter further develops and refines proposals to mitigate construction impacts (particularly those associated with dust and noise) in partnership with potentially affected receptors, particularly those downwind of the prevailing wind.		6.16) are given in Paragraph 6.8.6. The developer will follow measures to be prescribed through the Outline CoCP (document reference 6.16) in order to mitigate against potential impacts from construction dust upon premises surrounding the works.
The current submission does not include a specific section summarising the potential public health impacts. We understand that the promoter will wish to avoid unnecessary duplication and that many issues including air quality, emissions to water, waste, contaminated land etc. will be covered elsewhere in the ES, but we believe that the summation of relevant issues into a specific section of the report provides a focus which ensures that public health is given adequate consideration and due weight in the planning process. Such a section should summarise key information, risk assessments, outline any proposed mitigation, and identify any residual impacts or uncertainties. Compliance with the requirements of National Policy Statements and relevant guidance and standards should also be highlighted.	Public Health England	The local air quality assessment considers changes in air quality in relation to the Air Quality Standards which are set for the protection of human health as set out in Table 6.2. The health impacts as a result of the scheme are discussed in Section 6.4 and Section 6.10, with the sensitivity of the area to construction related human impacts defined in accordance with Table 1.4 in Appendix 6B.

Section 42 Item	Consultee	Addressed in the ES
The PEIR indicates that air quality impacts of the large vessel waiting facility will be considered in an updated construction assessment. Vessels at berth alongside the bridge will release products of combustion in an urban area. Their emissions and associated short and long-term impacts, along with road traffic emissions (including those associated with idling road traffic during vessel movements), should be included in the operational-phase local air quality assessment. The promoter may wish to consider associated mitigation measures to prevent or reduce short-term air quality impacts associated with emissions from idling road or river traffic waiting to pass the bridge.	Public Health England	Vessels which require an opening of the bridge to pass will have arranged their passage and thus should not be idling. In order to prevent emissions from idling river traffic Requirement 14 of the draft DCO requires signs instructing masters of vessels utilising the vessel waiting facilities to switch off vessel engines whilst vessels are moored. The Defra background air quality maps include shipping emissions and the background mapping has been incorporated into the operational phase local air quality model results.
The PEIR focuses on compliance with air quality standards. There are benefits to public health in improving air quality beyond standards and limits. We recommend that the promoter considers the potential benefits to air quality and health associated with road and traffic management design and mitigation options and seeks to maximise benefits. This could include evaluation of potential population-level	Public Health England	The development of the scheme design is given in the Design Report (document reference 7.4). The local air quality operational assessment sets out the change in air quality at sensitive receptors in the Scheme Opening Year as defined in DMRB guidance giving a prediction of where improvement and worsening of local air quality will be likely to occur across the Study Area. The Study Area incorporates over 10,000

Section 42 Item	Consultee	Addressed in the ES
exposure reduction in the local urban area, as well as impacts and benefits associated with changes in emissions on a regional basis. We support the promoter's intent to provide provision for pedestrians and cyclists and encourage and increase the use of the most active modes of transport (walking and cycling).		receptors within the urban area of Great Yarmouth. See Section 6.6. A key benefit of the scheme is the predicted reduction in pollutant concentrations at properties along Hall Quay to the east of the Haven Bridge where the baseline air quality dispersal modelling gave the highest pollutant concentrations within the Study Area. The Regional Air Quality Assessment shows the benefit of the Scheme upon emissions in a regional context see Section 6.4 and Table 6.20.
The recommended distance criteria for air quality assessment including dust during construction and diffuse air pollution caused by increased traffic during operation is 200m. On this basis we advise that the Outer Thames Estuary SPA is scoped into the air quality assessment and any significant impacts considered. Dust generated from construction should be measured against baseline levels to ascertain if there will be a significant increase.	Natural England	The construction phase dust assessment presented in Section 6.7 and Figure 6.3 has considered properties up to a distance of 500m for potential trackout and for wind-blown dust. The Outer Thames Estuary SPA is considered sensitive to dust and is situated within 20m of the construction area meaning the SPA is at highest risk from construction dust impacts. The mitigation measures recommended in Paragraph 6.8.6 to be applied through the Outline CoCP (document reference 6.16) include the recommendation of appropriate onsite air quality monitoring during the construction phase.

Section 42 Item	Consultee	Addressed in the ES
		The application of suitable mitigation measures will minimise the risk of construction dust impacts upon the SPA. The operational detailed local air quality assessment considers the dispersal of air pollution caused by the distribution of traffic within 200m of affected roads following the methodology of the DMRB guidance as defined in Section 6.4.

6.4.4 Table 6.5 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

6.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 6.5: Summary of Consultation Undertaken to Date

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
GYBC	Environmental Health Officer (EHO)	18/07/2017 Air quality monitoring location consultation via email	Locations for NO_2 scheme-specific diffusion tube air quality monitoring agreed with EHO.
GYBC	EHO	22/06/2018 Pre-application telephone call	Agreed approach to the local air quality assessment regarding receptor and dispersion model coverage. Discussed Local Authority air quality monitoring data for model verification purposes.
GYBC	EHO	12/12/2019	Agreed the model verification

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
		Email	approach and noted that localised wind speed and direction data for 2018 would shortly be available. This data is not quality controlled or representative of stable wind direction thus was unsuitable for modelling but was used to inform the construction dust assessment.
GYBC	EHO	15/02/2019 Email	Agreed to continue with the 2017 Weybourne meteorological data for dispersal modelling due the lack of quality control procedure for the local wind data measurements and the likelihood that sensor was below the 10m height recommended to avoid ground turbulence effects.

Insignificant Effects

6.4.6 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would be insignificant and have therefore not been considered further in the assessment:

- The large vessel waiting facility has been removed from the design and large vessels will have an allotted time for a bridge opening therefore will not be idling in the river channel so emissions related to idling large vessels will not arise. It is noted that the Defra background air quality

maps include shipping emissions and the background mapping has been incorporated into the operational phase local air quality model results.

- Leisure craft and small vessels will be directed by signage to turn off their engines when awaiting a bridge opening therefore emissions related to idling small vessels will not arise.

- The River Yare component of the Outer Thames Estuary Marine SPA has a habitat of sublittoral sediment which is not considered sensitive to changes in ambient NO_x and Nitrogen deposition, therefore this has not been considered further in line with DMRB (HA207/07) guidance (Ref 6.2), Annex F. The River Yare component of the SPA has been considered as a sensitive receptor for construction dust impacts.

Likely Significant Effects

Construction Phase

6.4.7 The following likely significant effects that have been assessed in this chapter include:

- The potential impacts of construction dust upon sensitive human and ecological receptors within 500m of the Application Site and within 50m of potential Heavy-Duty Vehicle (HDV), routes to the Principal Application Site.

Operational Phase

6.4.8 The following likely significant effects that have been assessed in this chapter include:

- The potential impacts of the operation of the Scheme upon local air quality at sensitive receptor locations in the Scheme Opening Year 2023.

- The potential impacts of the operation of the scheme upon ambient NO_x concentrations and Nitrogen deposition rates upon the Breydon Water Site of Special Scientific Interest (SSSI) Unit 10, SPA, Ramsar site in the Scheme Opening Year 2023.

- The potential impacts of the operation of the Scheme upon regional air pollutant emissions in the Scheme Opening Year 2023 and the Scheme Design Year 2038.

- The potential for the Scheme to introduce non-compliance with the EU Directive on ambient air quality and clean air for Europe (2008/50/EC) along the Defra Pollution Climate Mapping (PCM) Links.

Extent of the Study Area

6.4.9 The Construction Phase Study Area for consideration in the Construction Dust Assessment was determined following the guidance from the Institute of Air Quality Management (IAQM) (Ref 6.4), based upon the distance of human and ecological receptors that are considered potentially sensitive to construction dust in relation to the Application Sites and is presented in Figure 6.3. The construction dust assessment for air quality considers the on-site activities for the entirety of the programme by volume, area and number of vehicles when defining the potential magnitude of effects as presented in Appendix 6B, Table 1.1.

6.4.10 The extent of the Study Area for construction traffic impacts depends on the likely changes in daily average vehicle numbers on routes connecting to the Application Site. The numbers of vehicles and routes affected are likely to vary according to the nature of the works ongoing throughout the construction programme presented in Chapter 2: Description of the Scheme. As presented in Chapter 17: Traffic and Transport, a worst-case of 140 two-way HDV trips and 290 Light Duty Vehicle (LDV) trips per day has been assumed for when the construction is at its peak for the worst-case day in the programme in November 2021. The area over which the construction traffic has been is described in Chapter 2: Description of the Scheme. A Framework Construction Traffic Management Plan is given in Appendix A to the Outline CoCP (document reference 6.16) to minimise any adverse effects related to construction traffic.

6.4.11 The Study Area for the assessment of construction phase dust emissions and associated potential local air quality impacts as discussed in Section 6.7 and Appendix 6B (the Construction Study Area), has been defined by the location of sensitive receptors in accordance with IAQM guidance (Ref 6.4). Sensitive receptors have been identified within 350m for earthworks and construction site activities, and within 500m of the Application Site to incorporate receptors located within 50m of construction traffic routes up to a distance of 500m from the Application Site, where trackout of construction dust via vehicles may be experienced. The sensitive receptors within the study area are given in Table 6.16. The Satellite Application Sites are included in the study area for the assessment of construction phase dust emissions, as detailed in Paragraph 6.7.7, and shown in Figure 6.3. Further detail of the construction phase assessment methodology is given in Section 6.7 and Appendix 6B. For ecological receptors, the study area for construction impacts is within 50m of the construction boundary or within 50m of the route used by construction vehicles on the public highway up to 500m from the construction site entrances.

6.4.12 The local air quality assessment for operational phase emissions has considered changes in concentrations of NO_2, PM_{10} and $PM_{2.5}$ at sensitive receptors identified within 200m of roads that will be affected by the implementation of the Scheme (the Operational Study Area). The Study Area is defined with reference to the criteria given by the DMRB (HA207/07) as

specified in Paragraph 6.4.42. The following process determines the Operational Study Area:

- The screening of traffic data against the criteria given in Paragraph 6.4.42 determines the Local Affected Road Network (LARN) as presented in Figure 6.2. The LARN for the Do Something operational Study Area includes the proposed changes to the road network and additional roads within the Principal Application Site.

- Sensitive receptors representing properties considered sensitive to changes in air quality within 200 m of the LARN were selected for modelling. The selection of sensitive receptors is explained in Section 6.6.

- Following the selection of receptors additional roads within the traffic model Traffic Reliability Area (TRA) that fall within 200 m of a sensitive receptor were added to the LARN to produce the Model Road Network (MRN).

6.4.13 The regional emissions assessment has considered changes in emissions of NO_x, PM_{10}, $PM_{2.5}$ and CO_2 as a result of operation of the Scheme with reference to the criteria given by the DMRB (HA207/07). Further information on the criteria defining an affected road regional assessment is given in Paragraph 6.4.71 as presented in Figure 6.3.

6.4.14 The Ecological Assessment Study Area for operational effects, presented in Figure's 6.2, 6.18 and 6.19 was determined by the selection of designated ecological sites considered sensitive to changes in Air Quality as defined by DMRB (HA207/07) and following review of the ecological site features considered sensitive to changes in air quality as per the APIS (Ref 6.8). The Breydon Water SSSI was the only designated site meeting the criteria for assessment. The River Yare element of the Outer Thames Estuary SPA which is situated within the Principal Application Site was not considered further based upon the nature of the SPA designated feature of the Gavia Stellata - Red Throated Diver and the Sterna hirundo - Common Tern, for which the designated habitat (sublittoral sediment) is not considered sensitive to changes in NO_x concentrations or Nitrogen deposition (N-deposition) according to the APIS. For the Breydon Water SSSI, a transect has been modelled which extends across the footprint of Unit 10 from the boundary closest to the nearest road into the site as presented in Figure 6.2.

Limitations

6.4.15 The modelling of future air quality has associated uncertainties. In future years, one such uncertainty relates to the projection of vehicle emissions and, in particular the rate at which emissions per vehicle will improve over time. This assessment has utilised the most recent version of Defra's Emissions Factors Toolkit (EFT) to provide the most up to date estimate of current and future vehicle emissions projections.

6.4.16 Current projections for vehicle emissions factors are only available until 2030, which covers the Scheme opening year (2023), but precedes the Scheme future design year (2038). Therefore, following standard practice, vehicle emissions factors adopted for the future design year scenarios in the regional emissions assessment were based on the 2030 projected factors, which provides a conservative assessment because it is assumed that the trend of improvement in vehicle emissions will continue from 2030 to 2038.

Method of Baseline Data Collation

Desk Study

6.4.17 The 2018 Air Quality Annual Status Report (ASR) published by GYBC was reviewed to establish baseline air quality conditions within the Operational Study Area. The ASR provides the annual mean NO_2 monitored levels at a number of monitoring sites relevant to the Scheme location.

6.4.18 In addition, background air pollutant concentrations corresponding to the 1 km^2 grid squares covering the Operational Study Area were obtained from Defra's published national pollutant mapping data. Background concentrations for 2017, 2018, and 2023 were obtained to represent current and future baseline air quality conditions within the assessment scenarios.

6.4.19 Ordnance Survey (OS) mapping and address layer data were used to identify potentially sensitive receptors in proximity to the Scheme and surrounding areas. The OS address layer data gives a coordinate point location for each building with a code describing the use of the building. When visualised with OS mapping, the use of each building can be determined and this information was used to collate the locations of sensitive receptors for the local air quality assessment given in Paragraph 6.6.7 and Figure 6.2.

6.4.20 Information on the locations of designated ecological sites was obtained from the Defra Magic website and the ecological information provided in Chapter 8: Nature Conservation.

Site Visit

6.4.21 For the purpose of this assessment, no site visit was required.

Air Quality Surveys

6.4.22 A Scheme-specific baseline NO_2 monitoring survey was completed between August 2017 and January 2018 to inform the review of existing conditions. These monitoring data were used to enable model verification and adjustment as part of the atmospheric dispersion modelling study. The survey results are presented in Section 6.5 and the monitoring locations used in the model verification procedure are shown Figure 6.17.

Assessment Methodology

Construction Phase

6.4.23 The assessment of local air quality impacts due to the release of fugitive dust, including particulates (PM_{10}), during the construction phase was informed by the methodology detailed in the IAQM guidance, with reference to DMRB (HA207/07). Full details of the construction assessment methodology are provided in Appendix 6B which explains the detailed steps of the assessment.

6.4.24 In terms of emissions from construction vehicles on the local road network and associated traffic management measures, DMRB (HA207/07) states that these should be considered where construction is predicted to last for more than six months, the phased construction programme presented in Chapter 3: Description of the Scheme exceeds six months duration. Information on specific traffic management measures, the precise location of construction site entrances, and the precise number of vehicle movements related to construction on particular access routes were not available at the time of assessment. However, as discussed in the Transport Assessment (document reference 7.2) the following has been assumed for the purposes of the assessment based upon the worst-case quarter of the phased construction programme from October to December 2021:

- A peak of 140 construction related two-way HDV movements per day is anticipated to the construction compound to be situated to the east of the Scheme within the Principal Application Site. A peak of 82 construction related two-way LDV vehicle movements per day is anticipated to the western compound.
- A peak of 20 construction related two-way HDV movements per day is anticipated to the construction compound to be situated to the west of the scheme within the Principal Application Site. A peak of 290 construction related two-way LDV vehicle movements per day is anticipated to the eastern compound.
- The predicted vehicle numbers are based on the anticipated worst-case day of the phased construction programme. Construction traffic movements on any given route will be intermittent and temporary.
- Traffic management measures will be introduced during the phased construction programme. The effect of the traffic management measures on traffic flows and subsequently upon local air quality has not been assessed in this chapter.
- The eastern compound will be accessed via the trunk road network including Acle New Road, South Quay, South Denes Road with site access from Fish Wharf.

- The western compound will be accessed via William Adams Way, Suffolk Road and Queen Anne's Road.

6.4.25 The criteria provided by DMRB (HA207/07) stipulates that further assessment of vehicle emissions is required where a change in vehicle flow volume of 1,000 annual average daily traffic (AADT) movements or more is expected, or the HDV flow will change by 200 AADT or more. The corresponding criteria for vehicle emissions assessment in the IAQM/ Environmental Protection UK (EPUK) Guidance, titled 'Land-Use Planning & Development Control: Planning for Air Quality' is a change of 100 HDV AADT or more outside of an AQMA. These criteria are not specific to the construction phases but are applied in determining whether construction traffic modelling is required.

6.4.26 The peak construction traffic movements given in Paragraph 6.4.24 are below the DMRB criteria requiring a transport based construction phase assessment, but above the IAQM/EPUK HDV criteria requiring a transport based construction phase assessment. Considering the worst-case quarter of the phased construction programme, it is not predicted that the peak HDV movements will be in excess of 100 HDV movements to a single compound for a period longer than 21 days (see Chapter 17 for further information on construction traffic predictions). The increases to traffic flows will be temporary in nature in line with the construction phasing, therefore assessment of construction phase vehicle emissions has not been taken further in this assessment.

6.4.27 The assessment during the Construction phase has therefore focussed on potential impacts associated with fugitive dust and particulate emissions from the following types of activity that will occur throughout the entirety of the construction programme. The following activities were considered in Section 7.3 Step 2A of the IAQM guidance:

- Demolition;
- Earthworks;
- Construction; and
- Trackout (dust generating material which leaves the site via attachment to vehicle tyres).

6.4.28 Dust impacts associated with annoyance due to soiling have been assessed, in addition to potential human health effects due to an increase in exposure to PM_{10} and $PM_{2.5}$, and potential harm to identified ecological receptors. Factors including the scale and nature of the activity, in addition to the sensitivity of the area, have been considered when assessing the risk of dust impacts, which are determined prior to assigning mitigation measures.

6.4.29 The Construction Study Area has been defined by the location of sensitive receptors identified within 500m of the Application Site and potential site

entrances; this being the worst case maximum distance from source to receptor for any construction activities that could be a source of dust emissions, as defined by the screening criteria within Box 1 of the IAQM guidance and Section 7.3, Step 2B.

6.4.30 Box 1 states that:

"…an assessment will normally be required where there is a 'human receptor' within:

- *350m of the boundary of the site; or*
- *50 m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s)."*

6.4.31 Box 1 of the IAQM guidance also states that an assessment is required where there is:

"…an 'ecological receptor' within:

- *50 m of the boundary of the site; or*
- *50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s)."*

6.4.32 Human and ecological receptors have been considered up to a distance of 500m from the Application Sites to incorporate the distances specified by IAQM.

6.4.33 Following the screening criteria provided in Box 1 of the IAQM guidance the construction phase of the Scheme does require an assessment. In determining the Study Area further criteria are provided in Section 7.3, Step 2B of the IAQM guidance.

6.4.34 Section 7.3, Step 2B of the IAQM guidance to define the sensitivity of the area considers the number of human receptors:

"exact counting of the number of 'human receptors' is not required. Instead it is recommended to use professional judgement to determine the number of receptors in each band".

6.4.35 The distance bands are given in Table 2 of the guidance as shown in Table 6.6 below. The sensitive receptor counts for the Scheme are presented in Table 6.16.

Table 6.6: Sensitivity of the Area to Dust Soiling Effects on People and Property

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

6.4.36 When considering the sensitivity of the construction Study Area to impacts from demolition, earthworks, construction and trackout, matrices based upon the distance from source to receptor for assessing each activity are given in Section 7.3 Step 2B of the IAQM guidance. In Table 2, Table 3 and Table 4 of the guidance, for each level of sensitivity "*only the highest level of area sensitivity from each table needs to be considered*" as stated in the footnotes to Table 6B.3, Table 6B.4 and Table 6B.5 given in Appendix 6B. Receptors sensitive to trackout from a large construction site can situated on roads up to 500m from the construction site exits. The construction traffic routes given in Paragraph 6.4.24 were considered within the assessment for trackout.

6.4.37 The findings of the demolition element of the construction assessment have been incorporated as a component of step two of the assessment as detailed in Appendix 6B.

6.4.38 The outcomes of the construction phase assessment are used to enable appropriate mitigation measures to be defined. The requirement to undertake the measures given in Paragraph 6.8.6 are set out in the Outline CoCP (document reference 6.16) which sets out that the details of the measures which the contractor will be responsible for creating and submitting to the local planning authority for approval, following consultation with GYBC.

Operational Phase

6.4.39 The assessment of local air quality and regional emissions impacts associated with the operation of the Scheme, and the risk to compliance with the European Ambient Air Quality Directive has been informed by the approaches detailed in DMRB (HA207/07) and Highways England IAN 175/13 with reference to respective Defra LAQM(TG16) and IAQM guidance.

Local Air Quality Assessment

6.4.40 The local air quality assessment has focused on the following scenarios, for which traffic data has been provided from the Transport Assessment

(document reference 7.2) to facilitate atmospheric dispersion modelling of vehicle emissions:

- Base Year (2017) based upon 2018 traffic flows which are valid for 2017 as per the Transport Assessment (document reference 7.2.A) Document 7.8.
- Opening Year 2023 without scheme (Do Minimum); and
- Opening Year 2023 with scheme (Do Something).

6.4.41 The Do Minimum (DM) and Do Something (DS) scenarios facilitate comparison of the air quality both without and with the Scheme, thereby informing the conclusion of significance with regard to local air quality effects. The Base year scenario is modelled for model verification purposes. During verification the outputs from the Base model were compared to monitoring at the respective monitoring locations to produce a factor accounting for under prediction in the model, which is applied to the results for the modelled sensitive receptors in all scenarios. Further details on verification are provided in Appendix 6C.

6.4.42 Screening of the DM and DS traffic data was completed to identify affected road links that adhere to the following criteria as provided by DMRB (HA207/07):

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

6.4.43 The DMRB criteria were applied initially as the thresholds for assessment are higher compared to the IAQM equivalent criteria (Ref 6.3) and therefore, as these DMRB criteria were met, there was no need to carry out further screening against the lower thresholds prescribed by the IAQM. Conducting the assessment in this way is also helpful as the DMRB criteria also define the affected road network.

6.4.44 Traffic data for the Scheme opening year were screened to identify the Operational Study Area for the local air quality assessment and is presented in Figure 6.2. Details of the traffic conditions and traffic model are provided in Chapter 17: Traffic and Transport and the Transport Assessment (document reference 7.2).

6.4.45 Emissions inventory databases for each pollutant (NO_x, PM_{10}, $PM_{2.5}$) were developed for all three of the above scenarios using Defra's latest EFT (v8.0.1), which accounts for vehicle flow characteristics, such as:

- Link flow volumes as annual average daily traffic (AADT);
- Link average speed (km/hr);
- Vehicle type composition (e.g. percentage HDVs); and
- Link (i.e. road section) length.

6.4.46 In January 2018, the latest EFT v8.0.1 was released, which incorporates updated emission functions from the European Environment Agency COPERT V5 model. Therefore, EFT v8.0.1 incorporates the most up to date information that is available on the emissions from the national fleet and it is this version that has been used in the assessment.

6.4.47 Each scenario emissions database was entered to an atmospheric dispersion model (ADMS-Roads v4.1) to enable prediction of pollutant concentrations at the identified sensitive receptor locations. The modelling exercise utilised the following key inputs:

- Pollutant emission rates for each affected road link within the Operational Study Area;
- Geometry of each affected road link;
- Representative time-varying emissions based on diurnal variation in traffic flow for the affected roads;
- Hourly sequential meteorological data obtained from the closest representative coastal meteorological measurement station at Weybourne for 2017; and
- Coordinates of each sensitive receptor at which the model calculated pollutant concentrations.

6.4.48 The year 2017 was selected as the Base Year for Air Quality modelling purposes as a full year of meteorological data is required as an input to the Air Quality dispersal model and the air quality monitoring data for model verification purposes was collected in 2017, therefore providing consistency for model verification as agreed with GYBC during consultation. Verification of the ADMS-Roads model outputs was undertaken using the annual mean NO_2 base year (2017) outputs and the annual mean NO_2 Scheme-specific monitoring data obtained over 5 months in combination with monitoring data from GYBC. This enabled appropriate adjustment factors, derived with reference to Defra's technical air quality guidance, to be applied to model outputs to improve the performance of the dispersion model within the

context of the monitoring data presented in Appendix 6E and at the locations shown on Figure 6.17.

6.4.49 Verification of PM_{10} and $PM_{2.5}$ has been completed using the same factor determined through verification of NO_2 concentrations, in accordance with LAQM TG(16) technical guidance, Paragraph 7.529 which states:

"…in the absence of any PM_{10} (and $PM_{2.5}$) data for verification, it may be appropriate to apply the road-NOx adjustment to the modelled road-PM_{10} /$_{2.5}$".

6.4.50 Although particulates are monitored in Great Yarmouth, the monitoring site was relocated in 2017 so a full annual dataset at a consistent location was not available for verification purposes. LAQM TG(16) guidance also advises caution when applying adjustment based on a single monitoring site for PM_{10} and $PM_{2.5}$ as such adjustment may not be representative of other locations within the Study Area.

6.4.51 Further detailed information of the modelling process, input data and the model verification and adjustment procedure are presented in Appendix 6C.

6.4.52 The results of the atmospheric dispersion modelling at each identified sensitive receptor (as discussed below) have been compared to the respective air quality objective values, set for the protection of human health and, where applicable, ecosystems, to evaluate the potential for exceedances in all scenarios.

6.4.53 The magnitude of change of predicted concentrations at each location, as a result of the Scheme, has been derived through analysis of the opening year (2023) Do Something versus Do Minimum scenario data. The significance of potential changes to local air quality has been determined in accordance with the criteria provided by IAQM.

Sensitive Receptor Identification

6.4.54 There is the potential for vehicle emissions to impact local concentrations of air pollutants at the identified sensitive receptors situated within the Operational Study Area (see Figure 6.2).

6.4.55 According to DMRB (HA207/07) the influence of vehicle emissions on ambient air quality is negligible beyond 200m of the respective road source, predominantly due to horizontal and vertical atmospheric mixing. As such, a desk-based review of potentially sensitive receptors to air quality was undertaken using OS mapping and address layer plus data as explained in Section 6.6 and Table 6.14 to identify those located within 200m of the Scheme alignment and associated affected links.

6.4.56 Designated ecological sites (Ramsar, SPAs, SACs or SSSIs) listed in Section 6.6 have been assessed in accordance with the DMRB HA207/07 Annex F, which provides the relevant assessment procedure.

Significance Criteria

6.4.57 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme.

6.4.58 The significance level attributed to each effect has been assessed based on the magnitude of change due to the Scheme and the sensitivity of the affected receptor, as well as a number of other factors that are outlined in more detail in Chapter 4: Approach to EIA. The sensitivity of the affected receptor is assessed on a scale of high, medium, low and negligible, and the magnitude of change is assessed on a scale of large, medium, small and negligible (as shown in Chapter 4: Approach to EIA).

Construction Phase Significance

6.4.59 The significance of any construction dust emissions from the construction of the Scheme has been assessed in accordance with Section 9 Step 4 of guidance provided by IAQM (Ref 6.4).

6.4.60 Step four of the IAQM guidance states that *"…For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation."*

6.4.61 The outcomes of the construction dust assessment are used to define appropriate level of risk of construction dust impacts, mitigation measures commensurate to the risk are identified in Paragraph 6.8.6 to reduce the possibility of adverse effects from the construction phase of the Scheme. As such, the assessment does not identify specific assessment significance criteria.

6.4.62 The IAQM guidance states in Section 2 in the terminology definition of effects that:

"…in the context of construction impacts any effect will usually be adverse, however professional judgement is required to determine whether this adverse effect is significant based on the evidence presented"

6.4.63 Furthermore, in Section 1 introduction text that:

"…it is anticipated that with the implementation of effective site-specific mitigation measures the environmental effect will not be significant in most cases".

Operational Phase Significance

6.4.64 The IAQM Guidance describes the magnitude of incremental concentration change (Do Minimum versus Do Something) at each individual sensitive

receptor as a proportion of a relevant AQAL. In this assessment, the AQALs are the annual mean NO_2, PM_{10} and $PM_{2.5}$ objectives.

6.4.65 The magnitude of incremental concentration change (Do-Minimum versus Do-Something) is considered at each individual sensitive receptor as a proportion of a relevant AQAL. The incremental change at each sensitive receptor is examined in the context of the total predicted annual mean concentration and its relationship with the AQAL as detailed within Table 6.7. This allows an impact descriptor to be assigned to each receptor, with overall significance of the effects of any impacts assigned by professional judgement based on knowledge of similar schemes. The significance of the local air quality assessment results was evaluated based on this guidance.

Table 6.7: Impact Descriptors for Modelled Sensitive Receptors (annual mean NO_2 PM_{10} and $PM_{2.5}$)

Annual Mean NO_2/PM_{10} concentration at receptor	**Value of Change in Annual Average NO_2 and PM_{10}**			
	1%	**2-5%**	**6-10%**	**>10%**
≤75% of AQAL (≤30g/m^3)	Negligible	Negligible	Slight	Moderate
76-94 of AQAL (30-38µg/m^3)	Negligible	Slight	Moderate	Moderate
95-102% of AQAL (38-41µg/m^3)	Slight	Moderate	Moderate	Substantial
103-109% of AQAL (41-44µg/m^3)	Moderate	Moderate	Substantial	Substantial
≥110% of AQAL (≥44µg/m^3)	Moderate	Substantial	Substantial	Substantial
AQAL refers to the annual mean air quality objective for NO_2 and PM_{10}.				
Annual Mean $PM_{2.5}$ concentration at receptor	**Value of Change in Annual Average $PM_{2.5}$**			
	1%	**2-5%**	**6-10%**	**>10%**
≤75% of AQAL (≤19g/m^3)	Negligible	Negligible	Slight	Moderate
76-94 of AQAL (19-24 µg/m^3)	Negligible	Slight	Moderate	Moderate
95-102% of AQAL (24-26µg/m^3)	Slight	Moderate	Moderate	Substantial
103-109% of AQAL (26-28µg/m^3)	Moderate	Moderate	Substantial	Substantial

Annual Mean $PM_{2.5}$ concentration at receptor	Value of Change in Annual Average $PM_{2.5}$			
	1%	1%	1%	1%
≥110% of AQAL (≥28µg/m³)	Moderate	Substantial	Substantial	Substantial
Note: AQAL refers to the annual mean air quality objective for $PM_{2.5}$.				

6.4.66 In instances where a sensitive receptor is found to be in exceedance of the objective concentration for a pollutant, or within 10% of the objective concentration, then the significance of the local air quality assessment results for NO_2, PM_{10}, and $PM_{2.5}$ would be evaluated based on IAN 174/13 (Ref 6.7).

6.4.67 Where IAN 174/13 is used, changes in pollutant concentrations greater than imperceptible (more than 0.4 µg/m³) at each identified receptor, based on the Do Minimum versus Do Something opening year (2023) model results, are compared with guideline bands that inform the potential significance of the Scheme. The guideline band ranges set the upper level of likely non-significance and the lower level of likely significance. Between these two levels are the ranges where likely significance is more uncertain, and greater onus is afforded to professional judgement based on knowledge of similar schemes.

6.4.68 However, the results of this assessment do not meet the criteria for the application of IAN 174/13 as no sensitive receptors were found to be within 10% of the objective concentration as demonstrated in Paragraph 6.8.30 and Figure's 6.11 to 6.13.

6.4.69 Whilst the approach contained within IAN 174/13 focusses on receptors already exceeding an annual mean objective, or within 10% of exceeding the objective, guidance for determining the impact of the operational phase of the Scheme on each of the individual local air quality sensitive receptors is provided by IAQM as described in Table 6.7. Information on the magnitude of change, applying the increments given in Table 6.7 is presented in Table 6.18.

Regional Emissions

6.4.70 The regional emissions assessment has focussed on total annual mass emissions of NO_x, PM_{10}, $PM_{2.5}$, and carbon dioxide (CO_2) associated with the aforementioned opening year scenarios, in addition to:

- Design year (2038) without Scheme (Do Minimum); and
- Design year (2038) with Scheme (Do Something).

6.4.71 Screening of the Do Minimum and Do Something traffic data was undertaken to identify affected road links that adhere to the following criteria as provided by DMRB HA207/07:

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

6.4.72 The affected road links identified through screening are presented in Figure 6.4. Traffic data for affected road links in each scenario were entered to Defra's EFT v8.0.1, enabling the calculation of total annual mass emissions of the respective vehicle exhaust species. This allowed the magnitude of change of total mass emissions associated with the operation of the Scheme to be predicted.

6.4.73 There are no relevant published significance criteria in relation to regional emissions assessments and DMRB (HA207/07) acknowledges that changes in regional emissions associated with road schemes, such as the Scheme, are expected to be small within the context of national emissions. As stated in the NPS NN see Paragraph 6.8.52, it is very unlikely that the impacts of a road project will, in isolation, affect the Government's ability to meet its carbon reduction targets. However, regional and national emissions data published by the National Atmospheric Emissions Inventory (NAEI) have been utilised to provide context to the predicted change in emissions during the operational phase of the Scheme.

Assessing Implications for UK Compliance with the EU Ambient Air Quality Directive

6.4.74 The Defra Pollution Climate Mapping (PCM) model is used to fulfil the UK's requirements to report on the concentrations of particular pollutants in the atmosphere to the EU. The PCM model contains key road sources across the UK for which projected representative roadside pollutant concentrations are published. Highways England IAN 175/13 provides guidance on how to assess the risk from a road development upon compliance with the EU Directive on ambient air quality and clean air for Europe (2008/50/EC). IAN 175/13 has a status of 'withdrawn' pending an update, however, in the absence of updated or an alternative guidance, it is still considered appropriate to apply it to this assessment[1].

6.4.75 The compliance assessment is included in Appendix 6D.

[1] This approach was recently approved by the Secretary of State in relation to the Silvertown Tunnel DCO.

Effect Significance

6.4.76 The significance of air quality effects has been assessed following the relevant guidance from IAQM/EPUK for the operational air quality assessment (Ref. 6.3) and IAQM (Ref. 6.4), for the construction phase air quality assessment as set out in Section 6.4 (Significance Criteria).

6.5 Baseline Conditions

Local Air Quality Management Review

6.5.1 A review of the latest LAQM report published by GYBC confirmed that there are no AQMAs declared within the Borough and there is no requirement for GYBC to progress to a detailed assessment of air quality for any pollutant. There are no AQMAs declared within the region of Waveney District Council. The AQMA's for NO_2 declared within the region of Suffolk Coastal District Council at Woodbridge Junction in Woodbridge, Dooley Inn near the Port of Felixstowe and Long Row in Stratford St Andrew are located more than 20 km from the Scheme and are not of relevance to this assessment. The AQMA for NO_2 declared within the region of Norwich City Council in Central Norwich is considered too far away to be of relevance to this assessment being more than 20km from the Scheme and beyond the LARN.

Background Pollutant Concentrations

6.5.2 The background air pollutant data published by Defra for the UK accounts for a multitude of local emissions sources including road vehicles, industrial installations, domestic heating and other transport modes, in addition to regional sources and imported emissions. The modelled background data is available for years 2015 to 2030 inclusive.

6.5.3 For the purposes of reviewing the existing background and predicted future background levels, the maximum, minimum and average annual mean concentrations of each pollutant (NO_2, PM_{10}, $PM_{2.5}$) based on the 1km^2 grids encompassing the Operational Study Area, are presented in Table 6.8.

Table 6.8: Defra Mapped Background Annual Mean Concentrations for Each Pollutant in the Air Quality Model Base (2017), and Opening (2023) Years

Pollutant	2017 Background Concentration (µg/m^3)			2023 Background Concentration (µg/m^3)		
	Max	Min	Average	Max	Min	Average
NO_2	14.3	9	11.7	12.8	7.7	10.2
NO_x	19.8	12	15.9	17.6	10.2	13.7
PM_{10}	18.8	12.4	15.1	18.2	12	14.6
$PM_{2.5}$	14.3	8.5	11	13.7	8.1	10.5

6.5.4 The predicted current and future background concentrations presented in Table 6.8 are well below the respective health-based annual mean objective values for NO_2 (40µg/m^3), PM_{10} (40µg/m^3), and $PM_{2.5}$ (25µg/m^3). Similarly, the annual mean NO_x objective value (30µg/m^3) set for the protection of vegetation and ecosystems, is not predicted to be exceeded.

6.5.5 Existing operations at the Peel Ports Great Yarmouth generate exhaust emissions from onshore and offshore emissions. Emissions from shipping sources, and industrial sources are accounted for within the Defra LAQM background maps (Ref 6.15).

Local Air Quality Monitoring

6.5.6 GYBC operated an automatic continuous air quality monitor at Gorleston to monitor levels of NO_2 and PM_{10} within Great Yarmouth until it was decommissioned in 2016. A continuous monitor was subsequently installed at South Denes and is now operational, measuring concentrations of NO_2, PM_{10} and $PM_{2.5}$. The Gorleston continuous monitor was situated to the west of the River Yare close to Malthouse Lane, approximately 410m to the southwest of the Scheme. The new South Denes monitor is situated to the east of the River Yare close to Fenner Road, approximately 570m to the southeast of the Scheme.

6.5.7 The annual mean PM_{10}, $PM_{2.5}$, and NO_2 concentrations at these locations, as presented in Table 6.9, Table 6.10, and Table 6.11 respectively, demonstrate that there have not been any exceedances of the respective air quality objectives for the period reviewed (2012-2018).

Table 6.9: Local Authority PM_{10} Automatic Monitoring Results

Site ID	Monitoring Type	Monitoring Site	X,Y	PM_{10} Annual Mean Concentration (µg/m^3)				
				2012	2013	2014	2015	2016
CM1 Gorleston	Automatic	Urban Background	652498, 305600	19.9*	20.7*	16.6*	16.8*	15.5*
CM2 South Denes	Automatic	Urban Background	652983, 305664	The provisional annual mean concentration for 2018 is 20µg/m^{3**}				
Annual mean objective				**40**				

*Values represent annualised concentrations derived by GYBC in LAQM Annual Status Report 2017 & 2018 as per Technical Guidance LAQM.TG16 (Ref 6.5).

**Air Quality England Air Pollution Report for CM2 at South Denes – Site GYBC1 (Ref 6.14) Ratification status of monitoring data checked 21/03/19

Table 6.10: Local Authority $PM_{2.5}$ Automatic Monitoring Results

Site ID	Monitoring Type	Monitoring Site	X,Y	$PM_{2.5}$ Annual Mean Concentration (µg/m^3)
CM2 South Denes	Automatic	Urban Background	652983, 305664	The provisional annual mean concentration for 2018 is 12µg/m^{3*}
Annual mean objective				**25**
**Air Quality England Air Pollution Report for CM2 at South Denes – Site GYBC1 (Ref 6.4)				

Table 6.11: Local Authority NO_2 Automatic Monitoring Results

Site ID	Monitoring Type	Monitoring Site	X,Y	NO_2 Annual Mean Concentration (µg/m^3)				
				2012	2013	2014	2015	2016
CM1 Gorleston	Automatic	Urban Background	652498, 305600	18.8*	18.2*	17.1*	16.8*	14.5*
CM2 South Denes	Automatic	Urban Background	652983, 305664	The provisional annual mean concentration for 2018 is 14µg/m^3				
Annual mean objective				**40**				
*Values represent annualised concentrations derived by GYBC as per Technical Guidance LAQM.TG16. (Ref 6.5) ** Air Quality England Air Pollution Report for CM2 at South Denes – Site GYBC1 (Ref 6.14)								

6.5.8 GYBC operates an extensive network of NO_2 diffusion tube monitoring sites, 12 of which are located adjacent to roads that are likely to experience a change in air quality during the operational phase of the Scheme, as shown in Figure 6.17 and Table 6.12.

6.5.9 The annual mean NO_2 concentrations at these locations, obtained from GYBC and shown in Table 6.12 for the period 2010 – 2017 inclusive, demonstrate that there has not been an exceedance of the air quality objective value. The maximum monitored annual mean concentration recorded in the last two years (2016/2017) was 36.7µg/m^3 adjacent to the B1141 Southgate Road at monitoring location DT4.

Table 6.12: Local Authority NO_2 Monitoring Results

Site ID	Site Type	X,Y	Annual Mean Concentration (µg/m^3)					
			2012	2013	2014	2015	2016	2017
DT1	Roadside	652053,308188	25.8	22.1	22.0	21.9	21.1	25.6
DT2	Roadside	652079,307828	24.8	24.0	24.1	22.5	21.2	20.9
DT3a	Roadside	652104,307665	25.6	25.4	26.9	25.4	24.4	21.8
DT3b	Roadside	652104,307665	27.7	N/A	N/A	N/A	N/A	N/A
DT4	Roadside	652611,306223	23.8	20.8	22.9	20.9	20.3	36.7
DT5	Roadside	652092,307419	38.8	37.5	37.8	37.4	33.2	21.7
DT6	Roadside	652520,306862	25.1	25.3	23.5	23.8	22.9	22.3
DT7	Roadside	652569,306537	26.4	25.8	25.6	24.4	22.2	19.0
DT8a	Urban Background	652492,305612	18.5	18.2	17.8	16.0	17.7	18.8
DT8b	Urban Background	652492,305612	18.3	14.3	16.9	16.3	17.7	18.3
DT8c	Urban Background	652492,305612	17.8	17.2	15.4	15.7	17.1	18.4
DT9	Roadside	652066,307874	20.0	20.2	18.7	19.9	18.5	18.8
DT10	Roadside	652326,307376	33.2	34.0	30.6	32.8	33.7	33.2
DT11	Roadside	652490,307174	28.8	N/A	N/A	31.6	27.4	27.9
DT12	Roadside	651993,307370	N/A	N/A	N/A	N/A	24.9	20.0
Annual Mean Objective			**40**					

Scheme Specific Monitoring (NO_2)

6.5.10 A Scheme-specific NO_2 baseline air quality monitoring survey, comprising 40 diffusion tubes, was established for a five-month monitoring period from August 2017 to January 2018, covering the operational Study Area. Details of the monitoring locations and data processing are provided in Appendix 6E and the monitored annual mean NO_2 concentrations are summarised in Table 6.13.

6.5.11 The locations of these tubes, which were agreed through consultation with GYBC, are presented in Figure 6.17 for sites where the monitoring was used in the model verification procedure.

6.5.12 All monitored values are well below the respective annual mean NO_2 objective, with the highest concentration (30.8µg/m^3) recorded adjacent to St Peters Road on the approach to the mini roundabout at the junction with Nelson Road.

Table 6.13: Summary of Scheme Specific Monitored NO_2 Annual Mean Concentrations (August 2017 to January 2018)

Site	Location Description	X	Y	Site Annual Mean Concentration (µg/m³)*
WSP1	Runham Rd	651935	308536	26.6
WSP2	School Rd	651964	308314	23.8
WSP3	Northgate Street	652340	308077	23.9
WSP4	Priory Gardens	652491	307941	20.3
WSP5	Nelson Rd N Jury St	652842	307991	25.7
WSP6	Nelson Rd N Trafalgar St	652850	307378	26.4
WSP7	Nelson Rd N St Peters Rd	652873	307074	30.8
WSP8	Queens Rd	652756	306572	22.3
WSP9	Admiralty Rd	652769	306047	21.3
WSP10	Sutton Rd	652658	306040	23.2
WSP11	Southgates Rd	652611	306229	22.2
WSP12	S Quay Nottingham Way	652468	307090	32.8
WSP13	Yarmouth Way	652459	307304	28.5
WSP14	Stonecutters Way	652178	307619	25.7
WSP15	Greyfriars Way	652371	307422	27.9
WSP16	Trafalgar College Thamesfield Way	651732	306714	26.2
WSP17	Gapton Hall Rd	651531	306309	22.2
WSP18	Vincent Close	651517	307179	23.2
WSP19	Mill Rd	651627	307643	14.5
WSP20	Mill Rd jnc. Bridge Rd	652016	307412	22.4
WSP21	Southtown Rd	652042	307298	18.4
WSP22	Station Rd	651865	306968	18.7
WSP23	Southtown Rd 2	652231	306856	23.6
WSP24	Boundary Rd	652373	306231	24.1
WSP25	Cromwell Rd	652386	306036	24.5

Site	Location Description	X	Y	Site Annual Mean Concentration (µg/m^3)*
WSP26	Queen Anne's Rd	652360	305868	19.6
WSP27	Queen Anne's Rd 2	652166	305970	22.4
WSP28	Southtown Rd 3	652408	305818	29.4
WSP29	Manby Rd	652404	305357	21.8
WSP30	Burgh Rd	652309	305188	21.6
WSP31	Alpha Rd	652396	305674	18.7
WSP32	A143	652071	304949	29.8
WSP33	Plane Rd	651959	304891	16.2
WSP34	Lynn Grove	651514	304700	18.1
WSP35	Beccles Rd	651224	304384	19.6
WSP36	Baliol Rd	652306	304368	12.1
WSP37	Middleton Rd	652270	303862	18.2
WSP38	Brasnose Avenue	652278	302742	21.7
WSP39	Horsley Drive	651967	301967	10.7
WSP40	Cormorant Way	650866	305188	15.4
Annual Mean Objective		**40**		

* Concentrations have been bias adjusted and annualised based on data retrieved for 5 months of monitoring.

6.6 Sensitive Receptors

6.6.1 There is the potential for vehicle emissions to impact local concentrations of air pollutants at the identified sensitive receptors situated within the Operational Study Area (see Figure 6.2).

6.6.2 According to DMRB (HA207/07) the influence of vehicle emissions on ambient air quality is negligible beyond 200m of the respective road source, predominantly due to horizontal and vertical atmospheric mixing. As such, a desk-based review of potentially sensitive receptors to air quality was undertaken using OS mapping and address layer plus data as to identify those located within 200m of the Scheme alignment and associated affected links.

6.6.3 Sensitive receptors as defined in the DMRB Section 11.3.1 (DMRB HA207/07) include:

- Residential dwellings;

- Designated ecological sites;
- Locations of the young and elderly;
- Hospitals; and
- Schools.

6.6.4 Properties within the Application Site which are to be demolished have not been considered within the assessment as sensitive receptors as these properties will no longer be present in the Scheme Opening Year. The Kings Community Centre on Queen Anne's Road has been included as an additional receptor following consultation.

6.6.5 Designated ecological sites (Ramsar, SPAs, SACs or SSSIs) given in Paragraph 6.4.14 have been assessed with reference to the DMRB HA207/07 Annex F, which provides the relevant assessment procedure.

6.6.6 All key sensitive ecological receptor locations are shown on Natural Environment Constraints Plan (document reference 6.4A).

6.6.7 The distribution of identified sensitive receptors specific to the operation phase assessment of the Scheme, according to type, is presented in Table 6.14.

Table 6.14: Identified Potentially Sensitive Receptor Locations

Property Type	Count
Residential	10,721
Education	15
Health Care (Hospitals, Care Homes etc.)	50
Ecological sites*	Breydon Water SSSI Unit 10, SPA, Ramsar
Additional receptor	The Kings Centre

* As defined by DMRB HA207/07 (SACs, SCI's, cSCI's, SPA's, pSPA's, SSSI's and Ramsar sites).

6.6.8 Receptors were selected for modelling where they were situated within 200m of an affected road link. The local air quality model area is slightly larger than the LARN, as shown in the figures. This captures the influence from emissions of roads covered by the traffic model Study Area within a distance of 200m upon the modelled receptors.

6.6.9 Breydon Water SSSI, SPA, Ramsar depicted in Figure 6.18 and 6.19, lies within 200m of the affected road network. It has therefore been considered in this assessment.

6.6.10 The outcomes of the designated sites assessment are provided in Appendix 6G and Paragraph 6.8.42.

6.6.11 The base year NO_x concentrations and Nitrogen deposition rates for the ecological sites considered in this assessment are given in Table 6.15.

Table 6.15: Base Year Conditions at Ecological Sites

Ecological Site	Habitat Description	Habitat Critical Load (kg N ha^{-1} yr^{-1})	Base Year Background NOx Concentration ($\mu g/m^3$)	Baseline Nitrogen Deposition Rate (kg N ha^{-1} yr^{-1})*
Breydon Water SSSI Unit 10**	Lowland Neutral Grassland Feature sensitive to Nitrogen: Wigeon and Shellduck	20-30	13.9	12.46

*Baseline conditions Nitrogen deposition rate obtained from APIS for site specific coordinates.

**Designated site as defined by DMRB HA207/07 (SACs, SCI's, cSCI's, SPA's, pSPA's, SSSI's and Ramsar sites). Base conditions also apply to areas of The Broads SAC and the Broadland RAMSAR site.

6.7 Establishing the Scenario for Assessment

Construction Phase

6.7.1 Construction works have the potential to generate fugitive dust emissions during earthworks and construction activities, as well as from the trackout of dust and dirt by vehicles onto public highways. Dust emissions can cause annoyance through soiling of buildings and surfaces or can adversely impact human health.

6.7.2 Potential construction phase air quality impacts assessed in this section are considered prior to the application of site-specific mitigation measures.

6.7.3 Major construction activities that are likely to be required during construction phase of the Scheme will include the following:

- Site clearance (assessed as earthworks and demolition as appropriate);
- Topsoil strip (assessed as earthworks);
- Excavation (assessed as earthworks);
- Landscaping (assessed as earthworks and construction as appropriate);

- Material import/export (assessed as trackout);
- Demolition (assessed as demolition);
- Temporary stockpile of resources (assessed as construction, potentially dusty materials);
- Construction of compounds and access points (assessed as trackout); and
- Construction of road/bridge and footway (assessed as construction).

6.7.4 The main potential air quality impacts that may arise from the aforementioned activities are:

- Dust deposition, resulting in the soiling of surfaces;
- Dust plumes, affecting visibility and amenity; and
- Elevated ambient PM_{10} concentrations due to fugitive dust releases.

6.7.5 The potential for sensitive receptors to be affected is dependent on the scale and locations of the dust generating activities, the nature of the activity, and local meteorological conditions when the activity is taking place.

6.7.6 There are sensitive residential receptors located within 500m of the Application Site and located on approach roads within 500m of the Principal Application Site, where the aforementioned activities could occur. The nearest sensitive residential receptors are located within 20m of the Principal Application Site.

6.7.7 Distance bandings contained within Table 6B.3, Table 6B.4 and Table 6B.5 of Appendix 6B were analysed based on the Application Site. The number and location of existing dust sensitive receptors from the Application Site is shown in Table 6.16.

Table 6.16: Receptor Count within 350m of Earthworks and Construction Activities and within 500m of the Application Sites including Potential Site Entrances to Include Receptors that May be Subject to Impacts from Construction Dust Trackout on Vehicles.

Distance Bandings	Sensitive Receptor Counts				
Distance from Application Site (m)	**Residential**	**Educational**	**Medical and Residential Care**	**Ecological**	**Total Including Other**
<20	197	1	0	1 - River Yare (Outer Thames Estuary SPA)	381
20-50	198	1	0	1 - River Yare (Outer Thames Estuary SPA)	291
50-100	1225	1	13	1 - River Yare (Outer Thames Estuary SPA)	1730
100-200	1595	5	18	2 - River Yare (Outer Thames Estuary SPA) and Breydon Water SSSI/SPA/Ramsar	2211
200-350	3008	4	4	2 - River Yare (Outer Thames Estuary SPA) and Breydon Water SSSI/SPA/Ramsar	4055

Distance Bandings	Sensitive Receptor Counts				
Distance from Application Site (m)	**Residential**	**Educational**	**Medical and Residential Care**	**Ecological**	**Total Including Other**
500	3476	3	11	2 - River Yare (Outer Thames Estuary SPA) and Breydon Water SSSI/SPA/Ramsar	4089
50m from construction traffic routes	2722	5	8	2 - River Yare (Outer Thames Estuary SPA) and Breydon Water SSSI/SPA/Ramsar	3739

6.7.8 A distance of 50m from the source of construction dust is specified in IAQM guidance as appropriate for the assessment of the sensitivity of the area to ecological impacts from construction dust.

6.7.9 The Port of Great Yarmouth is situated within and adjacent to the construction compound sites on the southern and northern bank of the River Yare. Operations at the Port could be adversely affected by construction dust.

6.7.10 The highest risk receptors are those that are downwind of potential dust-generating construction activities. A wind rose derived from data recorded at Weybourne meteorological station for the year 2017, presented in Appendix 6F, demonstrates a prevailing south-westerly wind. 2018 Wind data measured at a lower height at the South Denes Air Quality Monitor shows that localised wind effects can also include winds from the northwest at a higher frequency than indicated by the Weybourne data. Therefore, those receptors located to the northeast, east and south east of, and within close proximity to, the construction activities, are more likely to be affected by fugitive dust releases. As the precise location of dust generating activities within the construction site is not known, a conservative approach was taken assuming that these activities could occur anywhere up to the site boundary.

6.7.11 The effects of construction dust generated during dry conditions could lead to annoyance through dust deposition and also localised increases in PM_{10} concentrations with the potential to adversely impact human health. The maximum background annual mean PM_{10} concentration for the Construction Study Area – as predicted by Defra - is 18.8µg/m^3 (Table 6.8), which is well below the annual mean objective value of 40µg/m^3. Therefore, it is unlikely that the short-term construction operations would cause the daily (50µg/m^3) or annual mean (40µg/m^3) objective value to be either approached or exceeded at sensitive receptors near to the Scheme construction area.

6.7.12 The overall risk of construction dust impacts occurring; namely annoyance due to soiling (deposition) and impacts to human health, in the absence of mitigation, is detailed in Appendix 6B. Overall, the risks are high. The mitigation proposals to minimise the risks from fugitive dust and PM_{10} emissions are included in Paragraphs 6.8.6 to 6.8.9. With appropriate mitigation the effects are likely to be not significant.

6.7.13 Embedded mitigation includes construction phase monitoring of dust and PM_{10} at monitoring locations to be agreed with the county planning authority in consultation with GYBC, with baseline monitoring taking place at least 3 months before construction works commence.

Operational Phase

6.7.14 The Application Site is situated within the town centre of Great Yarmouth, within an area with residential properties and other sensitive receptors as defined in Table 6.14. The Scheme introduces a new section of road, the proposed bridge and associated access routes and roundabout which will

introduce new sources of emissions but will also provide an additional crossing over the River Yare redistributing traffic. The highest risk receptors are those that are located close to roads predicted to be subject to changes in traffic flows and speeds because of the Scheme which may experience an increase in concentrations of air pollutants as a result of increased traffic emissions. The sensitive receptors considered within the local air quality operational assessment are presented in Figure 6.2.

6.7.15 Key aspects of the Scheme informing the operational air quality assessment were the Scheme design as described in Chapter 2: Description of the Scheme the changes to traffic informing the environmental assessments within the Traffic Reliability Area and the locations of sensitive receptors in relation to road links predicted to experience changes in traffic specified by DMRB (HA207/07) guidance (Ref 6.2) which defines the LARN. The Traffic Reliability Area is the area within which changes to traffic meet the criteria for screening for assessment of changes to air quality. The DMRB (HA207/07) traffic criteria are specified in Paragraph 6.4.37 and the road links for the local air quality operational assessment are shown in Figure 6.2 and for the regional air quality assessment the traffic criteria are given in Paragraph 6.4.71 and the road links are shown on Figure 6.4. The key Scheme aspects are as set out in Chapter 2: Description of the Scheme.

6.7.16 The assessment of the impact of the Scheme upon local operational air quality is presented in Paragraph 6.10.9 and the assessment of the impact of the scheme upon regional air quality emissions is presented in Paragraph 6.10.16. An assessment was also made of changes to air quality in relation to the Defra Pollution Climate Mapping links as described in Paragraph 6.10.18 and Appendix 6D.

6.7.17 Operational mitigation is not applicable to the operational air quality assessment and no recommendations for operational mitigation have been made. The local air quality operational assessment considers the Scheme Opening Year and does not make an assessment of residual effects. However, due to the improvements in engine technology and changes to the national fleet, emissions are predicted to reduce in the future so the assessment based upon the Opening Year is considered to represent the most cautious emissions scenario.

6.7.18 The regional emissions assessment considers the emissions of pollutants with long range impacts, this assessment considers the changes to emissions as a result of the Scheme in the Opening and Design Year as presented in Table 6.20.

6.8 Construction Phase

Likely Significant Effects

6.8.1 In the absence of further mitigation, construction of the Scheme is considered to represent a high risk with respect to potential dust impacts at

nearby sensitive receptors which could result in a reduction in amenity and in impacts upon health. The construction of the scheme is considered to represent a high risk with respect to potential dust impacts at sensitive ecological receptors as the River Yare element of the Outer Thames Estuary SPA is situated within the Application Site at a distance within 50m of construction activities. As such, a number of mitigation measures are recommended; with reference to IAQM guidance, that are commensurate to the scale and nature of the construction activities.

6.8.2 The sensitivity of receptors situated within 500m of the construction and demolition activities within the Application Site and within 50m of the routes to be used by construction traffic is high, and the potential risk for construction phase dust impacts prior to mitigation, is also predicted to be high. Therefore, there is likely to be a direct, temporary, short-term potentially significant effect on receptors within a distance of up to 500m from the Application Site and within 50m of the construction traffic access routes prior to the implementation of mitigation measures.

Mitigation

6.8.3 Given the proximity of receptors considered sensitive to construction dust and the high-risk rating with respect to potential dust impacts monitoring of dust and PM_{10}, mitigation measures have been incorporated into the Outline CoCP (document reference 6.16) for development into an air quality management plan to be secured through Requirement 5(e) of the draft DCO (document reference 3.1). These measures have been focussed on particularly sensitive locations adjacent to likely construction activity areas.

6.8.4 Dust and PM_{10} monitoring is also included within the Outline CoCP (document reference 6.16) as embedded mitigation for medium to high risk sites, as defined by IAQM. The monitoring locations should be agreed with the county planning authority in consultation with GYBC, with baseline monitoring taking place at least three months before construction works commence.

6.8.5 The following additional mitigation will be applied through the OCoCP with further measures as practicable to be applied to demolition, trackout, and construction activities through the relevant phases of the construction programme.

6.8.6 The following mitigation measures focus on controlling fugitive releases of dust during construction and will be implemented by the contractor through the Outline CoCP (document reference 6.16). Such additional measures include, but may not be limited to:

- Regular monitoring will be undertaken including regular onsite and offsite inspection where receptors are nearby and are accessible, to monitor dust, record inspection results, and make the log available to the local authority when requested. The frequency of site inspections by the

person accountable for air quality and dust issues on site will be increased when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions;

- Site management will be applied to - record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken; make the complaints log available to the local authority when asked; record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book; hold regular liaison meetings with other high risk construction sites within 500m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes.

- Regarding preparing and maintaining the site – the site layout will be optimized so that machinery and dust causing activities are located away from receptors, as far as is possible; solid screens or barriers will be erected around dusty activities or the site boundary that are at least as high as any stockpiles on site; where applicable for specific operations where there is a high potential for dust production and the site is actives for an extensive period full enclosure may be required; Measures will be taken to avoid site runoff of water or mud; Site fencing, barriers and scaffolding will be kept clean using wet methods; Materials that have a potential to produce dust will be removed from site as soon as possible, unless being re-used on site. Stockpiles will be covered to prevent wind whipping.

- Dust generating activities (e.g. cutting, grinding and sawing) will be minimised and weather conditions considered prior to conducting potentially dust emitting activities. Cutting, grinding or sawing equipment will be fitted or used in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems where practicable;

- Fine material will not be stockpiled to an excessive height in order to prevent exposure to wind and dust nuisance;

- Scabbling (roughening of concrete surfaces) will be avoided if possible.
- Sand and other aggregates will be stored in bunded areas and not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
- Bulk cement and other fine powder materials are to be delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
- For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.
- Roads and accesses will be kept clean;
- Where practicable, plant will be located away from site boundaries that are close to residential areas;
- Water will be used as a dust suppressant, where applicable;
- Drop heights from excavators to crushing plant will be kept to a minimum;
- Distances from crushing plant to stockpiles will be kept to the minimum practicable to control dust generation associated with the fall of materials. Use enclosed chutes and conveyors and covered skips; Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate; Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
- Skips will be securely covered;
- Soiling, seeding, planting or sealing of completed earthworks will be completed as soon as reasonably practicable following completion of earthworks;
- Dust suppression and the maintenance of the surface of access routes will be appropriate to avoid dust as far as practicable, taking into account the intended level of trafficking;
- Wheel wash facilities to minimise trackout of dust;
- Material will not be burnt on site; and
- Engines will be switched off when not in operation.

- A Framework Construction Traffic Management Plan is given in Appendix A to the OCoCP to minimise any adverse effects related to construction traffic.

6.8.7 The following mitigation measures focus on controlling fugitive releases of demolition dust and will be implemented by the contractor through the Outline CoCP (document reference 6.16). Such additional measures include, but may not be limited to:

- Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where practicable, to provide a screen against dust).
- Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.
- Avoid explosive blasting, using appropriate manual or mechanical alternatives.
- Bag and remove any biological debris or damp down such material before demolition.

6.8.8 The following mitigation measures focus on controlling fugitive releases of dust due to trackout and will be implemented by the contractor through the Outline CoCP (document reference 6.16). Such additional measures include, but may not be limited to:

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.
- Avoid dry sweeping of large areas.
- Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
- Record all inspections of haul routes and any subsequent action in a site log book.
- Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.

- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).
- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.
- Access gates to be located at least 10m from receptors where practicable.

6.8.9 The following mitigation measures focus on controlling fugitive releases of dust due to earthworks and will be implemented by the contractor through the Outline CoCP (document reference 6.16). Such additional measures include, but may not be limited to:

- Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.
- Use Hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
- Only remove the cover in small areas during work and not all at once.

6.8.10 The Outline CoCP (document reference 6.16) requires that the full CoCP stipulates the following to ensure the aforementioned mitigation is implemented effectively, continually monitored and updated accordingly:

- Identification of a responsible environmental manager; and
- Method statements for the control of dust in such locations.

6.8.11 The mitigation measures will reduce both the magnitude and duration of fugitive dust releases throughout the construction phase. With these measures in place, the residual dust impact will be, at worst, slight adverse at the highest risk receptors located downwind and within 50m of construction activities (as per IAQM Guidance, see Table 6.6).

6.8.12 Any such, impacts are expected to be intermittent and temporary for the duration of the respective activities and therefore would not constitute a significant environmental effect.

Residual Effects

6.8.13 The sensitivity of receptors situated within 500m of the construction and demolition activities within the Application Site and within 50m of the routes to be used by construction traffic is high, following mitigation the risk of construction dust impacts will be reduced. Therefore, there is unlikely to be a residual or significant effect on receptors within a distance of up to 500m

from the Application Site and within 50m of the construction traffic access routes.

Monitoring

6.8.14 Real-time continuous PM_{10} monitoring before the construction begins to establish a baseline and throughout the construction phase is recommended to monitor construction dust emissions and is set out in the Outline CoCP (document reference 6.16).

Operational Phase

Local Air Quality Assessment

6.8.15 A total of 10,787 sensitive receptors (see Table 6.14) were selected for inclusion in the atmospheric dispersion modelling assessment, most of which are situated in the urban area of Great Yarmouth. The Operational Study Area incorporating the sensitive receptors which could potentially experience a reduction in amenity or impacts upon health are presented in Figure 6.2.

6.8.16 The Scheme Base Year is 2018, however for Air Quality modelling purposes the 2018 traffic has been used to determine emissions for the year 2017 and a Base Year of 2017 has been modelled. The traffic data provided for 2018 is applicable to 2017 as no significant growth in traffic was expected between the two years, as stated in the Economic Appraisal Report (document reference 7.6) and the Transport Assessment (document reference 7.2.A). Air Quality dispersal modelling requires a historical meteorological dataset and was undertaken using 2017 meteorological data and model verification was completed based on 2017 ambient air quality monitoring data.

6.8.17 A summary of the modelled annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations across the assessment study in the base year (2017) and Scheme opening year (2023) is provided in Table 6.17.

Table 6.17: Summary of Predicted Annual Mean NO_2, PM_{10} and PM_{25} Concentrations at Sensitive Receptor Locations in Base (2017) and Opening Year (2023)

Factor	Parameter	NO_2	PM_{10}	$PM_{2.5}$
	Annual Mean Objective	**40 µg/m³**	**40 µg/m³**	**25 µg/m³**
Number exceedances of the respective	Base 2017 Exceedance	15	0	0
	DM 2023 Exceedance	0	0	0
	DS 2023 Exceedance	0	0	0

Factor	Parameter	NO_2	PM_{10}	$PM_{2.5}$
	Annual Mean Objective	**40 µg/m³**	**40 µg/m³**	**25 µg/m³**
objective by scenario	New Exceedance	0	0	0
Total number of receptors with:	Improvement in Concentration	4,423	3,295	1,995
	Deterioration in Concentration	5,631	3,655	2,590
	No Change in Concentration	733	3,837	6,202
DS-DM Annual Mean Change (µg/m³)	Maximum Worsening	8.5	2.1	1.1
	Maximum Benefit	-9.3	-1.9	-1.1

Maximum Worsening and Benefit at Sensitive Receptor Locations in 2023						
Maximum	**Receptor**	**X**	**Y**	**DM**	**DS**	**Change**
Worsening	31890	652647.88	306043.62	17.9	26.4	8.5
Benefit	16380	652358.12	307310.81	32.1	22.8	-9.3

6.8.18 For clarity, the monitoring results presented in Table 6.12 and Table 6.13 for the Base year represent monitoring locations where measurements from ambient air were taken. The Base scenario results presented in Table 6.17 are a prediction of pollutant concentration at sensitive receptor locations based upon dispersion modelling of emissions from vehicle movements.

6.8.19 The dispersion modelling results demonstrate that there are 15 predicted exceedances of the annual mean NO_2 objective in the base year scenario, which are located on Hall Quay to the east of the junction with the existing Bascule Bridge and on the approach along South Quay between Hall Plain and Yarmouth Way. These properties consist of flats above commercial properties and terraced housing. The maximum predicted exceedance in the Base year is 45.6µg/m³ (5.6µg/m³ over the objective concentration) and the minimum exceedance is 40.2µg/m³ (0.2µg/m³ over the objective concentration). However, as a result of decreased emissions, these exceedances are predicted to be removed by 2023 in both the DM and DS scenarios, with no exceedances of any pollutant predicted. A greater improvement is observed in the DS scenario at the aforementioned properties when compared with the DM scenario, thereby these properties are predicted to experience an improvement in air quality with the Scheme in place.

6.8.20 The dispersion model has been verified against Scheme-specific and local authority monitoring of NO_2. Variations in the adjusted modelled versus monitored NO_2 values still occur due to the extent of the operational Study

Area and the number of monitoring locations used in the verification process. Therefore, whilst the baseline monitoring has not recorded any exceedances of the NO_2 annual mean objective within the operational Study Area, predicted exceedances at other locations within the model domain can occur where the distance between a road source and receptor is lower and/or due to variations in modelled traffic flows, composition and speed, particularly closer to junctions.

6.8.21 The model verification process is detailed in Appendix 6C and, through appropriate adjustment, has been shown to be performing within the recommended guidelines stated by Defra in LAQM TG(16), page 132 'Model Uncertainty' (Ref 6.2).

6.8.22 In the Opening Year, 4,423 receptors are predicted to experience an improvement in NO_2 annual mean concentrations, with 733 receptors experiencing no change, and 5,631 receptors experiencing a deterioration (see Figure 6.14).

6.8.23 The predicted magnitude of changes in annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations across all modelled sensitive receptors is presented in Figures 6.14, 6.15 and 6.16.

6.8.24 The majority of improvements in annual mean NO_2 concentrations are predicted to occur along the access routes to the existing A1243 Haven Bascule Bridge and A47 Breydon Bridge. The maximum improvement (-9.3 $\mu g/m^3$) is predicted to occur at a receptor situated adjacent to South Quay on the approach to the existing Haven Bascule Bridge, with the resulting annual mean value remaining well below the objective value.

6.8.25 Conversely, the locations predicted to experience the maximum worsening of NO_2 levels comprise properties along routes that traffic will use to access the Scheme (see Figure 6.14). The maximum deterioration of NO_2 (+8.5 $\mu g/m^3$) is predicted to occur on the A1243 junction with Sutton Road close to where the Scheme ties in to the existing road network, although the total annual mean value is predicted to remain below the objective value.

6.8.26 For the 1-hour mean objective for NO_2, in LAQM TG(16), Table 6.2, Defra advises that if the annual mean NO_2 concentration is less than 60$\mu g/m^3$, the hourly mean objective is not likely to be exceeded. The predicted maximum annual mean NO_2 concentration in the DS scenarios is 26.4$\mu g/m^3$ at a sensitive receptor adjacent to the A1243 and in proximity to the junction with Sutton Road. As such, the 1-hour mean objective is considered unlikely to be exceeded in the operational phase and has not be considered further in this assessment.

6.8.27 With regard to PM_{10} annual mean concentrations, 3,295 receptors are predicted to experience an improvement, with 3,837 receptors predicted to experience no change in concentration and 3,655 receptors experiencing a worsening in the operational phase (see Figure 6.15).

6.8.28 The IAQM and Defra guidance provides an approach to assessing the relationship between annual mean and 24-hour mean concentrations of PM_{10}. Potential exceedances of the 24-hour objective are more likely where the annual mean concentration is over 32µg/m^3. Given that all predicted annual mean PM_{10} values are well below this level, exceedances of the 24-hour objective are very unlikely both with and without the Scheme in operation and has not been considered further in this assessment.

6.8.29 For $PM_{2.5}$, 1,995 receptors are predicted to experience an improvement in $PM_{2.5}$ annual mean concentrations, 6,202 receptors are predicted to experience no change, and 2,590 receptors to experience a worsening, in the operational phase (see Figure 6.16).

6.8.30 The predicted magnitude of changes in annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations across all modelled sensitive receptors are summarised in Table 6.18. These were calculated with reference to the magnitude of change criteria provided in IAQM guidance. Given that there are no predicted exceedances of any pollutant in the Opening Year scenarios, it has not been necessary to use IAN 174/13 guidance to inform significance.

6.8.31 In terms of changes in annual mean NO_2, 10,511 of the 10,787 sensitive receptors are predicted to experience a negligible change in annual mean concentrations in accordance with IAQM guidance, with 82 sensitive receptors experiencing a slight improvement, 101 sensitive receptors experiencing a slight worsening, 66 sensitive receptors experiencing a moderate improvement and 27 sensitive receptors experiencing a moderate worsening. Of the 101 receptors predicted to experience a slight worsening and the 27 receptors experiencing a moderate worsening, all the predicted concentrations at these properties remain below 2 µg/m^3, which is well below the annual mean NO_2 objective.

6.8.32 The 27 locations predicted to experience a moderate worsening in NO_2 are situated at the junction of Sutton Road with South Denes Road (A1243), along Cromwell Road and between Queen Anne's Road close to where the Scheme will join the existing road network and to the new roadway forming the river crossing. There are also predicted increases on Mariners Road and on Blackfriars Road near to the junction with Malakoff Road. The increases on Mariners Road and Blackfriars Road are a result of the expected routing of traffic to the Scheme in the DS Scenario, which otherwise would have used the Haven Bridge route in the DM Scenario.

6.8.33 For both PM_{10} and $PM_{2.5}$, the annual mean changes are imperceptible in the operational phase.

Table 6.18: Predicted Change in Annual Mean Concentrations in the Opening Year for Concentrations below 75% of AQAL

Value of Change in Annual Average NO_2/PM_{10}/$PM_{2.5}$	NO_2	PM_{10}	$PM_{2.5}$
>10% improvement	66	0	0
>5 to 10% improvement	82	0	0
≤1% to 5% worsening or improvement	10,511	10,787	10,787
>5 to 10% worsening	101	0	0
>10% worsening	27	0	0

6.8.34 The sensitivity of the sensitive receptors is considered to be high, and the magnitude of change prior to mitigation, is considered to be predominantly imperceptible with minor to moderate increases and decreases in NO_2, PM_{10} and $PM_{2.5}$ concentrations in the Scheme Opening Year 2023 at a comparatively small number of sensitive receptors across the Study Area. Therefore, there is likely to be a direct, medium to long-term effect (**negligible** (not significant)) effect on the majority of the sensitive receptors within the Study Area.

Mitigation

6.8.35 There are no appropriate mitigation measures for operational air quality impacts.

Residual Effects

6.8.36 The assessment of operational air quality has not resulted in the recommendation of mitigation and therefore 'residual' effects are not considered as a distinct part of the assessment.

Monitoring

6.8.37 No monitoring is considered to be required for the Scheme in operation as a result of this assessment as there are no predicted exceedances of the AQS objectives for NO_2, PM_{10} or $PM_{2.5}$ as a result of the Scheme in the Opening Year 2023 and the predicted impacts upon local air quality are predominantly negligible (see Table 6.18), and are not significant.

Ecological Assessment

6.8.38 An assessment of change in air quality at the relevant designated site (Breydon Water SSSI, SPA and Ramsar), was undertaken with reference to the DMRB (HA207/07) guidance. The detailed results for a modelled transect representing the Breydon Water ecological site are given in Appendix 8G and the results are visualised in Figure 6.18 and 6.19.

6.8.39 The annual mean NO_x objective (30 µg/m^3) is not predicted to be exceeded at the Breydon Water SSSI, SPA, and associated Ramsar. A description of the Breydon Water SSSI/SPA/Ramsar is given in the Habitats Regulations Assessment (document reference 6.11). The assessment transect was modelled from the boundary of Unit 10 of the designated site nearest the A47 New Road into the ecological site. Breydon Water SSSI Unit 10 is designated for the protection of the habitat of Lowland Neutral Grassland and is specified as being in favourable condition.

6.8.40 The SSSI designation covers units of Littoral Sediment not considered sensitive to changes in Nitrogen Deposition rates of NO_x. and Lowland Neutral Grassland which is considered sensitive as present in Unit 10. The coverage of the traffic model Traffic Reliability Area, which is based upon the area over which changes in traffic should be considered where the changes in traffic are potentially in exceedance of the criteria set out in the DMRB as given Section 6.4, and therefore qualify as part of the LARN, did not extend for the entirety of the perimeter of Breydon Water, however coverage of the LARN was sufficient to make an assessment for the NO_x and nitrogen sensitive neutral grassland habitat in SSSI Unit 10.

6.8.41 The Breydon Water SPA citation is for European ornithological importance and the RAMSAR designation is for the habitats importance for wintering waterfowl. The predicted rates of nitrogen deposition with and without the Scheme in the Opening year were compared to the respective critical loads (CL) for the habitats within the ecological site to determine the potential for significant effects.

6.8.42 The nitrogen deposition rates predicted at the Breydon Water SSSI / Ramsar/ SPA are within the relevant critical load for the habitat in the Opening Year DM and DS scenarios as given in Table 6.19, representing approximately 50% of the lower end of the critical load range. The detailed nitrogen deposition rates for the ecological site assessed are given in Appendix 6G.

6.8.43 In the DS scenario, the highest nitrogen deposition rate of 10.3kgN.ha^{-1}.yr^{-1} was calculated for the Breydon Water SSSI at the edge of Unit 10 70m from the A47 New road.

6.8.44 The Nitrogen deposition rate does not change up to a distance of 155m with the scheme in operation as presented in Appendix 6G. Therefore, the Scheme is not expected to have a significant environmental effect on Unit 10 of the Breydon Water SSSI/SPA/Ramsar site (see Chapter 8, Section 8.7).

6.8.45 The sensitivity of the Breydon Water SSSI/Ramsar/SPA is considered to be high, and the magnitude of change prior to mitigation, is considered to be negligible. Therefore, there is likely to be no direct, temporary or long-term (**negligible** (not significant)) effect on the Breydon Water SSSI/Ramsar/SPA prior to the implementation of mitigation measures.

Table 6.19: Ecological Assessment Outputs Opening Year 2023

Ecological Site	Habitat Description	Habitat Critical Load (kg N ha^{-1} yr^{-1})	DM 2023 Maximum NOx Concentration ($\mu g/m^3$)	DM 2023 Maximum Nitrogen Deposition Rate (kg N ha^{-1} yr^{-1})*	DS 2023 Maximum NOx Concentration ($\mu g/m^3$)	DS 2023 Maximum Nitrogen Deposition Rate (kg N ha^{-1} yr^{-1})*
Breydon Water SSSI Unit 10**	Lowland Neutral Grassland Feature sensitive to Nitrogen: Wigeon and Shellduck	20-30	13.3	10.3	13.3	10.3

*Baseline conditions Nitrogen deposition rate obtained from APIS for site specific coordinates.
**Designated site as defined by DMRB HA207/07 (SACs, SCI's, cSCI's, SPA's, pSPA's, SSSI's and Ramsar sites). Base conditions also apply to areas of The Broads SAC and the Broadland RAMSAR site.

Mitigation

6.8.46 No mitigation measures have been proposed for the operational phase in relation to potential ecological impacts upon Unit 10 of the Breydon Water SSSI/SPA/Ramsar site.

Residual Effects

6.8.47 There is unlikely to be a direct, temporary or long-term effect upon Unit 10 of the Breydon Water SSSI/SPA/Ramsar site and therefore residual effects are not predicted.

Monitoring

6.8.48 No monitoring is considered to be required.

Regional Air Quality Assessment

6.8.49 A regional assessment of total emissions was undertaken for the opening year (2023) and design year (2038), focussing on the change in emissions of NO_x, PM_{10}, and CO_2 between the DM and DS scenarios for the Opening year and Design Year. The results of the assessment are presented in Table 6.20.

Table 6.20: Regional Emissions Assessment Outputs

Scenarios	Pollutant Emission (tonnes per year)		
	NO_x	PM_{10}	CO_2
Base Year (2018)	142.1	12.8	57,428
Do-Minimum (2023)	94.2	12.8	59,008
Do-Something (2023)	92.8	12.6	57,949
% Change from DM - DS (2023)	-1.5%	-1.6%	-1.8%
Do-Minimum (2038)*	62.8	14.6	65,931
Do-Something (2038)*	62.2	14.5	65,055
% Change from DM - DS (2038)	-1%	-0.7%	-1.3%
*Based on vehicle emissions factors for 2030, which is the latest future year for which projected vehicle emission factors are currently published by Defra.			

6.8.50 Overall, total emissions of each pollutant and CO_2 are predicted to decrease between the DM and DS scenarios in both the Opening (2023) and Design (2038) years. In the Opening Year (2023), this decrease in emissions equates to 1.4 tonnes per year for NO_x, 0.2 tonnes per year for PM_{10}, and 1,059 tonnes per year for CO_2.

6.8.51 In the Design Year (2038), the predicted decreases in NO_x PM_{10} and CO_2 emissions in the DS scenario relative to DM equate to 0.6 tonnes per year for NO_X, 0.1 tonnes per year for PM_{10} and 876 tonnes per year CO_2.

6.8.52 The National Atmospheric Emissions Inventory (NAEI) compiles data on UK CO_2 emissions by local authority and national data for emissions of NO_x and PM_{10}. The total emissions of CO_2 from the road sector within Great Yarmouth for the most recent available year (2016) were 114,345 tonnes.

6.8.53 In the context of the overall regional emissions, the predicted decrease in annual emissions of CO_2 (1,059 tonnes and 876 tonnes, respectively), attributed to the operational phase of the Scheme are not considered to represent a significant environmental effect.

6.8.54 The reported national emissions of NO_x and PM_{10} for the most recently available year (2016) were 893,000 tonnes and 170,430 tonnes, respectively. The predicted decrease in annual emissions of NO_x (1.4 tonnes and 0.6 tonnes) and PM_{10} (0.2 and 0.1 tonnes) in each assessment year are therefore not considered to be significant in the context of the national emissions.

Likely Significant Effects on Local Air Quality

6.8.55 The significance of local air quality changes as a result of the Scheme has been assessed with reference to IAQM guidance. Assessment against Highways England guidance is not required as IAN 174/13 only applies where the concentrations with the Scheme are within 10% of the objective for an assessed pollutant.

6.8.56 Of the 10,787 sensitive receptors assessed, there are no receptors predicted to exceed the annual mean objective value for each pollutant in the opening year (2023). None of the predicted air pollutant concentrations reported in the Scheme opening year at the identified sensitive receptors are within 10% of the respective objective value.

6.8.57 The change in annual mean concentrations of NO_2 at the sensitive receptors is shown in Figure 6.14 for PM_{10}, Figure 6.15 and for $PM_{2.5}$ Figure 6.16. A summary of the predicted changes in pollutant concentrations at the sensitive receptors is provided in Table 6.17 and Table 6.18 which have been used to inform the judgement on whether the Scheme is likely to have a significant effect on local air quality.

6.8.58 The impact descriptors provided by the IAQM guidance have been adopted to describe the potential impact of the Scheme on local air quality at each of the identified relevant receptors. The predicted impact at each receptor is described in Table 6.21 for the opening year (2023).

6.8.59 The local air quality impacts associated with the operation of the Scheme are predicted to be predominantly negligible, with more properties predicted to experience a moderate improvement in air quality as opposed to a moderate

worsening. There are 15 sensitive receptors predicted to be in exceedance of the 40µg/m^3 objective for NO_2 in the Base year, which are predicted to reduce below the objective in the Opening Year. The Proposed Scheme is not predicted to result in any new exceedances of the objective for NO_2, PM_{10} or $PM_{2.5}$.

6.8.60 Based on the results of the local air quality assessment and evaluation within the context of the significance criteria, the Scheme will not constitute a significant environmental effect with respect to local air quality.

Table 6.21: Predicted Sensitive Receptor Impact (IAQM)

Impact Descriptor (IAQM)	Pollutant		
	NO_2	PM_{10}	$PM_{2.5}$
Substantial improvement	0	0	0
Moderate improvement	66	0	0
Slight improvement	82	0	0
Negligible	10511	10787	10787
Slight worsening	101	0	0
Moderate worsening	27	0	0
Substantial worsening	0	0	0

6.8.61 The Scheme has no predicted exceedances of the health-based air quality objectives for air pollutants NO_2, PM_{10} and $PM_{2.5}$ as a result of the Scheme.

6.8.62 In terms of assessing compliance with the *EU Ambient Air Quality Directive* air pollutant limit values, based upon the outcome reported in Appendix 6D, the Scheme will not result in a zone becoming non-compliant or affect the ability of the region to achieve compliance.

Likely Significant Effect Regional Emissions

6.8.63 The predicted magnitude of changes in emissions associated with the operational Scheme for both the opening year (2023) and future year (2038) are likely to be insignificant within the context of total regional and national emissions. This is evidenced through the comparison of predicted decreases associated with the Scheme to the most recently published regional and national annual emissions reported by NAEI (see Paragraph, 6.8.53 and 6.8.54).

6.8.64 Therefore, changes in regional emissions as a result of the Scheme are not considered to constitute a significant environmental effect.

Mitigation

6.8.65 As there are no likely significant effects identified during the operation of the Scheme, no additional mitigation measures for operational Air Quality are required.

Residual Effects

6.8.66 No exceedance of the air quality objective values for NO_2, PM_{10} or $PM2_{.5}$. are predicted in the Opening Year as a result of the Scheme. The Scheme will not constitute a significant environmental effect with respect to local air quality.

Monitoring

6.8.67 No monitoring is considered to be required.

6.9 Limitations and Assumptions

6.9.1 Calculations of emissions from traffic have been based on the latest available emission factors at the time of the assessment using the DEFRA EFT. It has been assumed that the emission factors are representative as the EFT is the official source of such data for use in air quality assessments.

6.9.2 The air quality dispersal modelling was conducted with 2017 meteorological data from the nearest coastal meteorological station. This is situated approximately 55 kilometres to the north east of Great Yarmouth but was the best available data.

6.9.3 Traffic data covering the whole perimeter of the Breydon Water SSSI/SPA/Ramsar site was not within the Traffic Reliability Area considered to be applicable to the Scheme as explained in Paragraph 6.8.40.

6.9.4 The traffic data upon which the ecological assessment is made includes the eastern portion of the A47/New Road as detailed in Figure 6.18 and 6.19, the A47 being the major road in proximity to Breydon Water. The ecological assessment has focussed on Unit 10 of the Breydon Water SSSI/SPA/Ramsar site this being the habitat that is sensitive to changes in air quality within 200m of an affected road.

6.9.5 The traffic data supplied as 2018 has been confirmed as suitable for a 2017 model Base Year and modelled as such as per Paragraph 6.4.40.

6.9.6 The air quality dispersal modelling has been verified by comparison of the modelled data versus air quality monitoring data to ensure that the model is representative of the local area, but the predicted results are presented within the range of uncertainty determined through the verification process as presented in Appendix 6C.

6.10 Summary

6.10.1 This assessment has considered the change in air quality as a result of changes to traffic emissions associated with the Scheme. This has been assessed in the context of (i) Local Air Quality during the construction and operation of the Scheme; and (ii) Regional Air Quality.

Baseline Air Quality

6.10.2 Air quality monitoring undertaken by GYBC and Scheme-specific monitoring has demonstrated that NO_2 annual mean concentrations are greatest to the west of the existing bascule bridge over the River Yare, and on South Quay and connecting routes on the approach to the existing Haven bridge. However, there were no monitored exceedances of the annual mean objective for NO_2 throughout Great Yarmouth.

6.10.3 Background air quality in Great Yarmouth is good, with NO_2, PM_{10} and $PM_{2.5}$ annual mean background concentrations reported to be well below the respective objective values.

6.10.4 There are no AQMAs designated within Great Yarmouth.

Construction Phase

6.10.5 The construction phase air quality assessment has demonstrated that, in the absence of mitigation, the scale and nature of the Scheme construction, including demolition, represent a high risk of dust related impacts. The highest risk sensitive receptors are those located within 50m and downwind of potential dust-generating activities.

6.10.6 Mitigation measures will be implemented and secured via the full CoCP (Requirement 5(e) of the draft DCO, document reference 3.1) to prevent or minimise potential fugitive dust emissions. With these measures in place, the residual dust impact will be, at worst, slight adverse at the highest risk receptors.

6.10.7 Any such impacts are expected to be intermittent and temporary for the duration of the respective activities only and would not constitute a significant environmental effect.

Operation Phase

6.10.8 Operational phase air quality impacts are expected to be associated with changes to vehicle emissions caused by the implementation of the Scheme. Although residual worsening effects can be expected in the area of the Scheme and approach routes to the new crossing, in future years improvements in emissions are forecast.

Local Air Quality

6.10.9 The assessment has demonstrated that the operational Scheme would not result in any new exceedances of the air quality objectives for NO_2, PM_{10} and $PM_{2.5}$ at all sensitive receptor locations included in the detailed atmospheric dispersion modelling study. Indeed, there are predicted to be no exceedances of these objectives in both the Do Minimum and Do Something Opening Year (2023) scenarios.

6.10.10 Of the 10,787 sensitive receptors included in the modelling study, an improvement in annual mean pollutant concentrations is predicted to occur at 4,423 receptors (NO_2), 3,295 receptors (PM_{10}), and 1,995 receptors ($PM_{2.5}$) with the Scheme in operation when compared to without in the Opening Year (2023).

6.10.11 In contrast, 5,631 sensitive receptors are predicted to experience a worsening in annual mean concentrations of NO_2, 3,655 to experience a worsening in PM_{10}, and 2,590 receptors to experience a worsening $PM_{2.5}$.

6.10.12 The majority of the predicted changes in air pollutant concentrations, both improving and worsening, are classed as negligible or slight, A small number of changes are classed as moderate. In all cases, the predicted total pollutant concentrations in the 2023 DS scenario are well below the respective health-based national air quality objective.

6.10.13 Through adopting the significance criteria in the guidance provided by IAQM, the local air quality impacts associated with the operation of the Scheme (see Table 6.21) would not constitute a significant environmental effect.

Health Impacts

6.10.14 Assessment of the changes to air quality within the Local Air Quality Assessment against the Air Quality Standards objectives set for the protection of human health does not indicate an exceedance of the objective values for NO_2, PM_{10} or $PM_{2.5}$ as a result of the operation of the Scheme in the Opening Year 2023. Therefore, the Scheme is not predicted to result in significant health impacts. Health impacts are not predicted as a result of construction dust with application of the mitigation measures commensurate to a high-risk site as explained in Paragraph 6.8.6 and Appendix 6B to be applied through the Outline CoCP (document reference 6.16).

6.10.15 With the recommended mitigation measures in Paragraph 6.8.6 applied in accordance with IAQM guidance (Ref 6.4), the construction of the Scheme is not predicted to result in health impacts as a result of construction dust.

Regional Emissions

6.10.16 The assessment has demonstrated that emissions of oxides of nitrogen, particulates (PM_{10}) and carbon dioxide would all decrease during the operational phase of the Scheme in the opening year (2023) and the design

year (2038). Decreases in regional emissions with the Scheme are not considered to constitute a significant environmental effect within the context of the total regional and national emissions.

Designated Sites

6.10.17 No significant environmental effects are predicated within the assessed statutory designated ecological sites, as defined by the DMRB, during the operational phase of the Scheme.

NPS NN Compliance

6.10.18 The Scheme is not predicted to cause non-compliance with the NPS NN. There are no predicted impacts upon an existing AQMA and the Scheme would not affect the UK's ability to comply with the EU Ambient Air Quality Directive.

Table 6.22: Summary of Effects Table for Air Quality

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Potential for construction dust impacts at sensitive receptor locations	Receptors with the largest potential impacts form the high-risk construction site are those situated within 20m of the Application Sites, impacts may be experienced up to a distance of up to 500m from the Application Sites for dust when including trackout.	Moderate Significance ●-/T /D /ST	Recommended mitigation measures are given in Paragraph 6.8.6.	Negligible to slight adverse Significance ●- /T /D /ST
Operational Phase				
NO_2 concentrations at sensitive receptor locations	Receptor with largest increase in NO_2 was receptor 31890 with an increase of +8.5 µg/m^3 on South Denes Rd the greatest decrease in NO_2 of -9.3 µg/m^3 was predicted at receptor 16380 on South Quay.	Negligible Significance ●Neutral (both +/-)/D/ MT-LT	There are no relevant mitigation measures for local air quality.	Negligible Significance ●Neutral (both +/-)/D/ MT-LT

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
PM_{10} concentrations at sensitive receptor locations	Receptor with largest increase in PM_{10} was receptor 31890 with an increase of + 2.1 µg/m^3 on South Denes Rd, the greatest decrease in PM_{10} of -1.9 was predicted at µg/m^3 receptors 16380 and 7264 on South Quay.	Negligible Significance ●Neutral (both +/-) /D / MT-LT	There are no relevant mitigation measures for local air quality.	Negligible Significance ●Neutral (both +/-) /D /MT-LT
$PM_{2.5}$ concentrations at sensitive receptor locations	Receptor with largest increase in $PM_{2.5}$ was receptor 31890 with an increase of + 1.1 µg/m^3 on South Denes Rd the greatest decrease in $PM_{2.5}$ of -1.1 µg/m^3 was predicted at receptor 16380 on South Quay.	Negligible Significance ● Neutral (both +/-) /D/ MT-LT	There are no relevant mitigation measures for local air quality.	Negligible Significance ●Neutral (both +/-) /D / MT-LT

Key to table:

+ / - = Positive or Negative P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short-Term, Medium-Term or Long-Term N/A = Not Applicable

6.11 References

Ref 6.1: United Nations Economic Commission for Europe (UN/ECE) (2003), Empirical Critical Loads for Nitrogen. UN/ECE. 2003. Expert workshop.

Ref 6.2: Department for Transport (2007), Design Manual for Roads and Bridges (DMRB) HA207/07 Volume 11, Section 3, Part 1 Air Quality.

Ref 6.3: Institute of Air Quality Management (IAQM) (2017), Land Use Planning and Development Control Planning for Air Quality.

Ref 6.4: Institute of Air Quality Management (IAQM) (2014), Guidance on the Assessment of Dust from Demolition and Construction.

Ref 6.5: Defra (2016), Local Air Quality Management Technical Guidance LAQM TG(16).

Ref 6.6: Highways England (2013), IAN 175/13 Updated air quality advice on risk assessment related to compliance with the UE Directive on ambient air quality and on the production of Scheme Air Quality Action Plans for users of DMRB Volume 11, Section 3, Part 1 'Air Quality'.

Ref 6.7: Highways England IAN (2013), 174/13 Updated advice for evaluating significant local air quality effects.

Ref 6.8: JNCC (2018), APIS Air Pollution Information System accessed on 25/10/18.

Ref 6.9: Defra (2008), Diffusion Tubes for Ambient NO2 Monitoring: Practical Guidance for Laboratories and Users.

Ref 6.10: Defra (2018), Automatic Urban and Rural Network Introduction.

Ref 6.11: Defra (2018), Diffusion Tube Local Bias Adjustment AEA Precision and Accuracy Spreadsheet.

Ref 6.12: Defra 2017. UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations Technical Report July 2017.

Ref 6.13: Defra (2017), NO_2 projections data (2015 reference year), online, as accessed on 08/10/18.

Ref 6.14: Air Quality England (2019), Air Quality England Air Pollution Report for CM2 at South Denes – Site GYBC1.

Ref 6.15: Defra (2017), Defra Background Concentration Maps User Guide Appendix A: Background maps sectors.

7 Noise and Vibration

7.1 Introduction

7.1.1 This Chapter reports the outcome of the assessment of likely significant effects arising from the Scheme in respect of noise and vibration. The chapter considers the potential effects of construction noise and vibration to neighbouring properties. The chapter considers the potential effects of operational road traffic noise and vibration to properties.

7.1.2 The Chapter describes the assessment methodology and the baseline conditions at the Principal Application Site and in the surrounding area. It describes any embedded mitigation adopted for the purposes of the assessment and gives a summary of the likely significant effects taking into account national legislation, the additional mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

7.1.3 This Chapter (and its associated figures and appendices) is intended to be read as part of the wider ES including in particular Chapter 8: Nature Conservation.

7.1.4 The assessment has focused on the identification of likely significant effects at Noise Sensitive Receptors (NSRs) from construction noise, construction related vibration and operational noise. Appropriate mitigation of significant adverse effects is also identified.

7.1.5 This chapter builds on the findings and recommendations of the Scoping Opinion and PEIR, and, includes assessment of construction noise and vibration; construction traffic; operational road traffic and the new bridge opening (wig wag) alarm.

7.1.6 The assessment has been informed by relevant policies, legislation, standards and guidelines relating to noise and vibration, the most relevant of which are the Government's Noise Policy Statement for England (Ref 7.1) and the DMRB (Ref 7.2). The content of these and other relevant documents has been summarised in this chapter.

7.1.7 The general approach adopted for the noise and vibration assessment has been to:

- Identify locations where noise or vibration is likely to be generated during the construction and operation of the Scheme. This may include locations that are not in the immediate vicinity of the route corridor, and existing roads that do not form part of the Scheme but may exhibit a change in noise level because of changes in traffic flow;

- Identify NSRs near those locations where noise or vibration, or a change in noise or vibration, is likely to be generated as part of the Scheme;
- Calculate the levels of noise or vibration, or the change in noise or vibration levels, that would be experienced at those identified NSRs;
- Evaluate the significance of the calculated levels of noise or vibration, or the change in noise and vibration levels, considering the relevant legislation, standards and guidelines;
- Identify and assess potential mitigation measures where potentially significant adverse noise or vibration effects are predicted to occur and more generally to improve or enhance the noise and vibration climate wherever possible; and
- Identify residual potentially significant noise or vibration effects with mitigation in place.

7.1.8 The calculation and assessment methodologies used to predict the noise and vibration effects associated with the Scheme and the methods for identifying and assessing significant effects are described in this chapter.

7.2 Competent Expert

7.2.1 The noise and vibration lead, Robin Brown, is a Principal Acoustic Consultant, Member of the Institute of Acoustics (MIOA), and holds a BSc (Hons) degree in Audio Technology from The University of Salford (2004). The noise and vibration lead has six years' experience regarding EIA.

7.3 Legislation, Policy and Guidance Summary

7.3.1 The legislation, policy and guidance relevant to noise and vibration is detailed in Appendix 7A.

7.3.2 Table 7.1 provides a summary of the key legislation, policy and guidance for this assessment.

7.3.3 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 7A (document reference 6.2).

Table 7.1: Summary of Key Policy and Guidance

Policy/ Guidance	Summary	Chapter Reference
National Policy Statement for National Networks 2014 (NN NPS) **(Ref 7.3)**	Published by the Department for Transport, the NN NPS was designated for use by the Secretary of State in January 2015. It provides planning guidance for promoters of nationally significant infrastructure projects on the road and rail networks. Paragraph 5.189 of the NN NPS states where a development is subject to EIA and significant noise effects are likely to arise from the Scheme, the applicant should include a noise assessment which details the noise and vibration baseline, sensitive receptors, predictions of changes in baseline with the Scheme and mitigation measures. For operational noise paragraph 5.191 states that effects on human receptors 'should be assessed using the principles of the relevant British Standards and other guidance' and that 'prediction of road traffic noise should be based on the method described in the Calculation of Road Traffic Noise' (1988). For the prediction and assessment of construction noise, it is stated that 'reference should be made to any relevant British Standards and other guidance which also give examples of mitigation strategies'. The NN NPS goes on to state in paragraph 5.193 that developments must be undertaken in accordance with the statutory requirements for noise and that due regard must be given to the relevant sections of the NPSE and the NPPF. Paragraph 5.195 states that the *"Secretary of State should not grant development consent unless satisfied that the proposals will meet, the following*	The chapter conforms with the NN NPS by promoting the management of noise and vibration impacts through effective mitigation. All road traffic noise predictions have been completed in accordance with the calculation methodology presented in CRTN (1988) and Annex 4 of DMRB HD 213/11. See Section 7.8.

Policy/ Guidance	Summary	Chapter Reference
	aims, within the context of Government policy on sustainable development: • *avoid significant adverse impacts on health and quality of life from noise as a result of the new development;* • *mitigate and minimise other adverse impacts on health and quality of life from noise from the new development; and* • *contribute to improvements to health and quality of life through the effective management and control of noise, where possible".* The NN NPS also confirms that for most national network projects, the relevant Noise Insulation Regulations would apply.	
National Policy Statement for Ports 2012 (PNPS) **(Ref 7.4)**	The PNPS sets out the Government's strategy for new port infrastructure to meet current and future needs. It determines the approach planning decision-makers should take with respect to ports and port infrastructure proposals. The PNPS requires an applicant to assess the noise generating aspects of a development on the marine and terrestrial environment including noise sensitive areas and noise sensitive species which has been informed by the existing marine and terrestrial noise environment. These assessments should then identify any measures that are included to mitigate the effects of noise.	This chapter conforms with the PNPS by promoting the management of noise and vibration impacts through effective mitigation. Effects on ecological receptors are considered in Chapter 8: Nature Conservation.
Noise Policy Statement for England 2010 (NPSE)	The NPSE was published in March 2010 by the Department for Environment Food and Rural Affairs (Defra) and is the overarching statement of noise policy for England. It applies to all forms of noise	This chapter conforms with the NPSE through the consideration of health effects

Policy/ Guidance	Summary	Chapter Reference
(Ref 7.1)	other than occupational noise, with paragraph 1.6 setting out the long-term vision of Government noise policy which is to *"promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development".* The Explanatory Note to the NPSE introduces three concepts for use in the assessment of noise in England: • NOEL - No Observed Effect Level - This is the level below which no effect can be detected and below which there is no detectable effect on health and quality of life due to noise. • LOAEL - Lowest Observable Adverse Effect Level - This is the level above which adverse effects on health and quality of life can be detected. • SOAEL - Significant Observed Adverse Effect Level - This is the level above which significant adverse effects on health and quality of life occur. None of these three levels are defined numerically in the NPSE and for the SOAEL the NPSE makes it clear that the noise effect level is likely to vary depending upon the noise source, the receptor and the time of day and day of the week. The need for more research to investigate what may represent a SOAEL for noise is acknowledged and the NPSE asserts that not stating specific SOAEL values provides policy flexibility in the period until further evidence and guidance is published. This chapter sets out the approach to defining the NOEL, LOAEL and SOAEL for this Scheme in line with	through the adoption of NOEL, LOAEL and SOAEL. The primary source for defining significance is the NPSE in conjunction with DMRB HD 213/11. See Section 7.4.

Policy/ Guidance	Summary	Chapter Reference
	current best practice and guidance.	
National Planning Policy Framework 2019 (NPPF) **(Ref 7.5)**	The NPPF sets out the following generic guidance relating to noise, which supports the long-term vision of the NPSE. Under section 15 Conserving and enhancing the natural environment, paragraph 170, it is stated that *"Planning policies and decisions should contribute to and enhance the natural and local environment by:* *e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans"* Under section 15, paragraph 180, it is stated that *"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:* *a) mitigate and reduce to a minimum, potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life[60];* *b) identify and protect tranquil areas which have remained relatively*	This chapter conforms with the NPPF by identifying the likely effects from noise and vibration that occur as a result of the Scheme during construction and operation. Health effects are considered by the application of noise and vibration LOAEL and SOAEL. In addition, this chapter promotes the management of noise and vibration impacts through effective mitigation. See Section 7.8.

Policy/ Guidance	Summary	Chapter Reference
	undisturbed by noise and are prized for their recreational and amenity value for this reason;" Reference number 60 in the above quotation points to the Explanatory Note to the NPSE.	
Calculation of Road Traffic Noise 1988 (CRTN) **(Ref 7.6)**	The former Department of Transport/Welsh Office technical memorandum CRTN (1988) sets out a standardised method for the calculation of noise from road traffic. The factors which may influence road traffic noise levels can be divided into three groups: • Road related factors - gradient and surface type; • Traffic related factors - flow, speed and the proportion of heavy goods vehicles; and • Propagation factors – the distance between the road and the receptor location and either the type of ground cover between the road and receptor location or the presence of screening (i.e. barriers or buildings). The propagation of noise is also covered in CRTN (1988) and can influence the noise levels that would be experienced at receptor locations. Assumptions relating to the factors that affect the propagation of noise from the Scheme are set out in Section 7.8.	The road traffic noise propagation calculations in this chapter are completed in line with CRTN (1988). See Section 7.4.
Design Manual for Roads and Bridges HD 213/11 2011 (DMRB HD	The DMRB HD 213/11 sets out a methodology for assessing road traffic noise and vibration. Paragraph 4.2 of HD 213/11 states *"in*	The road traffic noise calculations and method of assessment are completed in line

Policy/ Guidance	Summary	Chapter Reference
213/11) **(Ref 7.2)**	*terms of permanent impacts, a change of 1 dB(A) in the short-term (e.g. when a project is opened) is the smallest that is considered perceptible. In the long-term, a 3 dB(A) change is considered perceptible. Such increases in noise should be mitigated if possible".* Further details of the methodology and application are contained in this chapter.	with DMRB HD 213/11. The primary source for defining significance is DMRB HD 213/11 in conjunction with the NPSE. See Section 7.4.
BS 5228-1: 2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites. Part 1: Noise (BS 5228-1) **(Ref 7.7)**	BS 5228-1:2009+A1:2014 provides guidance on the measurement, prediction and assessment of construction noise and recommends basic methods of noise control where there is a need to protect persons working or living near, and those working on, construction and open sites.	The construction noise calculations and method of assessment are completed in line with BS 5228-1:2009+A1:2014. See Section 7.4 and Section 7.8.
BS 5228-2: 2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites. Part 2: Vibration (BS 5228-2) **(Ref 7.8)**	BS 5228-2:2009+A1:2014 provides basic recommendations for vibration control where work on construction and open sites generates significant levels of vibration. It includes advice on methods for measuring, predicting and assessing its potential effect on people and buildings. The standard provides a database of historic vibration measurement results for a range of different construction working activities.	The construction vibration calculations and method of assessment are completed in line with BS 5228-2:2009+A1:2014. See Section 7.4 and Section 7.8.

7.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

7.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

7.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

7.4.3 Table 7.2 and 7.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 7.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
The study area is stated to be a boundary of 300m from the carriageway edge of the Proposed Development. However, Figure 3 (Environmental Constraints Plan) of the Scoping Report shows a 2km boundary for the study area for air quality and noise. The ES should clearly describe the extent of the study area and it should be shown on a plan within the ES.	PINS	The construction phase noise and vibration assessments have been undertaken at key receptors near the Principal Application Site. The assessments are based on the noise monitoring locations, as agreed with GYBC and shown on Figure 7.2, which are representative of nearby receptors and therefore those most likely to be worst affected by construction noise and vibration. The study area for the operational noise assessment has been determined using the guidance contained within DMRB HD 213/11, paragraph A1.11. The resulting study area is shown on Figure 7.1.
The results of the completed surveys regarding the existing noise climate should be fully reported in the ES and/or in an	PINS	Baseline noise surveys were completed in March and April 2018. Noise survey details and results are presented in Section

Scoping Opinion Item	Consultee	Response
associated Technical Appendix.		7.5.
The River Yare pSPA is identified in this aspect section as a potentially sensitive receptor. The Applicant should note that the River Yare pSPA has been formally designated as the Outer Thames Estuary SPA. It is important that inter-related effects across aspects are addressed in the ES. Accordingly, the assessment of acoustics should take into account relevant information contained in aspect chapters elsewhere in the ES, including Nature Conservation.	PINS	The benthic and fish ecology surveys at the River Yare (Appendix 8I) indicate that there are no important marine ecological features that would be sensitive to noise and vibration impacts. All other ecological features identified in Chapter 8: Nature Conservation are characteristic of terrestrial or freshwater environments. An assessment of terrestrial nature conservation features (water voles, breeding birds, bats) includes a qualitative approach to noise and vibration in Chapter 8. These features are either relatively insensitive to noise and/or the Principal Application Site has been determined to support low populations of local value only. A detailed assessment of underwater noise and vibration has therefore not been undertaken in this chapter. This chapter highlights noise and vibration level information for designated sites, the assessment on sensitive ecological receptors is considered within Chapter 8: Nature Conservation. During construction works, the mitigation measures to control and reduce noise and vibration emissions to ecological receptors will be included within the Outline CoCP (document reference 6.16) will be followed. Mitigation measures will include the adoption of the measures set out in the Joint Nature Conservation Committee (JNCC) document

Scoping Opinion Item	Consultee	Response
		entitled 'Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise' (2010) (Ref 7.9). Baseline noise surveys show that the areas around the Proposed Scheme are already noisy areas during the whole 24-hour period.
The Scoping Report has identified sensitive receptors within 300m of the Proposed Development. The Applicant should ensure that the study area is sufficient to encompass all sensitive receptors which may experience significant effects from the Proposed Development, including sensitive ecological receptors. The Applicant should also ensure that the study area is appropriate for the assessment of impacts resulting from the proposed bridge construction (e.g. potential impact of piling on sensitive ecological receptors in the River Yare).	PINS	The assessment Study Areas are considered to adequately include all potentially affected receptors. The construction phase noise assessment has been undertaken at the noise monitoring locations, as shown on Figure 7.2. These locations have been selected as representative of the nearest NSRs to the Scheme and therefore those most likely to be worst affected by the construction works. The study area for the operational noise assessment has been determined using the guidance contained within DMRB HD 213/11, paragraph A1.11. The resulting study area is shown on Figure 7.1. The construction and operation Study Areas include the sensitive ecological receptor sites.
The Scoping Report does not state whether any baseline noise monitoring has been undertaken by the Local Planning Authority (LPA). The ES should set out whether such information exists and whether it has been taken into account in the ES.	PINS	Baseline noise monitoring has not been undertaken by the LPA.

Scoping Opinion Item	Consultee	Response
The working hours for construction, including any out of hours or night time working, should be clearly stated and taken into account within the assessment of noise impacts.	PINS	The construction assessment has been completed for the key noise and vibration generating construction activities. These would take place during core working hours which are between 07:00 and 19:00 hours on weekdays and 07:00 and 13:00 on Saturdays; no working on Sundays and Bank Holidays. Key noise and vibration generating construction phases will be restricted through the Outline CoCP (document reference 6.16) to the core working hours. Works outside core hours will be agreed pursuant to an application for 'prior consent' from GYBC under Section 61 of the CoPA (Ref 7.10).
The Scoping Report states that various methodologies will be used to undertake the acoustic impact assessment both during construction and operation. The Applicant intends to reconcile any differences by undertaking each of these individually and considering the results in combination to make an overall assessment. The ES should clearly explain the methodology adopted for the assessment along with the method used to identify the receptors and study areas, ensuring that a robust assessment is carried out. The Applicant should seek to obtain agreement with relevant consultation bodies, including Norfolk County Council (NCC) and GYBC, in respect of the	PINS	The assessment methodology is detailed in Section 7.4. Details of methods used to identify sensitive receptors is given in Section 7.6. The construction phase noise assessment has been undertaken at the noise monitoring locations, as shown on Figure 7.2. These locations have been selected as representative of the nearest NSRs to the Scheme and therefore those most likely to be worst affected by the construction works. The study area for the operational noise assessment has been determined using the guidance contained within DMRB HD

Scoping Opinion Item	Consultee	Response
assessment methodology.		213/11, paragraph A1.11. The resulting study area is shown on Figure 7.1. Noise survey methodology and locations were agreed with GYBC. The locations are presented on Figure 7.2.
If predicted noise levels are modified following the results of surveys, this should be fully justified and explained in the ES.	PINS	Predicted noise levels are not modified using noise survey results. As stated in DMRB 213/11: “During the assessment process, measurements should not routinely be compared with calculations for the purpose of predicting changes in noise level”.
The noise monitoring locations to be agreed in consultation with NCC and GYBC should be identified on a plan contained within the ES.	PINS	Noise survey methodology and locations were agreed with GYBC. The locations are presented on Figure 7.2.
Although piling is listed in paragraph 6.3.15 as a typical activity associated with bridge construction, the Scoping Report does not provide any detailed information regarding the type of construction activities for the Proposed Development which may produce vibration. It also does not set out detailed methodology for the assessment of vibration. The ES should describe activities which may result in vibration and the methodology applied to identify and assess significant impacts of vibration on sensitive receptors, including human and ecological receptors (the latter including both terrestrial and aquatic receptors),	PINS	Construction activities are detailed in Chapter 2: Description of the Scheme, and those elements relevant to the noise and vibration assessment as summarised in Section 7.7. Construction Noise and Vibration methodology is presented in Section 7.4. Construction Vibration impacts are detailed in Section 7.8. Ecological receptors are considered within Chapter 8: Nature Conservation. During construction works, the mitigation measures to control and reduce noise and vibration emissions to ecological receptors included within the Outline CoCP

Scoping Opinion Item	Consultee	Response
where significant effects are likely to occur.		(document reference 6.16) will be followed. Mitigation measures will include the adoption of the measures set out in the Joint Nature Conservation Committee (JNCC) document entitled 'Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise' (2010). Baseline noise surveys show that the areas around the Proposed Scheme are already noisy areas during the whole 24-hour period.
PINS recommends an assessment of noise and vibration on ecological receptors, including sensitive aquatic receptors and receptors associated with the Outer Thames Estuary SPA (where relevant), be included in the ES. The assessment should consider both airborne and underwater noise and vibration impacts. PINS recommends that the assessment of noise and vibration on ecological receptors be presented in the Nature Conservation aspect chapter of the ES, with reference to relevant data obtained as part of the acoustic impact assessment. The Applicant should avoid duplication of assessments in the ES; however, cross-referencing between the two aspect chapters is advised. In addition to consultation with NCC and GYBC, the Applicant should also consult with the MMO in effort to agree the proposed assessment methodology for noise and vibration on aquatic receptors.	PINS	This chapter provides noise and vibration level information, the assessment on sensitive ecological receptors is considered within Chapter 8: Nature Conservation. During construction works, the mitigation measures to control and reduce noise and vibration emissions to ecological receptors will be included within the Outline CoCP (document reference 6.16) will be followed. Mitigation measures will include the adoption of the measures set out in the Joint Nature Conservation Committee (JNCC) document entitled 'Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise' (2010). Baseline noise surveys show that the areas around the Proposed Scheme are already noisy areas during the whole 24-hour period.

Scoping Opinion Item	Consultee	Response
The Scoping Report refers to mitigation measures which should be implemented through a CEMP. Proposed mitigation measures for noise and vibration impacts should be detailed in the ES, including their method of delivery, such as through a CEMP. The CEMP and mitigation measures, as appropriate, must be secured in the DCO.	PINS	Construction mitigation measures including BPM are presented in Section 7.8 and the Outline CoCP (document reference 6.16), these will be secured through the full CoCP, which is secured through the DCO.

Table 7.3: Summary of Section 42 Responses Received

Scoping Opinion Item	Consultee	Response
The current submission does not include a specific section summarising the potential public health impacts. We understand that the promoter will wish to avoid unnecessary duplication and that many issues including air quality, emissions to water, waste, contaminated land etc. will be covered elsewhere in the ES, but we believe that the summation of relevant issues into a specific section of the report provides a focus which ensures that public health is given adequate consideration and due weight in the planning process. Such a section should summarise key information, risk assessments, outline any proposed mitigation, and identify any residual impacts or uncertainties. Compliance with the requirements of National Policy Statements and relevant guidance and standards should also be highlighted.	Public Health England	This chapter conforms with the NPSE through the consideration of health effects through the adoption of NOEL, LOAEL and SOAEL. See Section 7.4. The chapter conforms with the NN NPS and the PNPS by promoting the management of noise and vibration impacts through effective mitigation. The construction noise and calculations and method of assessment are completed in line with BS 5228 Part 1 Noise and Part 2 Vibration. The road traffic noise calculations and method of assessment are completed in line with DMRB HD 213/11.

Scoping Opinion Item	Consultee	Response
		See Section 7.4 and Section 7.8.

7.4.4 Table 7.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

7.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 7.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
GYBC	Environmental Health Officer	02/02/18 Teleconference and email response to discuss noise survey locations and methodology.	Agree attended baseline noise survey, including locations and methodology.
GYBC	Environmental Health Officer	05/10/18 Pre-application email regarding agreement to the proposed noise and vibration assessment methodology as contained in the PEIR.	Agreement of the proposed methodology.
GYBC	Environmental Health Officer	22/02/19 Teleconference and email response to discuss Local Policy, local noise and vibration sources, sources	Details pertaining to construction and demolition activities. Background information on noise and vibration complaints, as well as local sensitive receptors.

Insignificant Effects

7.4.6 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would be insignificant and have therefore not been considered further in the assessment:

- Operational road traffic ground-borne vibration: Ground-borne vibrations are created by irregularities in road surface, and such irregularities will not be present in the new road surface created by a new piece of highway infrastructure.

Likely Significant Effects

Construction Phase

7.4.7 The following likely significant effects have been assessed in this chapter:

- Construction noise including piling;
- Construction vibration including piling; and
- Construction traffic noise.

Operation Phase

7.4.8 The following likely significant effects have been assessed in this chapter:

- Operational road traffic noise; and
- Noise effects from new bridge opening (wig wag) alarms.

Extent of the Study Area

Construction Noise

7.4.9 The construction phase noise assessment has been undertaken at the noise monitoring locations around the Principal Application Site, as shown on Figure 7.2. These locations have been selected and agreed with GYBC as representative of the nearest NSRs to the Scheme and therefore those most likely to be affected by the construction works.

7.4.10 The Satellite Application Sites are not included in this assessment. These works are short-term, small-scale and local. The required construction works are not expected to exceed in-combination noise thresholds and exposure durations that trigger the onset of significant effects. The duration thresholds are detailed in Table 7.7.

7.4.11 DMRB HD 213/11 states that "… the area in which construction is considered to be a nuisance is generally more localised than where the impacts of the road project are likely to be a cause of concern once it has opened to traffic. The impact of construction nuisance in one form or another diminishes rapidly with distance".

Construction Vibration

7.4.12 Vibration usually affects a smaller area than noise, as vibration tends to diminish much more rapidly with increasing distance from the source of the vibration. Furthermore, the types of construction activity that can result in perceptible levels of vibration are generally limited to piling works, the use of vibratory rollers, some ground improvement techniques and, in extreme circumstances, the use of machine-mounted percussive breakers and the passage of heavy construction vehicles. Based on the guidance contained within DMRB HD 213/11 and as per the construction noise assessment, the construction vibration assessment has been undertaken at the noise monitoring locations, which are considered representative of the nearest NSRs to the Scheme and most likely to be those affected by the construction works.

Operation Noise

7.4.13 The study area for the operational noise assessment has been determined using the guidance contained within DMRB HD 213/11, paragraph A1.11. The resulting study area is shown on Figure 7.1.

7.4.14 The DMRB HD 213/11 study area requires calculations of noise effects within 600m of new, improved and bypassed routes, and within 600m of any other 'affected routes' within 1km of new, improved and bypassed routes. This 600m buffer extent is referred to as the 'calculation area'.

7.4.15 Consideration of noise changes beyond the calculation area is also required to be given. This includes the determination of 50m buffers applied either side of the carriageway of identified affected routes beyond 1km of new, improved and bypassed routes.

7.4.16 Paragraph A1.11 of DMRB HD 213/11 details the methodology by which the *"affected routes"* are identified. An affected route is one which is predicted to experience a change in noise of ≥ ±1 dB(A) in the short term (i.e. in the baseline year), or ≥ ±3 dB(A) in the long term (i.e. to the future assessment year) .

7.4.17 To determine the number and location of any affected routes, the Basic Noise Levels (BNLs) ($L_{A10,18h}$) have been calculated for each road link (i.e. each road or section of road within the traffic model) based on the traffic data provided. The Do Minimum (DM) opening year BNL has been compared

against the Do Something (DS) opening year BNL, to predict the short-term change, and the DS design year BNL, to predict the long-term change.

7.4.18 In summary, the study area for operational noise is defined as:

- 1km from the Scheme carriageway edge (including proposed, bypassed or improved routes), which also encompasses the 600m calculation area; and
- 50m from any affected routes beyond 1 km.

Operational Airborne Vibration

7.4.19 The study area for airborne vibration is limited to 40m from all routes identified in the determination of the noise study area in line with the DMRB HD 213/11, the methodology for assessing airborne vibration nuisance has not been validated for greater distances.

Effect Significance

7.4.20 The significance of construction noise and vibration has been assessed based on BS 5228-1:2009+A1:2014 (Noise), BS 5228-1:2009+A1:2014 (Vibration) and the NPSE.

7.4.21 The significance of construction traffic noise has been assessed based on DMRB HD 213/11.

7.4.22 The significance of operational noise and vibration has been assessed based on DMRB HD 213/11 and the NPSE.

7.4.23 The significance of operational noise from the new bridge opening (wig wag) alarm has been assessed based on BS 4142:2014.

Method of Baseline Data Collation

Desk Study

7.4.24 The following data sources have been examined:

- The location of Defra Noise Important Areas taken from the EnvIS database;
- Consultation with GYBC;
- OS MasterMap database;
- OS AddressBase Plus;

- Google Street View (2016 images);
- Locations of existing noise barriers within the operational noise study area using imagery from Google Street View (2016 images); and
- Defra's 'Magic' online GIS portal.

Noise Surveys

7.4.25 Baseline noise surveys were completed in March and April 2018. Attended measurements were undertaken at six locations selected to be representative of dwellings close to the Scheme.

7.4.26 Further details of the noise surveys and the survey results are given in Section 7.5.

Assessment Methodology

7.4.27 Each topic area within the scope of this assessment requires its own methodology as there are different guidelines and standards that relate specifically to road traffic noise and vibration, and construction noise and vibration. The guidance that relates specifically to each topic has been used to derive assessment criteria that meet with the requirements as set out within the relevant standards and guidelines.

Significance Criteria

7.4.28 The following terms have been used to define the significance of the effects identified and, where an effect is defined as moderate or above, the effect is considered significant:

- Very large;
- Large;
- Moderate;
- Slight; and
- Neutral.

7.4.29 There is a discrepancy between the guidance set out in the NPSE compared to the guidance set out in the DMRB HD 213/11 and the various British Standards relating to noise and vibration. Specifically, the NPSE requires consideration to health effects through adoption of the NOEL, LOAEL and SOAEL, but by contrast, the DMRB HD 213/11 assessment methodology is

based on the magnitude of the noise level changes and associated changes in nuisance.

7.4.30 The determination of LOAELs and SOAELs is a subject of current research and to date, there has been no official guidance published on how to reconcile the DMRB and NPSE methodologies. It is of note that the NPSE states in paragraph 2.22 that it is "*… acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise*".

7.4.31 Therefore, presented further below is the approach that has been adopted to the determination of NOEL, LOAEL and SOAEL, based on current available guidance and best practice.

7.4.32 The approach adopted for this assessment has been to determine the significance of temporary effects during the construction phase against the current British Standards relating specifically to construction noise and vibration, and to determine the significance of operational effects against the guidance contained within DMRB HD 213/11 which relates specifically to road traffic noise and the NPSE. Where significant adverse effects are predicted, the assessment of mitigation options has been assessed with reference to the LOAELs and SOAELs. This approach has been adopted successfully for other recent NSIP road improvement schemes, such as the M20 Junction 10A project.

Noise during Construction

7.4.33 BS 5228-1:2009+A1:2014 contains guidance on the prediction of noise levels from the operation of fixed and mobile noise sources found on construction and open sites. It provides source sound level data for various machinery and tasks associated with the construction activities, together with a method that allows for the calculation of the cumulative noise level from all sources, as would be experienced at a receptor location outside the construction site. The calculation method considers the distance between the noise source(s) and receptor location, the type of intervening ground cover and the presence of screening from barriers, fences or buildings. The method also allows for the calculation of noise levels from mobile plant that may be working in a fixed area (e.g. dozers used for earthworks) and from construction vehicles (such as delivery wagons and dump-trucks).

7.4.34 Example criteria are presented in BS 5228-1:2009+A1:2014 for the assessment of the significance of noise effects. Such criteria are concerned with fixed noise limits and ambient noise level changes.

7.4.35 With respect to fixed noise limits, BS 5228-1:2009+A1:2014 discusses those included within Wilson Committee (Ref 7.11). These limits are presented according to the nature of the surrounding environment for a 12-hour working day. The limits presented in Wilson Committee are:

- 70 dB(A) in rural, suburban and urban areas away from main road traffic and industrial noise; and
- 75 dB(A) in urban areas near main roads and heavy industrial areas.

7.4.36 BS 5228-1:2009+A1:2014 also provides methods for determining the significance of construction noise levels considering the change in the ambient noise level brought about by the construction work. Two example assessment methods are presented, these are the 'ABC method' and the '5 dB(A) Change Method'.

7.4.37 The *'ABC method'*, as presented in Table 7.5, is based upon threshold noise levels defined by both time of day and existing ambient noise level. The method requires the ambient pre-construction noise level to be determined and rounded to the nearest 5 dB. The result is used to determine the applicable assessment category, A, B or C, with each category having an associated 'threshold value'. This construction noise level is then compared against the applicable threshold value. If the construction noise level exceeds the threshold value, then a potential significant effect is indicated.

Table 7.5: BS 5228-1:2009+A1:2014 Construction Noise Thresholds – The ABC Method

Assessment Category and Threshold Value Period	**Free-field Threshold Value, in decibels (dB) ($L_{Aeq,T}$)**		
	Category A	**Category B**	**Category C**
Night-time (23:00 - 07:00)	45	50	55
Evenings (19:00 - 23:00) and Weekends (13:00 - 23:00 Saturdays, and 07:00 - 23:00 Sundays)	55	60	65
Daytime (07:00 - 19:00) and Saturdays (07:00 - 13:00)	65	70	75
Note 1: A potential significant effect is indicated if the L_{Aeq} noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. Note 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total L_{Aeq} noise level for the period increases by more than 3 dB due to site noise. Note 3: Applied to residential NSRs only.			
Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values. Category C: threshold values to use when ambient noise levels (when rounded to nearest 5 dB) are higher than Category A values.			
Table source: Based on BS 5228-1:2009+A1:2014, Table E.1.			

7.4.38 The BS 5228-1:2009+A1:2014 '5 dB(A) Change Method' is based on a premise that a significant effect is deemed to occur if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB $L_{Aeq,T}$ from construction noise alone, for the daytime, evening and night-time periods respectively.

7.4.39 To account for the requirements of the NPSE, the approach to defining NOEL, LOAEL and SOAEL is shown in Table 7.6.

Table 7.6: Construction Noise – Effect Level Criteria

Difference Between Construction Noise Level and Defined ABC Criteria	Effect Level
Less than Category ABC threshold value minus 5 dB	NOEL
Category ABC threshold value minus 5 dB	LOAEL
Category ABC threshold value plus 5 dB	SOAEL

7.4.40 For the purposes of assessing the significance of noise effects during the construction phase of the Scheme, the duration and character of the noise has been considered. It is noted that noise from the construction works would be temporary in nature. Furthermore, noise and vibration levels from construction operations are inherently variable, with noise levels fluctuating on an hour-to-hour, day-to-day and week-to-week basis.

7.4.41 It is appropriate to account for these temporal factors when classifying the significance of predicted effects.

7.4.42 Taking the variability of the noise generated into account, consideration has been given to the duration criteria presented in BS 5228-1, such that a significant effect would be determined to arise if the LOAEL at an NSR is "…exceeded for a period of ten or more days of working in any fifteen consecutive days or for a total number of days exceeding 40 in any 6 consecutive months" (example E.4, page 120).

7.4.43 A significant adverse effect is deemed to arise where the construction noise level at an NSR is predicted to exceed the SOAEL, irrespective of the duration of the works. Similarly, significant adverse effects would not arise when the construction noise level is below the LOAEL.

7.4.44 The adopted significance of effect scale for construction noise in this assessment for receptors of high sensitivity (taken to be residential dwellings for the Scheme) is shown in *Table* 7.7.

Table 7.7: Significance of Effect Criteria for Construction Noise Combining Duration of Exposure and Effect Levels – High Sensitivity Receptors

Duration of Exposure	Noise Level < LOAEL	LOAEL < Noise Level < SOAEL	Noise Level > SOAEL
Less than 10 days of working in any 15 days and less than 40 days in any 6 consecutive months	Neutral	Slight	Large
10 or more days of working in any 15 days or 40 or more days in any 6 consecutive months	Neutral	Large	Very Large

7.4.45 For the Scheme, it is considered appropriate to assume that the construction works would exceed at least one of the duration criteria presented in paragraph 7.4.42 (i.e. 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months) and therefore only the criteria on the bottom line of *Table* 7.7 have been applied in the assessment of construction noise.

Vibration during Construction

7.4.46 BS 5228-2:2009+A1:2014 contains guidance on the prediction of vibration from the operation of fixed and mobile sources found on construction and open sites. It provides source vibration level data for some construction activities such as piling works, and various methods to predict vibration from both piling works and other construction plant and activities such as the use of vibratory rollers. The calculation methods are primarily based on the separation distance between the source and the receptor location and, for some types of plant, the mode of operation of that plant.

7.4.47 BS 5228-2:2009+A1:2014 also contains guidance on measuring and assessing the effects of vibration. Regarding the assessment of significance of vibration relating to human response, BS 5228-2:2009+A1:2014 refers to BS 6472-1:2008 (Ref 7.12). However, BS 5228-2:2009+A1:2014 (page 36) notes that:

"*...whilst the assessment of the response to vibration in BS 6472 is based on the Vibration Dose Value (VDV) and weighted acceleration, for construction it is considered more appropriate to provide guidance in terms of the Peak Particle Velocity (PPV), since this parameter is likely to be more routinely measured based upon the more usual concern over potential building damage. Furthermore, since many of the empirical vibration predictors yield a result in terms of PPV, it is necessary to understand what the consequences might be of any predicted levels in terms of human perception and disturbance...*".

7.4.48 BS 5228-2:2009+A1:2014 presents guidance on vibration levels and effects referenced to PPV criteria as reproduced in Table 7.8.

Table 7.8: BS 5228-2:2009+A1:2014 Guidance on Effects of Vibration Levels

Vibration Level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with the construction. At lower frequencies, people are less sensitive to vibration
0.3 mm/s	Vibration might be just perceptible in residential NSRs
1.0 mm/s	It is likely that vibration of this level in residential NSRs would cause complaint, but can be tolerated if prior warning and explanation has been given to residents
10.0 mm/s	Vibration is likely to be intolerable for any more than very brief exposure to this level
Table source: Based on BS 5228-2: Table B.1.	

7.4.49 BS 5228-2:2009+A1:2014 also provides limits for transient vibration above which cosmetic damage could occur in terms of the component PPV, which are summarised in *Table* 7.9.

Table 7.9: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures **Industrial and heavy commercial buildings**	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
Unreinforced or light framed structures **Residential or light commercial buildings**	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1: Values referred to are at the base of the building. Note 2: At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.		
Table source: Based on BS 5228-2: Table B.2		

7.4.50 It is noted that the values presented within *Table* 7.9 are applicable to cosmetic damage only. It is stated within BS 5228-2:2009+A1:2014 that minor structural damage is possible at vibration magnitudes which are greater than twice those given in Table 7.9.

7.4.51 To account for the requirements of the NPSE, the approach to defining NOEL, LOAEL and SOAEL is presented in Table 7.10. The vibration levels adopted for the NOEL and LOAEL are based on the guidance contained within BS 5228-2:2009+A1:2014 for human perception. However, it is noted that the range of vibration levels within BS 5228-2:2009+A1:2014 is wide and adopting 10 mms^{-1} is considered too high to be reflective of the SOAEL. Therefore, a vibration level of 3.0 mms^{-1} has been chosen as more reflective of the SOAEL, which is based on professional judgement and experience of similar schemes.

Table 7.10: Construction Vibration – Effect Level Criteria

Vibration Level (PPV)	Effect Level
<1.0 mms^{-1}	No observed effect (NOEL)
1.0 mms^{-1}	LOAEL
3.0 mms^{-1}	SOAEL

7.4.52 Construction vibration would be temporary and variable, with vibration levels fluctuating on an hour-to-hour, day-to-day, and week-to-week basis. It is therefore appropriate to account for these factors in reconciling the significance of predicted vibration levels when assessed in terms of effect levels (as required by NPSE and presented in Table 7.10) with the requirements to classify the significance of effect.

7.4.53 To address this issue, consideration has been given to the duration criteria presented in BS 5228-1:2009+A1:2014 such that a significant effect would be deemed to arise if the LOAEL is *"exceeded for a period of 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months"*[1].

7.4.54 A significant adverse effect is also deemed to arise when the construction vibration level at an NSR is predicted to exceed the SOAEL, irrespective of the duration of the works. Significant adverse effects are not deemed to arise when the construction vibration level is below the LOAEL.

7.4.55 Based on the above, the adopted significance of effect criteria for construction vibration for residential receptors is given in Table 7.11.

[1] The duration criteria quoted in paragraph 7.4.53 specifically relates to noise. However, these criteria have been adopted for the vibration assessment as BS 5228-2:2009+A1:2014 offers no specific guidance in relation to vibration.

Table 7.11: Significance of Effect Criteria for Construction Vibration Combining Duration of Exposure and Effect Levels

Duration of Exposure	Vibration Level < LOAEL	LOAEL < Vibration Level < SOAEL	Vibration Level > SOAEL
Less than 10 days of working in any 15 days and less than 40 days in any 6 consecutive months	Neutral	Slight	Large
10 or more days of working in any 15 days or 40 or more days in any 6 consecutive months	Neutral	Large	Very Large

Noise from Construction Traffic

7.4.56 An assessment of off-site construction traffic has been undertaken based on the numbers of construction vehicles (cars and HGVs) that require compound access versus the Do Minimum (DM) traffic flows in 2023. Details of the construction traffic vehicle movements and routes are provided in Chapter 17: Traffic and Transport. The with construction vehicle scenario was generated by adding the worst-case estimated construction vehicle numbers, 18 hour AAWT data provided by the traffic engineers, to the DM traffic flows in 2023.

7.4.57 BNLs, calculated in accordance with CRTN (1988), have been calculated for the construction route road links, identified by the traffic engineers, for both the pre-construction and during construction scenario for each route.

7.4.58 The pre-construction versus during construction scenario noise change is calculated for each road link, then the significance is assessed in line with the short-term significance criteria given in *Table* 7.14.

Identification of Appropriate Mitigation Measures

7.4.59 Potential construction phase effects are used to assist in identifying appropriate mitigation measures that would be implemented through the CoCP. These have been determined to be commensurate to the scale and duration of the identified effects. An Outline CoCP (document reference 6.16) accompanies this ES and outlines the mitigation measures that the contractor would be required to adopt during the construction phase of the Scheme.

Operational (Road Traffic) Noise

7.4.60 All road traffic noise predictions have been completed in accordance with the calculation methodology presented in CRTN (1988) and Annex 4 of DMRB HD 213/11.

7.4.61 Predicted noise levels at all NSRs, including the magnitude of change, are listed in Appendix 7E (dwellings) and Appendix 7F (other sensitive receptors).

Operational (Road Traffic) Noise – Processing of Traffic Flow Data

7.4.62 Traffic flow data have been provided for the roads shown within (and extending beyond) the operational noise study area (Figure 7.1) in the form of Annual Average Weekday Traffic (AAWT) flows for the 18 hour period from 06:00 to 24:00 hours. The traffic data also include percentage HDV and average vehicle speeds.

7.4.63 Traffic data have been provided for the following four scenarios:

- DM opening year (2023);
- DM design year (2038);
- DS opening year (2023); and
- DS design year (2038).

7.4.64 These data have been provided as two-way and one-way flows.

Operational (Road Traffic) Noise – Basic Noise Levels

7.4.65 BNLs, $L_{A10,18h}$, have been calculated for each road link in isolation to completely determine potential significant effects (a more than a 1 dB $L_{A10,18h}$ change in the short-term or more than 3 dB $L_{A10,18h}$ change in the long-term, indicates a potentially significant effect). In accordance with CRTN (1988), the BNL calculations have taken account of the following factors:

- Total vehicle flow;
- Percentage heavy goods vehicles;
- Average vehicle speed; and
- Road surface modelled as standard hot rolled asphalt.

7.4.66 The BNLs have been calculated for the following scenarios:

- DM opening year (2023);
- DM design year (2038);
- DS opening year (2023); and

- DS design year (2038).

Operational (Road Traffic) Noise – Noise Modelling

7.4.67 A 3D noise model has been prepared and used (built using NoiseMap v5 software) to predict the road traffic noise levels for the scenarios described in paragraph 7.4.63. The model includes the roads shown within (and extending beyond) the operational noise study area (Figure 7.1), topography and buildings.

7.4.68 This assessment has relied primarily on a comparison of predicted noise levels to determine the change in noise levels that would arise as a result of the Scheme for the following scenario comparisons:

- Comparison 1: DM opening year (2023) vs DS opening year (2023). This comparison identifies short-term changes in noise level at NSRs because of the Scheme.
- Comparison 2: DM opening year (2023) vs DS design year (2038). This comparison identifies long-term changes in noise level at NSRs because of the Scheme.
- Comparison 3: DM opening year (2023) vs DM design year (2038). This comparison identifies long-term changes in noise level at NSRs if the Scheme does not go ahead. This comparison has been interrogated where a potential significant effect has been identified in the DM opening year vs DS design year to ascertain whether the change in noise level is due to background traffic growth (i.e. it is not due to the Scheme).

7.4.69 The assessment presents both direct and indirect effects associated with the Scheme which would be experienced because of the scheme and associated traffic flow changes on the road network during the operational phase.

7.4.70 The assessment of predicted noise effects considers the guidance contained within DMRB HD 213/11 with the results also used to inform appraisal against the guidance contained within the NPSE.

7.4.71 The DMRB 213/11 methodology emphasises adverse effects associated with the Scheme, where the least beneficial change in noise level is reported for any NSR.

7.4.72 To account for the requirements of the NPSE, the numerical values used to define the NOEL, LOAEL and SOAEL for this Scheme are shown in Table 7.12.

7.4.73 The adopted threshold value for the SOAEL is based on the *'Relevant Noise Level'*, as set out in the Noise Insulation Regulations (NIR) (Ref 7.13). This is

the level of noise that would (provided that other criteria are met) trigger entitlement to the provision of sound insulated glazing (and, where necessary, ventilation) for residential properties located within 300m of a new road Scheme. The Relevant Noise Level specified in the NIR is 68 dB $L_{A10,18h}$, although the regulations require that noise levels calculated to be between 67.5 and 67.9 dB are rounded up to 68 dB.

7.4.74 The adopted daytime threshold value for the LOAEL is based on guidance contained within the World Health Organisation (WHO) Environmental Noise Guidelines (ENG) (Ref 7.14).

7.4.75 For road traffic, WHO ENG (page 30) *"strongly recommends reducing noise levels produced by road traffic below 53 dB L_{den}, as road traffic noise above this level is associated with adverse health effects."* WHO ENG uses a different noise index, L_{den}, to that used to quantify road traffic noise in the UK ($L_{A10,18h}$), but based on the guidance in Brink, M. et al (2018) (Ref 7.15) and Abbott, P. G. and Nelson, P. M., TRL Limited (2002) (Ref 7.16), $L_{den} \approx L_{A10,18h}$.

7.4.76 For night noise exposure, the WHO ENG (page 30) *"strongly recommends reducing noise levels produced by road traffic during night-time below 45 dB L_{night}, as night-time road traffic noise above this level is associated with adverse effects on sleep."*

Table 7.12: Traffic Noise Effect Levels

Daytime Traffic Noise Level, $L_{A10,18h}$ (dB)*	Night-time Traffic Noise Level, L_{night} (dB)**	Effect Level
< 53 dB(A)	< 45 dB(A)	No observed effect (NOEL)
53 dB(A)	45 dB(A)	LOAEL
68 dB(A)	55 dB(A)	SOAEL
* Façade level, 06:00 to 00:00. ** Free-field level, 23:00 to 07:00.		

7.4.77 The noise effect levels set out in Table 7.12 are based on the absolute daytime traffic noise level. With respect to the change in noise level because of a new road scheme, paragraph 4.2 HD 213/11 states "*… in terms of permanent impacts, a change of 1 dB(A) in the short-term (e.g. when a project is opened) is the smallest that is considered perceptible. In the long-term, a 3 dB(A) change is considered perceptible*".

7.4.78 Therefore, for the purposes of this assessment, the following road traffic noise change thresholds have been used, to denote the onset of impact:

- ≥ ±1 dB $L_{A10,18h}$ in the DM opening year 2023 to DS opening year 2023 scenarios (short term);
- ≥ ±3 dB $L_{A10,18h}$ in the DM opening year 2023 to DS design year 2038 scenarios (long term); and
- ≥ ±3 dB $L_{A10,18h}$ in the DM opening year 2023 to DM design year 2038 scenarios (long term).

7.4.79 In addition to the above, in the long term, an increase of 1 dB $L_{A10,18h}$ where the DM opening year noise level is already above the SOAEL is considered a potentially significant change. In other words, a lower magnitude of impact is applied where road traffic noise levels are particularly high.

7.4.80 The approach taken for this assessment has been to analyse the change in all noise levels for both short term and long-term scenarios. Where no individual change exceeds the thresholds given above, then it is assumed that there would be no significant effect (adverse or beneficial). However, where noise levels exceed the stated thresholds, this provides an indication that there is potential for a significant effect (adverse or beneficial) which triggers the need to consider mitigation where the effect is adverse in nature.

7.4.81 When long term significant adverse effects have been identified, the traffic flow data for the DM design year 2038 scenario have been interrogated to assist in determining whether the effects are because of the Scheme itself, or are rather a result of general traffic growth or other developments (i.e. Comparison 3 identified in paragraph 7.4.68 above).

7.4.82 Table 7.13 presents the magnitude of impact for short and long-term changes in noise levels, as set out in DMRB HD 213/11. Both adverse and beneficial changes are considered in the assessment.

Table 7.13: Classification of Magnitude of Noise Impacts

Magnitude of Impact (adverse or beneficial)	Noise Change ± (dB $L_{A10,18h}$)	
	Short Term	Long Term
No Change	0	0
Negligible	0.1 – 0.9	0.1 – 2.9
Minor	1.0 – 2.9	3.0 – 4.9
Moderate	3.0 – 4.9	5.0 – 9.9
Major	**≥5.0**	≥10.0

Table source: Based on DMRB HD 213/11.

Significance Criteria

7.4.83 The different assessment methodologies of NPSE and DMRB HD 213/11 are combined in the manner shown in *Table* 7.14 and Table 7.15. The overall significance classification (**slight**, **moderate**, **large** and **very large**) applies to situations where there is a beneficial effect (noise level decrease) as well as situations where there is an adverse effect (noise level increase). The significance classification applies to NSRs, which are all considered highly sensitive.

Table 7.14: Significance Effect Level Criteria for Operational Traffic Noise in the Short-term

Noise Increase dB $L_{A10,18h}$	Noise Level < LOAEL	Noise Level > LOAEL and < SOAEL	Noise Level > SOAEL
0.1 – 0.9	Slight	Slight	Slight
1.0 – 2.9	Slight	Moderate	Moderate
3.0 – 4.9	Slight	Large	Large
≥ 5.0	Slight	Very Large	Very Large

Table 7.15: Significance Effect Level Criteria for Operational Traffic Noise in the Long-term

Noise Increase dB $L_{A10,18h}$	Noise Level < LOAEL	Noise Level > LOAEL and < SOAEL	Noise Level > SOAEL
0.1 – 0.9	Slight	Slight	Slight
1.0 – 2.9	Slight	Slight	Moderate
3.0 – 4.9	Slight	Moderate	Large
5.0 – 9.9	Slight	Large	Very Large
≥ 10.0	Slight	Very Large	Very Large

7.4.84 Based on the above, and in line with the goals of the NPSE, the noise mitigation would aim to:

- Reduce, where practicably possible, **moderate**, **large** or **very large** significant increases, where the absolute noise level is above LOAEL; and
- Avoid **moderate**, **large** or **very large** significant increases, where the absolute noise level is above SOAEL.

7.4.85 It is noted that any mitigation measures are required to perform to an acceptable level in terms of in traffic, road safety, economic and other environmental terms.

7.4.86 It is noted that the assessment methodology detailed above is based on the change in daytime (06.00 to 24.00 hours) traffic noise levels. For non-motorway roads, the diurnal patterns in road traffic flows are such that noise levels during the night-time (00.00 to 06.00 hours) are approximately 10 dB lower[2] than those during the daytime. The relative change in noise levels, due to the introduction of a new scheme, should be the same for both the daytime and night-time periods. An assessment of daytime noise levels against the significance criteria detailed above is therefore considered to be sufficient to provide an overall assessment that would be equally applicable to the night-time period.

7.4.87 In addition to the above, an indication of the number of residential properties that could be eligible for noise insulation under the Noise Insulation Regulations (NIR) has been identified.

Bridge Opening Alarm

7.4.88 The bascule bridge will require appropriate audible alarms (wig wag) for use during the raising of the bridge.

7.4.89 The methodology is to adopt a source sound emission term based on current DfT / Highways England guidance for wig wags.

7.4.90 Using standard acoustic propagation models, predict the levels of noise from the wig wags as experienced at a number of representative sensitive receptors.

7.4.91 Assess the predicted noise levels via a comparison with measured background noise levels at each receptor location, in a manner similar to the method set out in BS 4142: 2014 (Red 7.17) (although noting that a strict interpretation of this standard is not applicable to noise from wig wags).

7.4.92 The calculation methodology is based on a standard acoustic propagation model, similar to that used in BS 5228-1:2009+A1:2014. The assumptions used are:

2 Based on the non-motorway equations of Method 3 of the TRL report (Abbott P. G. and Nelson P. M., TRL Limited (2002): *Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping)* and a typical road with an $L_{A10,18h}$ value of 65 dB, the night-time noise level is predicted to be 55 dB.

- The wig wags act as an omnidirectional point source;
- Attenuation due to geometric spreading is based on hemispherical propagation;
- The intervening ground between the source and receptor location is acoustically “hard” such that there is no excess attenuation due to ground effects (a worst-case assumption);
- Where there are intervening buildings between the source and receptor location, an acoustic barrier correction of -5 dB is applied where the building(s) just obstruct line-of-sight between source and receptor, and a correction of -10 dB is applied where the building(s) fully obstruct line-of-sight between source and receptor;
- There is no attenuation due to atmospheric absorption (a worst-case assumption); and
- Atmospheric conditions are neutral such that there are no meteorological effects affecting the propagation of sound (i.e. no strong wind or temperature gradients).

7.5 Baseline Conditions

7.5.1 A weekday noise survey was undertaken between 26 March and 27 March 2018; and a weekend survey was undertaken between 21 April and 22 April 2018. The noise surveys were undertaken outside school holidays and the weather was conducive to environmental noise monitoring, being dry with light winds.

7.5.2 Noise monitoring locations were selected to be representative of sensitive receptors located close to the Scheme. The survey positions and measurement timing were agreed with GYBC. The survey dates were chosen to be representative of normal conditions; local road works and any maintenance activities were avoided.

7.5.3 The noise survey informs the construction noise assessment and is used to identify existing noise sources which are not accounted for in the operational noise assessment, for example, air traffic and industrial or commercial activities.

7.5.4 Noise measurements were undertaken based on the guidance in BS 7445-2:1991 (Ref 7.18) and on the shortened measurement procedure set out in CRTN (1988). The shortened measurement procedure requires that measurements of L_{A10} are undertaken over three consecutive one-hour periods between 10:00 and 17:00 on a normal working day. The $L_{A10,18h}$ noise level is then estimated from these measurements by taking an

arithmetic average of the three results and subtracting 1 dB. During this survey, the daytime measurement in each consecutive 1-hour period was 15 minutes long. Due to the general unvarying nature of the level within each 15-minute period and across each consecutive measurement, each 15-minute measurement result was considered representative of the full hourly noise level.

7.5.5 Measurements were taken in free-field conditions and at a height of 1.5m above local ground level.

7.5.6 Short-term attended noise measurements were undertaken at six locations, detailed in Table 7.16 and Figure 7.2.

Table 7.16: *Baseline Noise Survey Locations*

Measurement ID	Location	Closest NSR	Distance between NSR and the Principle Application Site
L01	Beccles Road	3 Alpha Road	18m
L02	Queen Anne's Road	12 Queen Anne's Road	0m
L03	Southtown Road	145 Southtown Road	0m
L04	Cromwell Road	10 Cromwell Road	0m
L05	South Denes Road	1 South Denes Road	0m
L06	Southgates Road	31 Southgates Road	0m

7.5.7 The sound level meters were field calibrated before and after the surveys, with no significant calibration drifts observed. Details of the equipment used, including the expiry dates of their laboratory calibrations, and the WSP internal equipment reference (e.g. 'Duo 2'), are shown in Table 7.17.

Table 7.17: *Equipment Details*

Item	Make	Model	Serial Number	Calibration Expiry
Duo 2				
SLM	01 dB	Stella Dou	10618	20/09/2019
Microphone	01 dB	G.R.A.S 40CD	162008	20/09/2019
Pre-amplifier	01 dB	G.R.A.S Type 21	10627	20/09/2019
Calibrator	01 dB	01 dB Cal	3494010	21/09/2018
Solo 2				
SLM	01 dB	METRAVIB	61332	14/02/2019
Microphone	01 dB	METRAVIB MCE 212	57685	14/02/2019
Pre-amplifier	01 dB	METRAVIB 21 S	14425	14/02/2019
Calibrator	01 dB	01 dB Cal	3494010	21/09/2018

7.5.8 Weather conditions were recorded during the noise surveys and are summarised below:

- 13:30 Monday 26 March 2018. Temperature 7°C, south westerly wind, 0.3 m/s average (max. 1.0 m/s), humidity 85%, no precipitation, 50% cloud cover, road surfaces dry.
- 21:45 Monday 26 March 2018. Temperature 5°C, south westerly wind, 1.2 m/s average (max. 1.9 m/s), humidity 45%, scattered clouds, road surfaces dry.
- 10:45 Tuesday 27 March 2018. Temperature 6°C, no wind direction to report, 0.2 m/s average (max. 0.9 m/s), humidity 60%, clear skies, road surfaces dry.
- 14:05 Saturday 21 April 2018. Temperature 16°C, westerly wind, humidity 80%, light winds, dry conditions, clear skies, road surfaces dry.
- 21:00 Sunday 22 April 2018. Temperature 12°C, south easterly wind, 0.8 m/s average (max 1.6 m/s) humidity 80%, clear skies, road surfaces dry.

7.5.9 Summaries of the attended measurements at each location during the weekday and weekend periods are given in *Table* 7.18 to Table 7.23.

7.5.10 At Locations 1, 2, 3 and 4 near Harfrey's Roundabout, the dominant noise sources during all periods was from vehicle movements on local roads.

Secondary noise sources included more distant road traffic noise, seagull calls, domestic activities and emergency service sirens.

7.5.11 At Locations 5 and 6 on South Denes, the dominant noise source during the day was from vehicle movements on local roads including regular HDV movements and intermittent commercial/industrial activities. During the weekend evening measurements police sirens dominated the noise levels whilst during the night-time the dominant noise source was again from vehicle movements on local roads.

Table 7.18: Summary of Measured Noise Levels at L01, Free-field

Period	Time	Duration	Noise Level (dB)			
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}
Weekday	13:00 - 15:00	3 x 15 min	66.0	81.2	59.0	68.9
	20:48 - 21:03	1 x 15 min	62.3	73.1	49.9	66.7
	00:36 - 00:51	1 x 15 min	58.0	74.3	45.1	62.6
Weekend	12:25 - 14:00	3 x 15 min	64.5	79.8	55.2	67.7
	21:18 - 21:33	1 x 15 min	60.4	71.8	48.5	64.2
	00:37 - 00:52	1 x 15 min	59.8	71.8	45.0	65.3

Table 7.19: Summary of Measured Noise Levels at L02, Free-field

Period	Time	Duration	Noise Level (dB)			
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}
Weekday	13:15 - 16:15	3 x 15 min	53.8	69.9	49.5	55.4
	21:07 - 21:22	1 x 15 min	56.3	80.1	48.7	55.6
	00:58 - 01:13	1 x 15 min	44.8	57.2	42.8	48.0
Weekend	13:08 - 14:55	3 x 15 min	59.5	87.8	53.5	59.5
	20:55 - 21:11	1 x 15 min	53.6	63.4	48.9	56.3
	00:58 - 01:13	1 x 15 min	49.7	66.9	41.9	50.9

Table 7.20: Summary of Measured Noise Levels at L03, Free-field

Period	Time	Duration	Noise Level (dB)			
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}
Weekday	13:00 - 16:00	3 x 15 min	69.1	84.2	56.2	72.7
	21:37 - 21:52	1 x 15 min	62.6	76.9	45.9	67.0
	01:37 - 01:52	1 x 15 min	57.8	79.0	46.4	55.1
Weekend	12:17 - 14:15	3 x 15 min	67.9	86.6	54.1	71.2

Period	Time	Duration	Noise Level (dB)			
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}
	20:52 - 21:07	1 x 15 min	65.2	82.0	48.3	69.3
	01:18 - 01:33	1 x 15 min	61.7	77.9	44.6	65.2

Table 7.21: Summary of Measured Noise Levels at L04, Free-field

Period	Time	Duration	Noise Level (dB)			
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}
Weekday	13:00 - 16:00	3 x 15 min	50.8	66.1	46.3	52.3
	21:32 - 21:47	1 x 15 min	43.9	54.3	41.0	45.7
	01:20 - 01:35	1 x 15 min	39.1	47.4	37.4	40.4
Weekend	12:36 - 14:32	3 x 15 min	52.3	65.7	48.5	54.3
	21:09 - 21:24	1 x 15 min	48.5	68.1	43.4	47.7
	01:36 - 01:51	1 x 15 min	42.0	55.1	37.0	44.0

Table 7.22: Summary of Measured Noise Levels at L05, free-field

Period	Time	Duration	Noise Level (dB)			
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}
Weekday	10:00 - 13:00	3 x 15 min	70.7	88.4	55.7	74.7
	22:01 - 22:16	1 x 15 min	59.9	77.1	42.6	61.2
	02:04 - 02:19	1 x 15 min	52.1	77.7	37.1	42.2
Weekend	14:05 - 16:15	3 x 15 min	65.4	83.5	49.0	69.6
	21:43 - 21:58	1 x 15 min	64.3	81.5	49.8	67.1
	02:09 - 02:24	1 x 15 min	56.4	79.4	44.0	49.6

Table 7.23: Summary of Measured Noise Levels at L06, Free-field

Period	Time	Duration	Noise Level (dB)			
			L_{Aeq}	L_{AFmax}	L_{A90}	L_{A10}
Weekday	10:00 - 12:00	3 x 15 min	72.4	86.8	56.7	76.1
	02:23 - 02:38	1 x 15 min	62.9	86.1	46.9	56.4
Weekend	14:24 - 16:35	3 x 15 min	68.3	86.6	46.7	72.7
	21:45 - 22:00	1 x 15 min	69.3	92.7	47.5	68.1
	02:28 - 02:43	1 x 15 min	51.9	75.4	39.2	52.4

Defra Noise Important Areas

7.5.12 Defra Noise Important Areas (NIAs) are locations where the local population are amongst the 1% of the total UK population that are affected by the highest noise levels from major roads, according to the results of Defra's strategic noise maps.

7.5.13 There are six NIAs within the operational phase noise study area. They are identified in *Table* 7.24 and are shown in Figure 7.1.

Table 7.24: NIAs within the Operational Noise Study Area

NIA	Location	Highway Authority	No. of Dwellings
4985	Acle New Road and North Quay (A149)	Norfolk	15
4986	Lawn Avenue (A149)	Norfolk	13
4987	Lawn Avenue (A149)	Norfolk	22*
4989	A47	Highways England	35
4990	A47	Highways England	19
11282	A47	Highways England	4
* NIA 4987 extends outside the operation study area. This is the number of dwellings within this NIA and the study area.			

Future Baseline

7.5.14 The DM 2038 noise model has been used to determine the future baseline noise levels. This model is based on the baseline traffic flow data for growth to the design year (2038) in addition to flows associated with those developments included in the Transport Assessment (TA) (document reference 7.2).

7.6 Sensitive Receptors

7.6.1 NSRs are defined in the DMRB HD 213/11 as dwellings, hospitals, schools, community facilities and designated areas. NSRs are locations that are

sensitive to noise or vibration or a change in noise or vibration and which could therefore be significantly affected as a result[3].

7.6.2 Existing sensitive receptors within the Study Areas[4] have been identified using the AddressBase Plus® data and the results of the Desk Study. Residential buildings were identified as well as other sensitive receptors such as educational facilities (schools and nurseries etc.), medical facilities (Doctors surgeries, clinics etc.) religious facilities (churches, mosques and synagogues etc.), community facilities (libraries, halls and civic buildings etc.) and outdoor recreational areas (parks, playgrounds and recreational areas etc.).

7.6.3 The resulting residential data set for the Study Area has then been edited based on the results of the Desk Study (e.g. where no residential property has been identified, this entry has been removed, or where an additional residential property has been identified this has been added).

7.6.4 The receptor data set has then been supplemented where the Desk Study identified other non-address-based receptors such as designated areas, e.g. Areas of Outstanding Natural Beauty (AONB), National Parks, Special Areas of Conservation (SAC), Special Protection Areas (SPA), Sites of Special Scientific Interest (SSSI), Ancient Monuments, or Public Rights of Way (PRoW).

7.6.5 The operational study area contains 10,436 dwelling receptors and 221 other sensitive receptors.

7.6.6 All NSRs in this assessment are considered equally sensitive (high sensitivity), and are either buildings, or locations where people or operations are sensitive to noise and vibration.

7.6.7 Noise levels at areas of interest to nature conservation have been presented in *Table* 7.45 of this chapter to facilitate additional consideration within Chapter 8: Nature Conservation.

[3] Offices have not been included within the operational noise or vibration assessment as they are not considered a sensitive receptor in the DMRB HD 213/11.

[4] Construction Noise; Construction Vibration; Operational Noise; Operational Airborne Vibration.

7.7 Establishing the Scenario for Assessment

Construction Phase

7.7.1 The elements of the Scheme which have the potential to cause noise and vibration effects are:

- Principal Application Site construction works; and
- Off-site construction traffic.

7.7.2 A description of the Scheme is contained in Chapter 2: Description of the Scheme.

7.7.3 The noise and vibration construction assessment groups construction activities into key phases, which have been identified by the Contractor as the generating the highest levels and noise and vibration. In contrast, the air quality construction dust assessment considers the effect of activities for the entirety of the construction programme, see Technical Appendix 6B: Air Quality Construction Phase Assessment Methodology. For the avoidance of doubt, 'phases' for the purposes of this chapter does not mean the chronological order in which the Scheme will be constructed, but is used simply as a descriptor to separate out the activities considered.

7.7.4 The key construction phases that have the potential to cause noise and vibration effects have been identified by the Contractor, these are described below:

- Demolition West Bank;
- West Bascule Pit Combi-Wall;
- West Abutment Combi-Wall;
- West Embankment Support Piles;
- East Bascule Pit Combi-Wall;
- East Abutment Combi-Wall; and
- East Embankment Support Piles.

7.7.5 For each of the construction phases identified above, the Contractor has provided the following information which is the basis of the construction noise and vibration assessment: working hours, estimated duration of works, construction plant type and number, location of plant, on-times, methods of working and screening.

7.7.6 The construction plant items have been cross-referenced against Annexes C and D of BS 5228-1:2009+A1:2014 to identify appropriately similar plant with associated noise level data[5]. Appendix 7C details the assumed plant type, quantity, source noise level (in terms of the L_{Aeq} at 10m) and total sound pressure level for each construction phase that has been calculated for the purposes of this assessment.

7.7.7 A conservative assessment method has been undertaken. With respect to the geographical location of the plant, the full complement of plant for each phase, as identified in Appendix 7C, is assumed to operate together at a single point, set at 20m inside the closest working area or at the centre of the closest working area, whichever point is closest to each reference position.

7.7.8 Embedded mitigation for the Principal Application Site construction works include the core working hours, which are between 07:00 and 19:00 hours on weekdays and 07:00 and 13:00 on Saturdays; no working on Sundays and Bank Holidays. The assessment of construction works is limited to the key noise and vibration generating construction phases described above, which are restricted to core working hours.

7.7.9 Deviations to the core working hours will be required for limited activities. Works outside core hours will be agreed pursuant to an application for 'prior consent' from GYBC under Section 61 of the CoPA.

7.7.10 To avoid or reduce disturbance from noise and vibration as far as is practicable, all work will be completed in line with BPM, as defined in Section 72 of the CoPA. This includes the adoption of the advice contained within BS 5228-1:2009+A1:2014 and BS 5228-2:2009+A1:2014.

7.7.11 Compliance with BPM will be secured through the adoption and development of the Outline CoCP (document reference 6.16), which includes noise and vibration mitigation measures, compliance which is secured through the DCO.

7.7.12 For the assessment of noise from construction traffic, traffic data for the permitted routes to site from the trunk road network for the pre-construction and during construction scenarios have been taken from the information provided in Chapter 17: Traffic and Transport and Transport Assessment (TA) (document reference 7.2).

5 Plant item noise data is preferentially taken the more recent Annex C. Many Annex D measurements are older and were carried out prior to the implementation of EC noise limits.

Operational Phase

7.7.13 The operational elements of the Scheme which have the potential to cause noise and vibration effects are:

- Road traffic noise changes resulting from the introduction of the Scheme; and
- New bridge opening (wig wag) alarm.

7.7.14 A description of the Scheme is contained in Chapter 2: Description of the Scheme.

7.7.15 The key aspects of the Scheme which inform the assessment are the new physical infrastructure created by the Scheme, and the changes in traffic flow because of the Scheme.

7.7.16 For the assessment road traffic noise and vibration, traffic data for the do minimum and do something scenarios, for the opening year (2023) and design year (2038) have been taken from Chapter 17: Traffic and Transport and Transport Assessment (TA) (document reference 7.2).

7.7.17 During the operational phase no embedded or additional mitigation is proposed. A discussion of mitigation is detailed in paragraphs 7.8.98 to 7.8.101.

7.7.18 For the assessment of the new bridge opening (wig wag) alarm, traffic data from the opening year do something bridge link is used to establish the likely noise level required for the wig wags (+10 dBA above the ambient noise created by the traffic flow). Further details and assessment of traffic movements are provided in Chapter 17: Traffic and Transport and Transport Assessment (TA) (document reference 7.2).

7.8 Assessment of Effects, Mitigation and Residual Effects

Construction Phase

Predicted Noise Levels During Construction

7.8.1 Following the ABC assessment methodology contained within BS 5228-1, construction noise thresholds have been derived from the baseline noise survey measurement results, as presented in Table 7.25.

Table 7.25: Construction Noise Thresholds

Noise Monitoring Location	Weekday daytime $L_{Aeq,T}$ calculated using BS 5228 ABC methodology			Weekday night-time $L_{Aeq,T}$ calculated using BS 5228 ABC methodology		
	Free-field Ambient level	Rounded to nearest 5 dB	Threshold Value (Category)	Free-field Ambient level	Rounded to nearest 5 dB	Threshold Value (Category)
L01	66	65	70 (B)	58	60	58 (C)*
L02	54	55	65 (A)	45	45	50 (B)
L03	69	70	75 (C)	58	60	58 (C)*
L04	51	50	65 (A)	39	40	45 (A)
L05	71	70	75 (C)	52	50	55 (C)
L06	72	70	75 (C)	63	65	63 (C)*
NOTE 2 from Table 7.5 states: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total L_{Aeq} noise level for the period increases by more than 3 dB due to site noise.						

7.8.2 The BS 5228-1:2009+A1:2014 calculation procedures allow noise levels to be determined for various construction activities. However, the accuracy of any such predictions is necessarily limited by the number of assumptions made regarding the number and type of plant to be utilised, their location and detailed operating arrangements.

7.8.3 The information contained within BS 5228-1:2009+A1:2014 and an appropriate plant list for the construction works that would be undertaken is considered sufficient to perform a construction phase noise assessment. It focusses on key activities, with the aim of identifying whether a significant, temporary, noise effect might arise at the nearest NSRs.

7.8.4 A summary of the combined sound power levels for each construction phase is presented in Table 7.26.

7.8.5 The key noise generating construction phases, are to be restricted to the core working hours. The core working hours are between 07:00 and 19:00 hours on weekdays and 07:00 and 13:00 on Saturdays; no working on Sundays and Bank Holidays.

Table 7.26: Combined Activity Sound Pressure Levels during Construction Phases

Construction Phase	Sound Pressure Level at 10m	Duration
Demolition West Bank	91 dB(A)	15 days

Construction Phase	Sound Pressure Level at 10m	Duration
West Bascule Pit Combi-Wall	103 dB(A)	27 days
West Abutment Combi-Wall	92 dB(A)	12 days
West Embankment Support Piles	95 dB(A)	65 days
East Bascule Pit Combi-Wall	103 dB(A)	27 days
East Abutment Combi-Wall	104 dB(A)	12 days
East Embankment Support Piles	92 dB(A)	32 days

7.8.6 Construction phases are assumed to be undertaken separately. It is appreciated that some of the construction phases may overlap, however, the approach adopted is representative of predicting likely significant effects given that in the case of any such overlapping operations, it will be the closest operations to the receptor that will generally dictate the resulting noise levels.

7.8.7 In practice, the plant items identified for each stage will move around the site, operating at different times, for different durations and at different locations on any one day for the duration of the works. Consequently, noise levels at any receptor may vary considerably day-on-day. Hence, it is necessary to rationalise the geographic and temporal spread of activities to obtain a meaningful prediction (and subsequent assessment). To this end, various assumptions have necessarily been made as described in the following paragraphs.

7.8.8 The most important assumptions relate to the location of construction plant and their operational ‘on-time’ during the period of interest.

7.8.9 In calculating the overall sound pressure level for each construction phase the on-times for plant items as provided by the Contractor were used.

7.8.10 With respect to the geographical location of the plant, the full complement of plant for each phase, as identified in Appendix 7C, is assumed to operate together at a single point, set at 20m inside the closest working area or at the centre of the closest working area, whichever point is closest to each reference position. This is a pragmatic and reasonable approach given the space constraints associated with this Scheme, whilst still representative of likely significant effects to arise during the construction phase. The assumed single point operating distance for each construction phase and NSR is summarised in Table 7.27.

Table 7.27: Single Point Operating Distances Assumed for Prediction of Construction Noise

Construction Phase	Receptors					
	L01	L02	L03	L04	L05	L06
Demolition West Bank	220m	22m	32m	28m	340m	290m
West Bascule Pit Combi-Wall	285m	120m	65m	120m	300m	250m
West Abutment Combi-Wall	270m	100m	45m	95m	320m	260m
West Embankment Support Piles	270m	65m	40m	39m	342m	280m
East Bascule Pit Combi-Wall	310m	180m	135m	190m	260m	170m
East Abutment Combi-Wall	310m	180m	140m	200m	250m	155m
East Embankment Support Piles	320m	190m	150m	210m	230m	90m

7.8.11 Other assumptions which have been made with respect to the construction noise predictions are:

- No temporary or permanent noise barriers have been included;
- Acoustically hard ground cover has been assumed between the noise source and NSR (which therefore removes any attenuation effects due to ground absorption);
- No atmospheric absorption has been included;
- Predicted levels are quoted as equivalent free field levels at the location of the NSR façade where appropriate (i.e. 3 dB has not been added to account for façade reflections);
- Sources and receptors have both been taken to be 1.5m high; and
- Meteorological conditions have been taken to be 'neutral'.

7.8.12 On this basis, construction noise levels have been predicted at the six noise monitoring locations. These monitoring locations are representative of the nearest NSRs (as detailed in *Table* 7.16) to the construction works, and

more widely representative of the nearby NSRs. A summary of predicted noise levels during each construction phase is given in Table 7.28. The effect level (NOEL/LOAEL/SOAEL) in line with the criteria presented in Table 7.6 for each reference position is also presented.

Table 7.28: Predicted Unmitigated Construction Noise Level, $L_{Aeq,T}$ dB

Construction Phase	L01	L02	L03	L04	L05	L06
Demolition West Bank	64	84	81	82	60	62
	(NOEL)	(SOAEL)	(SOAEL)	(SOAEL)	(NOEL)	(NOEL)
West Bascule Pit Combi-Wall	74	81	87	81	74	75
	(LOAEL)	(SOAEL)	(SOAEL)	(SOAEL)	(LOAEL)	(LOAEL)
West Abutment Combi-Wall	64	72	79	73	62	64
	(NOEL)	(SOAEL)	(LOAEL)	(SOAEL)	(NOEL)	(NOEL)
West Embankment Support Piles	66	77	81	81	64	66
	(LOAEL)	(SOAEL)	(SOAEL)	(SOAEL)	(NOEL)	(NOEL)
East Bascule Pit Combi-Wall	73	78	80	77	75	78
	(LOAEL)	(SOAEL)	(SOAEL)	(SOAEL)	(LOAEL)	(LOAEL)
East Abutment Combi-Wall	75	79	81	78	76	81
	(SOAEL)	(SOAEL)	(SOAEL)	(SOAEL)	(LOAEL)	(SOAEL)
East Embankment Support Piles	62	67	69	66	65	73
	(NOEL)	(LOAEL)	(NOEL)	(LOAEL)	(NOEL)	(LOAEL)

7.8.13 Deviations to the core working hours will be required for limited activities. Works outside core hours will be agreed pursuant to an application for 'prior consent' from GYBC under Section 61 of the CoPA.

Evaluation of the Significance of Predicted Noise Levels during Construction

7.8.14 The potential construction noise effects for each phase has been assessed based on the magnitude of predicted noise levels and the effect levels (as defined in NPSE) set out in Table 7.6.

7.8.15 As stated in paragraph 7.4.45, it is considered appropriate to assume that the construction works would exceed at least one of the duration criteria presented in paragraph 7.4.42 (i.e. ten or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any six

consecutive months). Therefore, only the criteria on the bottom row of Table 7.7 have been applied in the determination of effect significance. The results of this assessment are presented in Table 7.29.

Table 7.29: Significance of Effect for Construction Noise

Construction Phase	L01	L02	L03	L04	L05	L06
Demolition West Bank	Neutral	Very Large	Very Large	Very Large	Neutral	Neutral
West Bascule Pit Combi-Wall	Large	Very Large	Very Large	Very Large	Large	Large
West Abutment Combi-Wall	Neutral	Very Large	Large	Very Large	Neutral	Neutral
West Embankment Support Piles	Large	Very Large	Very Large	Very Large	Neutral	Neutral
East Bascule Pit Combi-Wall	Large	Very Large	Very Large	Very Large	Large	Large
East Abutment Combi-Wall	Very Large	Very Large	Very Large	Very Large	Large	Very Large
East Embankment Support Piles	Neutral	Large	Neutral	Large	Neutral	Large

7.8.16 In line with BS 5228-1:2009+A1:2014 the construction noise results presented in Table 7.29 relate to residential NSRs only.

7.8.17 As significant effects are anticipated, **large** and **very large**, mitigation measures have been considered to minimise these effects. Construction mitigation is set out in paragraphs 7.8.28 to 7.8.42.

Designated Sites

7.8.18 The construction noise study area includes the Outer Thames Estuary SPA. The potential noise levels during key construction phases have been calculated at the shortest distance between working area and the Outer

Thames Estuary SPA. The noise level for each construction phase is presented in Table 7.30.

Table 7.30: Designated Sites Construction Noise

Construction Phase	Distance to works	Noise Level $L_{Aeq,T}$
Demolition West Bank	40 m	79 dB
West Bascule Pit Combi-Wall	10 m	103 dB
West Abutment Combi-Wall	10 m	92 dB
West Embankment Support Piles	40 m	81 dB
East Bascule Pit Combi-Wall	10 m	103 dB
East Abutment Combi-Wall	10 m	104 dB
East Embankment Support Piles	40 m	80 dB

7.8.19 The assessment of potential effects on ecological receptors within the Outer Thames Estuary is presented in Chapter 8: Nature Conservation.

Predicted Vibration Levels during Construction Phase

7.8.20 Groundborne vibration calculations have been performed for typical activities during construction based on the empirical prediction procedures presented within BS 5228-2:2009+A1:2014 and TRL report 429:2000 *Groundborne vibration caused by mechanised construction works* (applicable to vibratory rollers).

7.8.21 Such predictions have been performed to determine the possible distances at which the adopted magnitude of impact criteria may be registered. In this regard, groundborne vibration levels and associated distances have been identified for a sample of typical vibration sources which may be associated with the construction phase as shown in *Table* 7.31.

7.8.22 The Contractor has identified that driven piles are the most appropriate piling method throughout the Scheme. Based on the ground conditions, driven piles are the most time efficient method, reduce the risk of soil contamination and 'blowing sands', and are the most cost-effective method.

7.8.23 The key vibration construction phases are the same as identified in Paragraph 7.7.3.

Table 7.31: Predicted Groundborne Vibration Levels Applicable to Typical Vibration Generating Construction Activities

Construction Activity	Construction Phases	Distance (m)	PPV (mms^{-1})
Impact piling[1]	• Bascule Pit Combi Walls • Abutment Combi Walls • Embankment Support Piles	250	0.3
		100	1.0
		40	3.0
Vibratory piling (average of all operations)	• Bascule Pit Combi Walls • Abutment Combi Walls • Embankment Support Piles	100	0.3
		40	1.0
		18	3.0
Vibratory rollers – start and end[2]	All phases	60	0.3
		23	1.0
Vibratory rollers – steady state[2]	All phases	9	3.0

[1] Assumes a hammer energy of 6,000J, a pile toe depth of 10m and all piles driven to refusal.
[2] Assumes two rollers, 0.4mm amplitude, drum width of 1.3m, e.g. heavy-duty ride on roller.

7.8.24 It is noted that the data presented within *Table* 7.31 is general in nature and is not specific to any one site but is appropriate for producing a robust assessment. Furthermore, there may be a variety of different potential vibration generating activities employed other than those listed. However, the vibration levels and associated distances are used to determine the typical distances at which specific magnitudes can be registered.

7.8.25 The single point distances assumed for the construction noise activities for each phase, as presented in Table 7.27, have been assumed for the assessment of construction vibration.

7.8.26 A summary of predicted noise levels during each construction phase is given in Table 7.28. The effect level (NOEL/LOAEL/SOAEL) in line with the criteria presented in Table 7.6 for each reference position is also presented.

7.8.27 The potential construction vibration impact for each activity has been assessed based on the vibration level magnitude and the effect level (NOEL/LOAEL/SOAEL) presented in Table 7.10, the results are presented in *Table* 7.32.

Table 7.32: Predicted Unmitigated Construction Vibration Impact

Construction Phase	Construction Activity	L01	L02	L03	L04	L05	L06
Demolition West Bank	Impact Piling	N/A	N/A	N/A	N/A	N/A	N/A
	Vibratory Piling	N/A	N/A	N/A	N/A	N/A	N/A
	Vibratory rollers - start and end	NOEL	>LOAEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - steady state	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
West Bascule Pit Combi-Wall	Impact Piling	NOEL	NOEL	>LOAEL	NOEL	NOEL	NOEL
	Vibratory Piling	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - start and end	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - steady state	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
West Abutment Combi-Wall	Impact Piling	NOEL	NOEL	>LOAEL	>LOAEL	NOEL	NOEL
	Vibratory Piling	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - start and end	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - steady state	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
West Embankment Support Piles	Impact Piling	NOEL	>LOAEL	>LOAEL	>SOAEL	NOEL	NOEL
	Vibratory Piling	NOEL	NOEL	NOEL	>LOAEL	NOEL	NOEL
	Vibratory rollers - start and end	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - steady state	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL

Construction Phase	Construction Activity	L01	L02	L03	L04	L05	L06
East Bascule Pit Combi-Wall	Impact Piling	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory Piling	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - start and end	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - steady state	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
East Abutment Combi-Wall	Impact Piling	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory Piling	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - start and end	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - steady state	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
East Embankment Support Piles	Impact Piling	NOEL	NOEL	NOEL	NOEL	NOEL	>LOAEL
	Vibratory Piling	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - start and end	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL
	Vibratory rollers - steady state	NOEL	NOEL	NOEL	NOEL	NOEL	NOEL

Evaluation of the Significance of Predicted Levels of Vibration during Construction

7.8.28 The significance of effect due to construction vibration for each phase has been assessed. As stated in paragraph 7.4.45, it is considered appropriate to assume that the construction works would exceed at least one of the duration criteria presented in paragraph 7.4.42 (i.e. 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months). Therefore, only the criteria on the bottom line of Table 7.11 have been applied in the determination of effect significance. The worst-case significance for each construction phase is presented in *Table* 7.33.

Table 7.33: Significance of Effect for Construction Vibration

Construction Phase	L01	L02	L03	L04	L05	L06
Demolition West Bank	Neutral	Large	Neutral	Neutral	Neutral	Neutral
West Bascule Pit Combi-Wall	Neutral	Neutral	Large	Neutral	Neutral	Neutral
West Abutment Combi-Wall	Neutral	Neutral	Large	Large	Neutral	Neutral
West Embankment Support Piles	Neutral	Large	Large	Very Large	Neutral	Neutral
East Bascule Pit Combi-Wall	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
East Abutment Combi-Wall	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
East Embankment Support Piles	Neutral	Neutral	Neutral	Neutral	Neutral	Large

7.8.29 Where the magnitude is below NOEL, no significant effects are anticipated, irrespective of the duration of the works.

7.8.30 **Large** significant effects are predicted at four sample receptors, this is where construction vibration magnitude is above the LOAEL but below SOAEL.

7.8.31 A **very large** significant effect is predicted at one sample receptor, this is where construction vibration magnitude is above the SOAEL.

7.8.32 The significant effects are predicted due to a combination of the proximity of the NSR to the works and the nature of the construction activity. It is noted that the assessment is based on a scenario with plant working at a single point, set at 20m inside the closest working area or at the centre of the closest working area, whichever point is closest to each reference position.

7.8.33 As significant effects are anticipated, mitigation measures have been proposed to minimise these effects.

Designated Sites

7.8.34 The construction vibration study area contains the Outer Thames Estuary SPA. The potential vibration levels during key construction phases have been estimated at the shortest distance between working area and the Outer Thames Estuary SPA. The worst-case vibration level for each construction phase is presented in Table 7.34.

Table 7.34: Designated Sites Construction Vibration

Construction Phase	Distance to works	Vibration Level PPV
Demolition West Bank	40 m	<3.0 mm/s
West Bascule Pit Combi-Wall	10 m	>3.0 mm/s
West Abutment Combi-Wall	10 m	>3.0 mm/s
West Embankment Support Piles	40 m	~3.0 mm/s
East Bascule Pit Combi-Wall	10 m	>3.0 mm/s
East Abutment Combi-Wall	10 m	>3.0 mm/s
East Embankment Support Piles	40 m	~3.0 mm/s

7.8.35 The assessment of potential effects on ecological receptors within the Outer Thames Estuary is presented in Chapter 8: Nature Conservation.

Construction Noise and Vibration Mitigation

7.8.36 Legislative safeguards are available to reduce the effects of noise and vibration during the construction of a development such as the Scheme. These include:

- EC Directives and UK Statutory Instruments that limit noise emissions of a variety of construction plant; and
- Section 60 and 61 of the CoPA.

7.8.37 In addition to the above legislative controls, and as explained above as forming part of the embedded mitigation for the Scheme, the adoption of

best practicable means (BPM), as defined in Section 72 of the CoPA, is usually the most effective means of controlling noise and vibration from construction sites. This includes the adoption of the advice contained within BS 5228-1:2009+A1:2014 and BS 5228-2:2009+A1:2014.

7.8.38 The Outline CoCP (document reference 6.16) sets out the standards and procedures to which the Contractor must adhere.

7.8.39 In addition, and based on the principles of BPM, appropriate noise and vibration mitigation measures will be implemented and are set out in the Outline CoCP (document reference 6.16) including:

- Maintaining good public relations with residents that may be affected by noise from the construction works. Effective means of communication will be established, keeping residents informed of the type and timing of works involved by following the processes noted in section 2.6 of the Outline CoCP;
- Careful planning of construction activities and selection of appropriate plant to reduce noise emissions;
- Careful planning of construction activities and selection of appropriate plant to reduce noise emissions;
- Whenever possible noisy activities should be undertaken during core working hours;
- Where reasonably practicable, fixed items of construction plant should be electrically powered in preference to diesel or petrol driven;
- Whenever reasonably practicable, fabrication would be undertaken off site;
- Noisy plant would be kept as far away as reasonably practicable from sensitive areas (and may need localised acoustic and visual screening);
- As far as reasonably practicable the noise from reversing alarms would be controlled or limited. This would be undertaken through following a hierarchy of techniques:

  (a) The site layout would be designed to minimise reversing.

  (b) Banksmen would be utilised to avoid so far as reasonably practicable the use of reversing alarms.

  (c) Reversing alarms would incorporate, where reasonably practicable, features such as broadband signals to reduce the level of noise.

- All plant, equipment and noise control measures applied to plant and equipment will be maintained in good working order and operated such that noise emissions are minimised as far as reasonably practicable. Every effort would be made to plant, equipment or items fitted with noise control equipment found to be defective, not to be operated until repaired;
- Shutting down equipment when not in use;
- A Toolbox talk and information leaflet would be provided to operatives when working outside of the core working hours set out in the Outline Code of Construction Practice to brief them on the requirements to be considerate to local residents and any specific control measures required with each specific task being undertaken;
- Use of construction hoardings around the noise generating activity up to a height appropriate to ensure attenuation of noise is achieved;
- Where reasonably practicable, use of temporary barriers to screen noisy activities;
- Using silenced equipment where reasonably practicable, in particular, silenced power generators if night-time power generation is required for site security or lighting;
- Ensuring that vehicles do not park or queue for long periods outside Noise Sensitive Receptors (NSRs) with engines running unnecessarily;
- Generators and water pumps required for 24-hour operation would be silenced and/or screened, as appropriate; and
- Where reasonably practicable, soft start procedures for terrestrial piling would be used.

7.8.40 For working outside core hours, where practicable, silenced equipment and plant will be used, and/or temporary barriers will be installed to reduce noise at NSRs to below BS 522/-1:2009+A1:2014 threshold values where practicable.

7.8.41 During construction works, the mitigation measures to control and reduce noise and vibration emissions to ecological receptors will be included within the Outline CoCP (document reference 6.16) will be followed. Mitigation measures will include the adoption of the measures set out in the Joint Nature Conservation Committee (JNCC) document entitled 'Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise' (2010).

Residual Noise Effects

7.8.42 With appropriate mitigation in place, including compliance with the CoCP, a reduction in noise of as much as 10dB can typically be achieved. The reduction in noise assumes that multiple measures are applied, including site hoarding/temporary screening; using well maintained, quieter and/or silenced plant; turning off engines when not in use; locating noise and vibration plant away from sensitive receptors. Applying this 10dB(A) correction to the predicted construction noise levels presented in Table 7.28, the residual construction noise effects (in line with the NPSE) at the NSRs are as presented in Table 7.35.

Table 7.35: Residual Construction Significance of Impact for Construction Noise

Construction Phase	L01	L02	L03	L04	L05	L06
Demolition West Bank	Neutral	Very Large	Large	Very Large	Neutral	Neutral
West Bascule Pit Combi-Wall	Neutral	Very Large	Large	Very Large	Neutral	Neutral
West Abutment Combi-Wall	Neutral	Large	Neutral	Large	Neutral	Neutral
West Embankment Support Piles	Neutral	Large	Large	Very Large	Neutral	Neutral
East Bascule Pit Combi-Wall	Neutral	Large	Neutral	Large	Neutral	Neutral
East Abutment Combi-Wall	Neutral	Large	Large	Large	Neutral	Large
East Embankment Support Piles	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral

7.8.43 Where magnitude is below NOEL, no significant effects are anticipated, irrespective of the duration of the works.

7.8.44 Residual **large** significant effects are predicted at four sample receptors, representative of NSRs on Queen Anne's Road, Southtown Road, Cromwell Road/Cromwell Court and Southgates Road; this is where construction noise levels are in the LOAEL range. The **large** significant effects occur at:

- Queen Anne's Road during four construction phases:
  - West Abutment Combi-Wall;
  - West Embankment Support Piles;
  - East Bascule Pit Combi-Wall; and
  - East Abutment Combi-Wall.
- Southtown Road during four construction phases:
  - Demolition West Bank;
  - West Bascule Pit Combi-Wall;
  - West Embankment Support Piles; and
  - East Abutment Combi-Wall.
- Cromwell Road/Cromwell Court during three construction phases:
  - West Abutment Combi-Wall;
  - East Bascule Pit Combi-Wall; and
  - East Abutment Combi-Wall.

7.8.45 Residual **very large** significant effects are predicted at two sample receptors, representative of NSRs on Queen Anne's Road and Cromwell Road/Cromwell Court; this is where construction noise levels are in the SOAEL range. The **very large** significant effects occur at:

- Queen Anne's Road during two construction phases:
  - Demolition West Bank; and
  - West Bascule Pit Combi-Wall.
- Cromwell Road/Cromwell Court during three construction phases:

- Demolition West Bank;
- West Bascule Pit Combi-Wall; and
- West Embankment Support Piles.

7.8.46 Significant effects are due to a combination of the proximity of the NSRs to the works, the low existing noise climate, and the nature of the construction activities. It is noted that the assessment is based on a scenario with plant working at a single point, set at 20m inside the closest working area or at the centre of the closest working area, whichever point is closest to each reference position.

Residual Vibration Effects

7.8.47 With appropriate mitigation in place, it is considered that significance will be reduced by an effect level, for example, **very large** will become **large**; **large** will become **moderate**; and **moderate** will become **slight**.

7.8.48 Although mitigation measures will not reduce the vibration level experienced, the introduction of appropriate mitigation will reduce the perception of effect. The most important mitigation measure is effective communication with residents and other stakeholders.

7.8.49 The residual significance of effect for construction vibration during each phase is presented in *Table* 7.36.

Table 7.36: Residual Construction Significance of Effect for Construction Vibration

Construction Phase	L01	L02	L03	L04	L05	L06
Demolition West Bank	Neutral	Moderate	Neutral	Neutral	Neutral	Neutral
West Bascule Pit Combi-Wall	Neutral	Neutral	Moderate	Neutral	Neutral	Neutral
West Abutment Combi-Wall	Neutral	Neutral	Moderate	Moderate	Neutral	Neutral
West Embankment Support Piles	Neutral	Moderate	Moderate	Large	Neutral	Neutral
East Bascule Pit Combi-Wall	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
East Abutment Combi-Wall	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
East Embankment Support Piles	Neutral	Neutral	Neutral	Neutral	Neutral	Moderate

7.8.50 Residual **moderate** significant effects are predicted at four sample receptors, representative of NSRs on Queen Anne's Road, Southtown Road, Cromwell Road/Cromwell Court and Southgates Road.

7.8.51 A residual **large** significant effect is predicted at one sample receptor, Cromwell Road, during the West Embankment Support Piles construction phase. This sample receptor is representative of the residential properties on Cromwell Road/Cromwell Court.

7.8.52 Residual significant effects are predicted due to a combination of the proximity of the NSR to the works and the nature of the construction activity.

Construction Traffic Noise

7.8.53 For the assessment of noise from construction traffic, traffic data for the permitted routes to site from the trunk road network for the pre-construction and during construction scenarios have been taken from Chapter 17: Traffic and Transport and Transport Assessment (TA) (document reference 7.2).

7.8.54 Annual Average Weekday Traffic (AAWT) 18 hour traffic data for the permitted routes to site from the trunk road network, for the pre-construction and during construction scenarios, have been provided by the traffic engineers. These are presented in Table 7.37.

Table 7.37: Construction Traffic Data

Road	Pre-Construction			During Construction		
	Flow (veh.)	Speed (km/h)	HGV (%)	Flow (veh.)	Speed (km/h)	HGV (%)
Breydon Bridge	35498	59	2.8	35788	59	3.1
Haven Bridge	25415	40	5.5	25487	40	5.5
North Quay	12155	37	6.4	12443	37	6.4
South Quay	12710	47.5	6.6	13068	47.5	6.6
Southgates Road	7406	47.5	6.4	7764	47.5	6.4
William Adams Way	10415	33.3	1.9	10777	33.3	3.1
A47 north of Harfrey's RB	84304	71.5	2.7	84665	71.5	2.8
A47 south of Harfrey's RB	83496	71.1	4.3	83640	71.1	4.3

7.8.55 Basic Noise Levels (BNLs) have been calculated in accordance with the guidance contained in CRTN (1988) for both the pre-construction and during construction scenario for each route. A comparison between the results is presented in Table 7.38.

Table 7.38: Short-term Construction Traffic Noise Change, dB $L_{Aeq,18h}$

Road	Pre-Construction BNL	During Construction BNL	Short-Term Change in Noise Level
Breydon Bridge	73.7	73.9	0.2
Haven Bridge	71.5	71.5	0.0
North Quay	68.4	68.5	0.1
South Quay	69.3	69.5	0.2
Southgates Road	66.9	67.2	0.3
William Adams Way	65.8	66.5	0.7
A47 north of Harfrey's RB	78.7	78.8	0.1
A47 south of Harfrey's RB	79.1	79.1	0.0

7.8.56 Short-term changes in noise levels due to construction traffic are all less than 1 dB. Applying the short-term significance criteria, given in *Table* 7.14, the effect is **slight** adverse. Therefore, changes in traffic noise levels because of construction traffic are not considered to be significant and will not be considered further.

Construction Phase Monitoring

7.8.57 The Contractor will complete a programme of noise and vibration monitoring for the following reasons:

- To measure the performance of noise and vibration control measures;
- To ascertain noise and vibration from items of plant;
- To provide confirmation that noise and vibration thresholds are not exceeded.

7.8.58 A programme of monitoring will be set out in the full CoCP.

Operational Phase

7.8.59 A list of the operational phase predicted noise levels, and magnitude of change at NSRs is included in Appendix 7E (dwellings) and Appendix 7F (other sensitive receptors).

Short-term Effects: DM Opening Year versus DS Opening Year (2023)

7.8.60 The short-term noise change contour plot is shown in Figure 7.3.

7.8.61 The numbers of NSRs experiencing a change in traffic noise level in the short-term with the Scheme are identified in Table 7.39 (DM 2023 versus DS 2023).

Table 7.39: Short-term Operational Traffic Noise Level Changes

Change in Noise Level (magnitude of impact)		Dwellings	Other Sensitive Receptors
Increase in noise level, $L_{A10,18h}$	0.1 - 0.9	4666	73
	1.0 - 2.9	928	22
	3.0 - 4.9	117	5
	5 +	5	0
No change	0	820	30
Decrease in noise level, $L_{A10,18h}$	0.1 - 0.9	3032	65
	1.0 - 2.9	858	26
	3.0 - 4.9	10	0
	5 +	0	0

7.8.62 In the short-term with the Scheme in place, there are 8,518 (82%) dwellings and 168 (76%) other sensitive receptors that experience either no change or a negligible (imperceptible) noise level changes. These are the NSRs in the '0.1-0.9' and 'no change' rows of Table 7.39.

7.8.63 To determine the likelihood of significant effects in the short-term with the Scheme, the absolute noise level (in line with the requirements of the NPSE) also needs to be taken into consideration, as presented in *Table* 7.14. The short-term significance results are presented in Table 7.40.

Table 7.40: Short-term Operational Traffic Noise Significance

Change	Significance	Daytime	
		Dwellings	Other Sensitives
Adverse	Slight	5115	82
	Moderate	488	13
	Large	108	5
	Very Large	5	0
No change	Neutral	820	30
Beneficial	Slight	3742	81
	Moderate	149	10
	Large	9	0
	Very Large	0	0

7.8.64 In the short-term with the Scheme in place, significant adverse effects occur at 601 (6%) dwellings and 18 (8%) other sensitive receptors.

7.8.65 Significant beneficial effects (**moderate**, **large** or **very large**) occur at 158 (2%) dwellings and 10 (5%) other sensitive receptors.

7.8.66 Most receptors – 9677 (93%) dwellings and 193 (87%) other sensitive receptors – experience non-significant effects (**slight** or **neutral**).

Long-term Effects: DM Opening Year (2023) and DM Design Year (2038)

7.8.67 The numbers of NSRs experiencing a change in traffic noise level in the long-term without the Proposed Scheme are identified in *Table* 7.41 (DM 2023 versus DM 2038).

Table 7.41: Overall Long-term Operational Noise Level Changes – DM

Change in Noise Level (magnitude of impact)		Dwellings	Other Sensitive Receptors
Increase in noise level, $L_{A10,18h}$	0.1 - 2.9	10404	221
	3.0 - 4.9	0	0
	5.0 - 9.9	0	0
	10 +	0	0
No change	0	28	0
Decrease in noise level, $L_{A10,18h}$	0.1 - 2.9	4	0
	3.0 - 4.9	0	0
	5.0 - 9.9	0	0
	10 +	0	0

7.8.68 In the long-term without the Scheme in place, there are 10,436 (100%) dwellings and 221 (100%) other sensitive receptors that experience either no change or a negligible (imperceptible) noise change.

7.8.69 To determine the likelihood of significant effects in the long-term without the Scheme, the absolute noise level (in line with the requirements of the NPSE) also needs to be taken into consideration, as presented in *Table* 7.15. The long-term Do Minimum (DM 2023 versus DM 2038) significance results are presented in *Table* 7.42.

Table 7.42: Long-term Operational Traffic Noise Significance without Scheme

Change	Significance	Daytime	
		Dwellings	Other Sensitives
Adverse	Slight	10218	213
	Moderate	186	8
	Large	0	0
	Very Large	0	0
No change	Neutral	28	0
Beneficial	Slight	4	0
	Moderate	0	0
	Large	0	0
	Very Large	0	0

7.8.70 In the long-term without the Scheme, significant adverse effects occur at 186 (2%) dwellings and 8 (4%) other sensitive receptors.

7.8.71 There are no significant beneficial effects (**moderate**, **large** or **very large**).

7.8.72 Most receptors – 10,250 (2%) dwellings and 213 (96%) other sensitive receptors – experience non-significant effects (**slight** or **neutral**).

Long-term Effects: DM Opening Year (2023) and DS Design Year (2038)

7.8.73 The long-term noise change contour plot is shown in Figure 7.4.

7.8.74 The numbers of NSRs experiencing a change in traffic noise level in the long-term with the Scheme are identified in *Table* 7.43 (DM 2023 versus DS 2038).

Table 7.43: Long-term Operational Traffic Noise Level Changes with Scheme

Change in Noise Level (magnitude of impact)		Dwellings	Other Sensitive Receptors
Increase in noise level, $L_{A10,18h}$	0.1 - 2.9	8055	151
	3.0 - 4.9	264	10
	5.0 - 9.9	14	1
	10 +	0	0
No change	0	501	13
Decrease in noise level, $L_{A10,18h}$	0.1 - 2.9	1602	46
	3.0 - 4.9	0	0
	5.0 - 9.9	0	0
	10 +	0	0

7.8.75 In the long-term with the Scheme, there are 10,158 (97%) dwellings (97%) and 210 (95%) other sensitive receptors that experience either no change or a negligible (imperceptible) impact. These are the NSRs in the '0.1-2.9' and 'no change' rows.

7.8.76 To determine the likelihood of significant effects in the long-term with the Scheme, the absolute noise level (in line with the requirements of the NPSE) also needs to be taken into consideration, as presented in Table 7.15. The long-term Do Something (DM 2023 versus DS 2038) significance results are presented in *Table* 7.44.

Table 7.44: Long-term Operational Traffic Noise Significance with Scheme

Change	Significance	Daytime	
		Dwellings	Other Sensitives
Adverse	Slight	7667	144
	Moderate	584	16
	Large	79	2
	Very Large	3	0
No change	Neutral	501	13
Beneficial	Slight	1600	46
	Moderate	2	0
	Large	0	0
	Very Large	0	0

7.8.77 In the long-term with the Scheme, significant adverse effects occur at 666 (2%) dwellings and 18 (4%) other sensitive receptors.

7.8.78 Significant beneficial effects (**moderate**, **large** or **very large**) occur at 2 (<1%) dwellings and 0 (0%) other sensitive receptors.

7.8.79 Most receptors – 9,768 (94%) dwellings and 203 (92%) other sensitive receptors – experience non-significant effects (**slight** or **neutral**).

Designated Sites

7.8.80 The operational noise study area contains open area NSRs, including The Broads National Park; Breydon Water SSSI and SPA; and Outer Thames Estuary SPA. The results for these receptors are included in the other sensitive receptor (non-residential) counts in the section above but have been drawn out here to inform the assessment of potential effects on ecological receptors, as appraised within Chapter 8: Nature Conservation.

7.8.81 The predicted least beneficial change in noise level at each open area site are given in Table 7.45 (short term) and *Table* 7.49 (long term).

Table 7.45: Designated Sites Operational Noise Change – Short term

Designated Sites	Do Minimum	Do Something	Noise Change
	2023	2023	Short-term
The Broads National Park	73.9	73.9	0.0
Breydon Water SSSI and SPA	73.9	73.9	0.0
The Outer Thames Estuary	56.2	56.7	+0.5

Table 7.46: Designated Sites Operational Noise Change – Long term

Designated Sites	Do Minimum	Do Something	Noise Change
	2023	2038	Long-term
The Broads National Park	65.4	65.6	+0.2
Breydon Water SSSI and SPA	65.4	65.6	+0.2
The Outer Thames Estuary	42.4	43.7	+1.3

7.8.82 The assessment of potential effects on ecological receptors within these designated sites is presented in Chapter 8: Nature Conservation.

Noise Important Areas

7.8.83 There are six NIAs located within the operational study area, as detailed in *Table* 7.24 and shown in Figure 7.1. There are 108 dwellings across the six NIAs.

7.8.84 According to the results of Defra's strategic noise maps, dwellings in NIAs are already exposed to the highest noise levels from major roads and residents are at a greater risk of experiencing a significant adverse effect to health and quality of life. Therefore, a more detailed analysis of the predicted noise levels and noise level changes because of the Scheme has been undertaken at each NSR within each NIA, as presented in Table 7.47.

Table 7.47: Operational Traffic Noise Changes within NIAs - Dwellings

Change in Noise Level	Short-term		Long-term	
	Noise level	Dwellings	Noise level	Dwellings
Increase in noise level, $L_{A10,18h}$	0.1 - 0.9	41	0.1 - 2.9	97
	1.0 - 2.9	1	3.0 - 4.9	0
	3.0 - 4.9	0	5.0 - 9.9	0
	5 +	0	10 +	0
No change	0	45	0	7
Decrease in noise level, $L_{A10,18h}$	0.1 - 0.9	21	0.1 - 2.9	4
	1.0 - 2.9	0	3.0 - 4.9	0
	3.0 - 4.9	0	5.0 - 9.9	0
	5 +	0	10 +	0

7.8.85 In the short-term, one dwelling (which is in NIA 4989) is predicted to experience a minor increase (+1 dB change) in noise level because of the Scheme.

7.8.86 The other 107 dwellings are predicted to experience a noise level change in both the short and long-term that is either no change or negligible impact (imperceptible).

Table 7.48: Operational Traffic Noise Significance within NIAs - Dwellings

Change	Significance	Dwellings	
		Short-term	Long-term
Adverse	Slight	41	95
	Moderate	1	2
	Large	0	0
	Very Large	0	0
No change	Neutral	45	7
Beneficial	Slight	21	4
	Moderate	0	0
	Large	0	0
	Very Large	0	0

7.8.87 In the short-term, there is one (1%) short-term significant effect (**moderate**) in NIA 4989.

7.8.88 In the long-term, there are two (2%) long-term significant effects (**moderate**), both in NIA 4989.

7.8.89 There are no significant beneficial effects at dwellings within NIAs.

7.8.90 Most dwellings experience non-significant effects (**slight** or **neutral**); 107 (99%) in the short-term and 106 (98%) in the long-term.

Noise Insulation Regulations

7.8.91 The assessment of significant effects is based on the external noise levels predicted at NSRs, in line with the guidance in the DMRB HD 213/11. Therefore, a scheme for noise insulation of a property through the application of the Noise Insulation Regulations (NIR) will not alter the conclusions of the operational noise assessment.

7.8.92 An indication of the number of properties that may be eligible for the provision of noise mitigation (or a grant in respect thereof) under the NIR has been assessed.

7.8.93 To qualify for compensation under the NIR, four criteria must all be fulfilled at 1m in front of the most exposed door or window of an eligible room (including living rooms and bedrooms) in the façade of a property:

- Level - The highest total traffic noise level expected within the first 15 years' use of the road (the 'Relevant Noise Level') must be predicted to be not less than the Specified Level of 68 dB(A) $L_{A10,18h}$. Predicted noise levels of 67.5 dB $L_{A10,18h}$ and above are rounded up to 68 dB $L_{A10,18h}$;
- Increase - The Relevant Noise Level in the design year, or within any other year between the year before the highway construction works commenced and the design year, must be at least 1 dB(A) greater than that immediately before construction commenced (the 'Prevailing Noise Level');
- Contribution - Noise from traffic on the road for which the Regulations apply must contribute at least 1.0 dB $L_{A10,18h}$ to the Relevant Noise Level; and
- Locality - The property under consideration must be within 300m of the Scheme.

7.8.94 An indicative assessment, based on the results of the ES assessment, identifies 56 dwellings which may be eligible for noise insulation based on these criteria.

7.8.95 At detailed design stage, further analysis would need to be undertaken to determine whether the noise from traffic on the road to which the Regulations apply, contributes at least 1 dB $L_{A10,18hr}$ to the Relevant Noise Level. The criteria would also need to be met for any dwellings to qualify under the NIR.

Operational Noise and Vibration Nuisance

7.8.96 The DMRB HD213/11 also requires assessments to assess change in nuisance arising from the operational noise and vibration because of the Scheme, this is based on predicted receptor noise levels. As this assessment is independent from the EIA process and does not determine significant effects in EIA terms, the results are presented in Appendix 7D.

Mitigation

7.8.97 Significant adverse effects are predicted during the operational phase of the Scheme during the short and long-term. Consequently, mitigation measures have been explored to consider whether these effects can be reduced. Consideration has been given to the following mitigation measures:

- Changing location or alignment of the road;
- Changing the height of the road;
- Use of low-noise thin surface course system;
- Reducing traffic speed; and
- Use of roadside acoustic barriers, screens or bunds.

7.8.98 The majority of NSRs that are significantly adversely affected are located fronting the existing local road network and subject to ‘indirect’ effects associated with traffic flow changes on the surrounding road network. The practicalities of employing the above mitigation measures are explored in turn below.

7.8.99 Chapter 3: Consideration of Alternatives, provides commentary around the alternatives considered for the location and alignment of the Scheme, during which various factors were considered, including noise. The third crossing necessarily connects the west side of the river with the port and outer harbour on the eastern side, due to the layout of Great Yarmouth, and therefore any crossing would always pass near existing dwellings.

7.8.100 Lowering or increasing the height of existing roads by a significant amount to provide any screening is impractical as it would restrict access to properties which front directly onto the road. Lowering or increasing the height of new or altered routes to provide screening is also considered impractical due to

engineering and environmental constraints. To be effective, the new road height would need to block line-of-sight between road and receiver. This would mean either raising/lowering the height of the road above/below the height of the surrounding buildings. No further consideration has therefore been given to route alignment and height changes.

7.8.101 Whilst low noise road surfaces are available, these are most effective at higher speeds (around 50 mph and above), where the noise from the tyre and road interaction is dominant. At lower speeds, as in this case, where the engine and exhaust noise are dominant, any noise reduction afforded by such a measure would be minimal. Furthermore, given the route speed is already relatively low, a further reduction in speed is also not considered a viable measure.

7.8.102 Noise barriers are only effective when they break the line of sight between a noise source and the receptor. Therefore, to provide effective noise reduction for properties fronting the existing local road network, a continual barrier would need to be erected along the road edge, and any break in the barrier would negate its value in that location. This would create obvious difficulties for accessing driveways or the pavement from a parked car. Acoustic barriers are there not considered practical on the existing road network.

Residual Effects

7.8.103 Opportunities for mitigation measures to offset the predicted significant adverse effects are limited due to the urban nature of the surrounding area. Therefore, significant adverse effects remain, notwithstanding that some receptors may be eligible for noise insulation under the NIR.

Bridge Opening Alarm

7.8.104 The bascule bridge will require appropriate audible warning alarms (‘wig wags’) for use during the raising of the bridge. Whilst these warning alarms need to be clearly audible on the approach to the bridge, it is desirable that they do not cause a significant environmental noise effect at sensitive receptors.

7.8.105 A calculation exercise has been undertaken to determine the levels of noise (from the wig wags) that are likely to be experienced at dwellings near the bridge.

7.8.106 The assumed source sound level for the wig wags is based on the requirements set out in the (former) HA document TR2513 *Performance Specification for Wig Wag Signal Control Equipment, Appendix C: Moveable Bridges and Tunnels*. This requires that:

- "*An audible warning to pedestrians adjacent to the barrier shall be sounded when the barrier is changing positions up or down.*
- *Audible warning signals shall be provided at each end of the bridge structure and should persist from the commencement of the vehicle crossing signal until the barrier is in the fully lowered position.*
- *The audible signal (not the same as used at pedestrian crossings) shall be an appropriate constant tone at 10 dBA above the ambient noise between the limits of 50 dBA and 110 dBA measured at a distance of 1 metre of* (sic) *the sound source.*"

7.8.107 The existing ambient noise local to the wig wags is not representative at this stage as the local noise climate will change upon scheme opening. The ambient noise climate near the wig wags after scheme opening will be dominated by road traffic, and it is therefore possible to determine the ambient noise level by calculation, using the procedures set out in CRTN (1988).

7.8.108 The BNL, as defined in CRTN (1988), at 10m from the bridge carriageway is calculated to be 70 dB $L_{A10,18h}$, based on the AAWT for the opening year.

7.8.109 The equivalent ambient noise level is 68 dB $L_{Aeq,16h}$, using the conversion relationship set out in Transport Analysis Guidance Unit A3 (Ref 7.19) ($L_{A10,16h} = L_{Aeq,18h}$ -2 dB).

7.8.110 The noise level at 10m from the carriageway is considered representative of the ambient noise climate near the wig wags.

7.8.111 Based on the requirement that the sound emission from the wig wags is to be 10 dB above the ambient noise level (as measured at a distance of 1m from the wig wag), the source noise value for use in the calculations is taken to be 78 dB $L_{Aeq,T}$ at 1m.

7.8.112 The sound source associated with the wig wags are assumed to be located adjacent to the traffic barriers, at either end of the lifting section of the bascule bridge.

7.8.113 Calculations have been undertaken for the sample receptor locations, Table 7.16, where background / baseline noise measurement data is available. These locations are representative of nearby dwellings.

7.8.114 Activity Noise Levels (i.e. the noise levels from the wig wags when in operation) have been calculated for each of the receptor locations detailed above, in terms of the free-field $L_{Aeq,T}$ noise level, where T is the time period when the wig wags are operating. Calculations have been undertaken in terms of the free-field noise level to allow comparison with the free-field background noise levels measured at each receptor location.

7.8.115 Calculations have been for two wig wag alarms, one operating on the western approach and one on the eastern approach. The predicted noise levels, together with a breakdown of the calculation steps, are presented in *Table* 7.49 for the western approach and *Table* 7.50 for the eastern approach.

Table 7.49: Calculated Activity Noise Levels from Western Approach Wig Wag

Receptor	Source Noise Level (dB(A) at 1m)	Source-Receptor Distance (m)	Distance Attenuation (dB)	Barrier Correction (dB)	Activity Noise Level at Receptor (dB)
L01	78	260	-48.3	0	29.7
L02	78	105	-40.4	0	37.6
L03	78	60	-35.6	0	42.4
L04	78	105	-40.4	0	37.6
L05	78	300	-49.5	-10	18.5
L06	78	235	-47.4	0	30.6

Table 7.50: Calculated Activity Noise Levels from Eastern Approach Wig Wag

Receptor	Source Noise Level (dB(A) at 1m)	Source-Receptor Distance (m)	Distance Attenuation (dB)	Barrier Correction (dB)	Activity Noise Level at Receptor (dB)
L01	78	280	-48.9	0	29.1
L02	78	165	-44.3	0	33.7
L03	78	120	-41.6	0	36.4
L04	78	180	-45.1	0	32.9
L05	78	275	-48.8	-5	24.2
L06	78	165	-44.3	0	33.7

7.8.116 Following the guidance set out in BS 4142:2014, the ‘Rating Noise Level’ is calculated from the predicted activity noise levels by applying suitable corrections to consider:

- The duration of noise exposure; and
- The subjective influence of special characteristics to the noise, such as tonality.

7.8.117 BS 4142:2014 requires that the noise assessment is based on the $L_{Aeq,1h}$ during the daytime (taken to be 07:00 to 23:00 hours) and the $L_{Aeq,15min}$ during the night-time (taken to be 23:00 to 07:00 hours). As the wig wags will only sound during the closing or opening of the traffic barriers, the activity noise levels will not occur for the whole of the assessment period, during either the daytime or night-time periods. It is therefore appropriate that a suitable correction, in accordance with the methods set out in BS 4142:2014, is applied.

7.8.118 It is assumed for the purposes of this assessment that the duration of the noise exposure will be 1.5 minutes (90 seconds) during any 15-minute period or 6 minutes during any hour. An appropriate correction in accordance with the guidance set out in BS 4142:2014 has therefore been applied (the correction, in dB, is the same for both the 15-minute night-time period and the 1-hour daytime period).

7.8.119 Regarding the subjective influence of special characteristics to the noise, BS 4142:2014 allows for a "penalty" to be applied to the predicted noise level. For noise with tonal characteristics, this penalty can range from 0 to 6 dB. On the basis that the wig wags are specifically designed to be noticeable to pedestrians and other road users near the crossing, it is appropriate that the maximum "tonality penalty" be applied.

7.8.120 On this basis, appropriate Rating Noise Levels, for both the daytime and night-time, have been calculated for each receptor location. These are shown in Table 7.51.

Table 7.51: Calculated Rating Noise Levels at Receptors Locations

Receptor	Summed Activity Noise Level at Receptor (dB)	Duration Correction (dB)	Tonality Correction (dB)	Rating Noise Level at Receptor (dB)
L01	32.4	-10	+6	28.4
L02	39.1	-10	+6	35.1
L03	43.4	-10	+6	39.4
L04	38.9	-10	+6	34.9
L05	25.2	-10	+6	21.2
L06	35.4	-10	+6	31.4

7.8.121 The assessment involves a comparison of the calculated Rating Noise Levels with the measured background noise levels (measured as the $L_{A90,T}$ noise level) at each receptor location. In this assessment, the lowest

measured background noise levels at each receptor location have been used for the comparison, which makes the assessment more robust. Note that for the daytime period (07:00 to 23:00) these were often recorded during the evening (i.e. when traffic volumes were relatively low) and for both the daytime and night-time periods, were often recorded at the weekend (when road traffic and other sources of background noise are generally at their lowest).

7.8.122 The background noise levels used in the assessment are presented in *Table* 7.52.

Table 7.52: Background Noise Levels

Receptor	Lowest Recorded Background Noise Level – Daytime (07:00-23:00) dB $L_{A90,T}$	Lowest Recorded Background Noise Level – Night-time (23:00-07:00) dB $L_{A90,T}$
L01	48.5 *†	45.0 *
L02	48.7 †	41.9 *
L03	45.9 †	44.6 *
L04	41.0 †	37.1 *
L05	42.6 †	37.1
L06	46.7 *	39.2 *
* Measurement at a weekend.		
† Measurement during an evening period.		

7.8.123 BS 4142:2014 advises that, when undertaking this comparison (by subtracting the Rating Noise Level from the measured background noise level):

- Typically, the greater the difference, the greater the significance.
- A difference of around +10 dB or more (i.e. when the rating level is around 10 dB or greater than the background level) is likely to be an indication of a significant adverse effect, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse effect, depending on the context.
- The lower the rating level is relative to the measured background noise level, the less likely it is that the specific sound source will have a significant adverse effect. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a **slight** effect, depending on the context.

7.8.124 A comparison of the predicted Rating Noise Levels against the measured background noise levels, together with an assessment based on the BS 4142:2014 guidance is presented in the following tables (for the daytime and night-time periods separately).

Table 7.53: Bridge Alarm Assessment - Daytime

Receptor	Rating Noise Level at Receptor (dB)	Background Noise Level at Receptor (dB)	Difference (dB)	Assessment
L01	28.4	48.5	-20.1	Neutral
L02	35.1	48.7	-13.6	Neutral
L03	39.4	45.9	-6.5	Neutral
L04	34.9	41.0	-6.1	Neutral
L05	21.2	42.6	-21.4	Neutral
L06	31.4	46.7	-15.3	Neutral

Table 7.54: Bridge Alarm Assessment – Night-time

Receptor	Rating Noise Level at Receptor (dB)	Background Noise Level at Receptor (dB)	Difference (dB)	Assessment
L01	28.4	45.0	-16.6	Neutral
L02	35.1	41.9	-6.8	Neutral
L03	39.4	44.6	-5.2	Neutral
L04	34.9	37.0	-2.1	Slight
L05	21.2	37.1	-15.9	Neutral
L06	31.4	39.2	-7.8	Neutral

7.8.125 The calculation methodology used to predict the sound levels from the wig wags has adopted a number of worst-case assumptions, see paragraph 7.4.92, for example, no attenuation from ground effects or atmospheric absorption. As a further worst-case, the predicted sound levels have been assessed by comparison with the lowest measured background sound levels at each receptor location (often recorded at weekends and not mid-week).

7.8.126 Given that the calculations have been undertaken using some worst-case assumptions and that the assessment methodology is likely to overestimate

the potential impact, the assessment detailed above is considered conservative.

7.8.127 For this assessment, the BS 4142:2014 terminology has been translated to significance of effect. 'Low' impact is equivalent to **slight** adverse significance, and 'very low' impact is equivalent to **neutral** significant. The bridge opening alarm effects are not significant and are therefore not considered further (i.e. no mitigation is required).

Operation Phase Monitoring

7.8.128 No monitoring is required for the following reasons:

- There is currently no methodology available to take account of the potential errors associated with comparing measurements with calculations, especially when the receptor is some distance from the noise source; and
- Monitored noise levels included all sources of noise, whereas, calculations are based on road traffic noise predictions alone.

7.9 Limitations and Assumptions

7.9.1 Long-term unattended noise measurements were not taken, as representative and secure locations were not available within the study area.

7.9.2 The operational road traffic assessment only considers road traffic noise.

7.9.3 The accuracy of the noise predictions is directly related to the accuracy of the data provided.

7.9.4 AAWT 18 hour is given as both the total flow for all vehicles and the percentage HDVs within that total flow. HDVs are defined as having an unladen weight of greater than 3.5 tonnes.

7.9.5 The average speed of all vehicles using each link in kilometres per hour have been used.

7.9.6 CRTN (1988) states that calculations of noise level for traffic flows below 1,000 vehicles (AAWT 18 hour) are unreliable. Road links in the traffic model below 1,000 vehicles in any scenario are excluded.

7.9.7 Feeder links in the traffic database are excluded from the noise model.

7.9.8 Roundabouts in the traffic database are either modelled with road links in a circle (representing the actual geographic layout) or with road links joining in at a central node.

7.9.9 Ground height data from Environment Agency LIDAR Digital Terrain Mapping (DTM), as used in the assessment has a 2m horizontal spatial resolution.

7.9.10 The Scheme ground height data are taken from 3D engineering drawings.

7.9.11 Building outline data taken from OS MasterMap mapping database has been used.

7.9.12 NSR buildings have been identified using OS AddressBase Plus database.

7.9.13 Standard heights have been assumed for buildings, these being 6m above local ground level; equivalent to the height of a typical two-storey building.

7.9.14 Buildings with a total area less than $20m^2$ are deemed to be small buildings, for example, sheds, garages and lockups. These small buildings are excluded from the noise model.

7.9.15 Façade noise levels are calculated for buildings at a height of 1.5m and 4.0m above ground; and at 1.0m from the façade.

7.9.16 Free-field noise levels are calculated for open sites, e.g. ecological sites; parks, playgrounds and recreation grounds, at a height of 1.5m above local ground level.

7.9.17 Standard carriageway widths for a normal 2-way single carriageway road are taken to be 7.0 m. Non-standard carriageway widths are taken from OS MasterMap mapping.

7.9.18 Road surfaces are assumed to be equivalent to standard impervious bituminous, with a 2mm texture depth.

7.9.19 Intervening ground between any road and a receptor has been assumed to be acoustically ‘hard’.

7.9.20 Predicted noise levels are not modified using the survey results.

7.9.21 Noise change contour plots are modelled at 4.0m above local ground level and with a spatial resolution of 10m.

7.10 Summary

7.10.1 The noise baseline conditions are typical of a built-up urban area, with noise levels being dominated by traffic on the local roads; refer to Section 7.5: Baseline Conditions. This was true for weekday measurement periods, during the day, evening and night. During the weekend evening measurements, police sirens dominated the noise levels. Secondary noise sources include more distant road traffic, domestic activities, as well as

seagull calls. On the east bank, regular HDV movements were noted, together with industrial and commercial activities.

7.10.2 With appropriate mitigation in place, including compliance with the CoCP, residual significant adverse construction noise effects remain. Refer to the residual construction noise effects, paragraphs 7.8.42 to 7.8.45.

7.10.3 With appropriate mitigation in place, including compliance with the CoCP, residual significant adverse construction vibration effects remain. Refer to the residual construction vibration effects, paragraphs 7.8.47 to 7.8.52.

7.10.4 No significant effects are predicted due to construction traffic noise on the existing road network; refer to paragraph 7.8.56.

7.10.5 Residual significant adverse operational road traffic noise effects are predicted. Opportunities to offset the predicted effects are limited due to the urban nature of the surrounding area. Therefore, significant adverse effects would remain because of the operation of the Scheme, notwithstanding that some receptors may be eligible for noise insulation under the NIR. Refer to the residual effects during operation, with reference to paragraph 7.8.103.

7.10.6 No significant adverse effects are predicted due to the operation of the bridge opening (wig wag) alarm; refer to paragraph 7.8.127.

7.10.7 Table 7.55 presents a summary of the significant effects.

Table 7.55: *Summary of Effects Table for Noise and Vibration*

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Construction noise	NSRs surrounding the Principal Application Site	**Very large** and **large** adverse construction noise effects. - / T / D / ST	Works will be completed in line with BPM, as defined in Section 72 of the CoPA.	Significant effects are reduced, however, **very large** and **large** adverse construction noise effects remain. + / T / D / ST
Construction vibration	NSRs surrounding the Principal Application Site	**Very large** and **large** adverse construction vibration effects. - / T / D / ST	Works will be completed in line with BPM, as defined in Section 72 of the CoPA.	Significant effects are reduced, however, **large** and **moderate** adverse construction vibration effects remain. + / T / D / ST
Operational Phase				
Short-term road traffic noise	NSRs throughout the Study Area.	**Very large** (5); **large** (113) and **moderate** (501) operational road traffic noise effects. - / P / D & I / ST	None.	**Very large** (5); **large** (113) and **moderate** (501) significant operational road traffic noise effects are predicted. - / P / D & I / ST
Long-term road	NSRs	**Very large** (3); **large** (81) and	None.	**Very large** (3); **large** (81) and

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
traffic noise	throughout the Study Area.	**moderate** (600) significant operational road traffic noise effects are predicted. - / P / D & I / LT		**moderate** (600) significant operational road traffic noise effects are predicted. - / P / D & I / LT

NB: Aspects of the Scheme considered as part of the pre-mitigation scenario are summarised above in Section 7.5.

Key to table:

+ / - = Positive or Negative; P / T = Permanent or Temporary; D / I = Direct or Indirect; ST / MT / LT = Short-Term, Medium-Term or Long-Term; N/A = Not Applicable.

7.11 References

Ref 7.1: Department for Environment, Food and Rural Affairs (2010), Noise Policy Statement for England.

Ref 7.2: The Highways Agency, Scottish Government, Welsh Assembly Government and the Department for Regional Development Northern Ireland (2011), Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7, HD 213/11 revision 1. Noise and Vibration.

Ref 7.3: Department for Transport (2014), National Policy Statement for National Networks.

Ref 7.4: Department for Transport (2012), National Policy Statement for Ports.

Ref 7.5: HM Government (2019), National Planning Policy Framework.

Ref 7.6: Department of Transport and Welsh Office (1988), Calculation of Road Traffic Noise.

Ref 7.7: The British Standards Institution (2014), BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 1: Noise.

Ref 7.8: The British Standards Institution (2014), BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 2: Vibration.

Ref 7.9: Joint Nature Conservation Committee (JNCC) (2010), Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise.

Ref 7.10: HM Government (1974), Control of Pollution Act 1974.

Ref 7.11: HMSO (1963), (Wilson) Committee on the problem of noise – Final report.

Ref 7.12: The British Standards Institution (2008), BS 6472:2008 Guide to evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting.

Ref 7.13: HM Government (1975, as amended 1988), The Noise Insulation Regulations 1975, as amended 1988).

Ref 7.14: World Health Organisation (2018), Environmental Noise Guidelines for the European Region.

Ref 7.15: Brink, M. et al (2018) Conversion between noise exposure indicators Leq24h, LDay, LEvening, Lnight, Ldn, and Lden: Principles and practical guidance.

Ref 7.16: Abbott P. G. and Nelson P. M., TRL Limited (2002), Project Report PR/SE/451/02 Converting the UK traffic noise index LA10,18h to EU noise indices for noise mapping.

Ref 7.17: The British Standards Institution (2014), BS 4142:2014 Methods for rating and assessing industrial and commercial sound.

Ref 7.18: The British Standards Institution (1991), BS 7445-2:1991 Description and measurement of environmental noise – Part 2: Guide to the acquisition of data pertinent to land use.

Ref 7.19: Department of Transport (2015), TAG unit A3 environmental impact appraisal.

8 Nature Conservation

8.1 Introduction

Background

8.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Scheme upon terrestrial and aquatic ecology. The assessment of this topic area considered potential effects relating to the following aspects:

- Statutory and non-statutory designated sites;
- Important or protected habitats; and
- Legally protected species and species of conservation concern.

8.1.2 The chapter describes the assessment methodology and the baseline conditions at the Principal Application Site (but not the Satellite Application Sites see paragraph 8.4.9) and in the surrounding area. It describes any embedded mitigation that has been adopted for the purposes of the assessment and presents a summary of the likely significant effects taking into account national legislation, the additional mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

8.1.3 The chapter is supported by Appendices 8A to 8I presented in ES Volume II: Technical Appendices (document reference 6.2) and Figures 8.1 to 8.7, presented in ES Volume III: Figures (document reference 6.3).

8.1.4 Appendices 8A to 8I refer specifically to the following:

- 8A: Legislation, Policy and Guidance
- 8B: Preliminary Ecological Appraisal;
- 8C: Preliminary Ecological Appraisal Update;
- 8D: Breeding Bird Survey Report;
- 8E: Protected Species Survey Report;
- 8F: Water Vole Survey Report;
- 8G: Preliminary Bat Roost Report;

- 8H: Detailed Arboriculture Report; and
- 8I: Benthic Ecology and Fish Survey Report.

8.1.5 This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES with particular reference to chapters 6: Air Quality and 11: Road Drainage and the Water Environment.

8.2 Competent Expert

8.2.1 The Nature Conservation lead, Ian Ellis, is a full member of the Chartered Institute for Ecology and Environmental Management who holds an MRes degree in Ecology and Environmental Management from The University of York (1999). The Nature Conservation lead has significant experience regarding ecological assessment and the preparation of EIAs for the DCO process.

8.3 Legislation, Policy and Guidance Summary

Legislative Framework

8.3.1 Ecological features receive protection through legislation and planning policy. Sensitive ecological receptors relevant to the Scheme and therefore assessed in this chapter have been identified following the completion of a survey and desk study programme.

8.3.2 The assessment has been compiled with reference to the relevant nature conservation legislation, planning policy and the UK Biodiversity Framework from which the protection of sites, habitats and species is derived in England. An overview of the applicable legislative framework is given in Appendix 8A with a summary provided below in Table 8.1.

Planning Policy Context

National Policy Statements

8.3.3 The National Policy Statements (NPSs) set out Government planning policy for Nationally Significant Infrastructure Projects (NSIPs) across a range of sectors. The Planning Act 2008 requires the Examining Authority and the Secretary of State to use the relevant NPSs to make decisions on applications for development consent.

8.3.4 Planning policy on highway NSIPs, including in relation to ecology and nature conservation, is contained in the National Policy Statement for National Networks (NPS NN).

8.3.5 The revised National Planning Policy Framework (NPPF) published in February 2019 (Ministry of Housing, Communities & Local Government) sets out the Government's planning policies for England and how these are expected to be applied. DCO applications should be determined in accordance with the relevant NPS but the NPPF is also likely to be an 'important and relevant' consideration in decisions on NSIPs, to the extent it is relevant to that project.

8.3.6 Full background to these policy statements is provided in Appendix 8A, with a summary provided below in Table 8.1.

Table 8.1: Summary of Key Legislation, Policy and Guidance

Legislation/ Policy/ Guidance	Summary	Chapter Reference
The Conservation of Habitats and Species Regulations (Habitats Regulations) 2017 (as amended)	The Conservation of Habitats and Species Regulations 2017... transpose Council Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora (EC Habitats Directive), into national law. They also transpose elements of the EU Wild Birds Directive in England and Wales.	Natura 2000 sites (the collective term for the network of sites in the European Union including SACs and SPAs) identified for consideration in this chapter are detailed in section 8.5 and further assessed in the Habitat Regulations Report (Reference 6.11) for the Scheme.
The Wildlife and Countryside Act (WCA) 1981 (as amended)	The Wildlife and Countryside Act 1981 is the primary legislation which protects animals, plants and habitats in the UK.	Species listed on the schedules of the WCA relevant to the Principal Application Site are detailed in Section 8.5 and assessed through the framework in Section 8.4.
National Policy Statement for National Networks (NPS NN) (2014)	NPS NN provides policy on how biodiversity should be considered in DCO applications including European sites, SSSIs, regional and local sites and the protection of habitats and species. NPS NN also includes an overview of mitigation requirements.	The chapter conforms to the policy statement; species and sites relevant to the Principal Application Site are described in Section 8.5 and assessed through the framework in Section 8.4. Mitigation measures deemed required for the Scheme are described in Section

Legislation/ Policy/ Guidance	Summary	Chapter Reference
		8.8.
National Planning Policy Framework (NPPF) (2019)	The NPPF is consistent with the NPS NN and is not intended to contain specific policies for NSIPs where quite particular considerations apply. It considers biodiversity with regards to the objective under the Town and Country Planning Act 1990 to contribute to, and enhance the natural and local environment by minimising impacts on biodiversity and to promote the conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species.	The chapter conforms to the policy framework; species and sites relevant to the Principal Application Site are described in Section 8.5 and assessed through the framework in Section 8.4. Mitigation measures deemed required for the Scheme are described in Section 8.8 in addition to enhancement measures design to increase the ecological value of the Principal Application Site.

Protected Sites

Natura 2000 Sites

8.3.7 This chapter identifies all relevant Natura 2000 sites including SACs and SPAs. The Habitats Regulations transpose the requirements of the Habitats Directive into national law. SACs are designated in recognition of their value as best representatives of the range and variety within the EU of habitats and (non-bird) species listed on Annexes I and II to the Habitats Directive.

8.3.8 Directive 2009/147/EC on the conservation of wild birds (the codified version of Council Directive 79/409/EEC as amended) (Birds Directive) provides a framework for the conservation and management of, and human interactions with, wild birds in Europe. Mechanisms for the achievement of the objectives of the Directive are set by each Member State (in the UK delivery is via several different statutes).

8.3.9 SPAs are designated under the Birds Directive due to their value as areas of the most important habitat for rare and vulnerable birds (listed on Annex I of the Directive), and for regularly occurring migratory bird species within the European Union.

8.3.10 Although not a European site designation, sites designated under the 1971 Ramsar Convention for their internationally important wetlands (commonly known as Ramsar sites) were originally designated to protect sites of importance as waterfowl habitat, and were later broadened to include all aspects of wetland conservation. The NPS NN states that Ramsar sites and potential SPAs (pSPAs) are also considered in the same way as SACs, SPAs and candidate SACs (cSACs).

8.3.11 Although not a statutory designation, European Marine Sites refer to management units which incorporate areas designated such as SACs or SPAs or SSSIs, which are statutory protected sites supporting the best examples of the UK's flora, fauna, geological or physiographical features.

8.3.12 The term Natura 2000 site therefore, for the purposes of this chapter, can refer to all the designations listed above.

Sites of Special Scientific Interest

8.3.13 SSSIs are designated to protect the best examples of the UK's flora, fauna, or geological or physiographical features. The designation may extend into intertidal areas out to the jurisdictional limit of local authorities, generally Mean Low Water in England. SSSIs are notified under the Wildlife and Countryside Act 1981 (as amended). National Nature Reserves (NNR) are established to conserve and enhance landscapes. They promote public enjoyment and consider the social and economic well-being of those living within them.

Local Designations

8.3.14 Local Nature Reserves (LNR) are local authority designations under the National Parks and Access to the Countryside Act 1949. They are designated in consultation with relevant statutory nature conservation agencies and are managed for nature conservation and people.

County Wildlife Sites

8.3.15 The County Wildlife Site (CWS) system is managed by a partnership led by Norfolk Wildlife Trust which also involves Norfolk County Council, Norfolk Biodiversity Information Service (NBIS), Natural England, the Environment Agency and the Broads Authority. CWS are areas of land outside of the nationally protected areas which are rich in wildlife although they do not receive statutory protection.

8.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

8.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

8.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

8.4.3 Table 8.2 and 8.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 8.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
ID: 1 Table 19 of the Scoping Report (DCO Document 6.6) identifies suitable habitat for amphibians and reptiles within close proximity to the Scheme, including allotments within the footprint of the Scheme, but does not indicate that any further surveys are proposed for these species. The Scoping Report Appendix E: Preliminary Ecological Appraisal states at paragraph 4.3.1 that 'overall, amphibians and reptiles are unlikely to be present' and 'no further work in respect of amphibians and reptiles is recommended'. The justification provided in the Scoping Report does not demonstrate the information necessary to support the decision to scope this out. The Scoping Report identifies suitable habitat within the footprint for the Proposed Development but information has not been provided to demonstrate an absence of likely significant effects. The Inspectorate considers there could be a	PINS	The Preliminary Ecological Appraisal (PEA) was undertaken in 2016 (Appendix 8A). An update to the PEA was undertaken in 2018 (Appendix 8B). Appendix 8B details that great crested newts are unlikely to be present and thus no surveys have been undertaken. Appendix 8B identifies that the Principal Application Site is of negligible potential for reptiles and due to this finding, no surveys have been undertaken. Issues scoped out of assessment are detailed in Table 8.9 of this chapter.

Scoping Opinion Item	Consultee	Response
potential for effects on such species, if present, including a requirement for mitigation to comply with legislation in respect of reptiles. If significant effects are likely, surveys should be carried out in order to support the assessment. Effort should be made to agree the approach and the need for surveys with relevant consultation bodies. Where mitigation measures are determined necessary, these should be detailed in the ES and appropriately secured.		Natural England have been presented with the scope of ecological surveys undertaken to inform this chapter and have not provided any indication of disagreement.
ID: 2 The Scoping Report defines the study area for nature conservation stating that there are two study areas; however, it is noted that more than two study areas have actually been identified in the Scoping Report. The Inspectorate considers the approach to vary the study area for each ecological receptor to be appropriate; however, the ES should clearly state the study areas applied in the ES and explain why they have been chosen. The study areas should also be identified on clear figures or plans accompanying the ES.	PINS	Three study areas have been detailed in this chapter (see para 8.4.8) with details included as to their scope. These study areas are shown on Figures 8.1 and 8.2.
ID: 3 The Inspectorate welcomes the assessment of Outer Thames Estuary SPA. Reference is also made in the Scoping Report to the Outer Thames Estuary extension pSPA. The extension will include tern species and their foraging habitat, including the River Yare, over and in which the Proposed Development lies. The Applicant should note that the proposed changes to the Outer Thames Estuary SPA were formally accepted and notified to the EU in October/November 2017. The assessments in the ES should therefore consider the most up-to-date status of this designated site.	PINS	A full assessment of the Outer Thames Estuary SPA (including its extension which has now taken effect) is provided in the HRA (document reference 6.11) in addition to assessment in this chapter (see Sections 8.5 - 8.8).

Scoping Opinion Item	Consultee	Response
ID 4: The Environmental Constraints Plan (Figure 3) accompanying the Scoping Report identifies designated sites up to 2km from the Proposed Development. The Scoping Report discusses designated sites beyond 2km. The ES must include a clear plan(s) showing all statutory and non-statutory sites of nature conservation, as relevant to the impact assessment.	PINS	Three study areas have been detailed in this chapter (see para 8.4.8) with details included as to their scope. The Natural Environment Constraints Plan (document 6.4) does not attempt to replicate the study areas used in Chapter 8 but focuses on constraints that have potential for functional linkage with the Scheme.
ID 5: Given the nature of the receiving environment and the potential for significant effects to marine and coastal receptors, the Applicant should make effort to agree the applicability of Chartered Institute of Ecology and Environmental Management's 'Guidelines in Ecological Impact Assessment in Britain and Ireland: Marine and Coastal (2010)' to the assessment with relevant consultation bodies.	PINS	Methodologies applied in this chapter have referred to this prescribed guidance where appropriate (see section 8.4). It is acknowledged that CIEEM updated their guidance in 2018 (Ref 8.1).
ID 6: Paragraph 6.4.26 of the Scoping Report identifies that further surveys for water voles, and bat roosts are to be undertaken, together with breeding black redstarts, and aquatic ecology. Appendix F: Protected Species Survey of the Scoping Report contains the results of further surveys for bats and water voles. It is not entirely clear from the Scoping Report as to whether further update surveys for these species are proposed to be undertaken prior to the submission of the ES, or whether they are to inform any mitigation licence application(s) that may be required. Appendix F of the	PINS	As detailed in Section 8.1, Appendix 8D provides details of breeding bird surveys undertaken in 2018. Appendix 8E provides a Protected Species Survey report produced in 2017, which details the findings of bat and water vole surveys. Appendix 8F details the findings of the update water vole survey undertaken in 2018.

Scoping Opinion Item	Consultee	Response
Scoping Report indicates that further surveys for water voles will be undertaken to allow an accurate assessment of impacts and to inform any water vole mitigation licence that may be required (paragraph 5.1.5). The Inspectorate advises that surveys be undertaken in line with relevant best practice guidance prior to the writing of the ES, where there is a need to assign value, assess impacts, and determine relevant mitigation for such species receptors. The results of ecological surveys used to inform the ES should be presented in a Technical Appendix/ appendices to the ES to ensure the information supporting ES Nature Conservation aspect chapter is available for the Examination. Appropriate mitigation strategies should also be detailed in the ES and be appropriately secured.		Appendix 8G provides results of a preliminary appraisal for bat roosts undertaken in 2018. Appendix 8I provides results of surveys of benthic ecology, conducted in 2019. All this work informs the findings of this chapter. Mitigation measures are set out in section 8.8 of this chapter.
ID 7: The Inspectorate recommends that the Nature Conservation aspect chapter include clear sub-headings for aquatic ecology receptors to clearly present the baseline, impact assessment and any mitigation measures for aquatic ecology receptors. The Scoping Report identifies the need for aquatic surveys but gives no further information as to the target species and habitats and also what these surveys would comprise. However, the Inspectorate acknowledges the statement at paragraph 6.4.4 of the Scoping Report that states 'discussions with Natural England, the EA and the Marine Management Organisation (MMO) are ongoing in relation to surveys in respect of the marine environment.' The ES should include an assessment of effects on benthic ecology and fish, including migratory fish, in particular		Section 8.5 details the baseline environment regarding benthic and fish ecology which is informed by Appendix 8I. The methodology applied for the surveys detailed in Appendix 8I were agreed with both Natural England and the MMO (see Table 8.4). The assessment of effects on benthic and fish ecology, including in relation to noise and vibration effects, is given in Section 8.8. Assessments of the effects of noise and vibration on ecological receptors is based on the framework and

Scoping Opinion Item	Consultee	Response
those that migrate through the River Yare to access the inland river system. The ES should assess any likely significant effects on protected fish species and species of conservation concern, including European eel, smelt and river lamprey. The ES should also present in the Nature Conservation aspect chapter an assessment of potential impacts of noise and vibration on sensitive aquatic receptors, including benthic ecology and fish receptors, together with an assessment of noise and vibration on sensitive receptors associated with designated sites, where significant effects are likely to occur. The methodology for assessing noise and vibration effects on sensitive ecological receptors, including the methodology for any data collected/surveys undertaken, must be clearly stated in the ES. Appropriate cross-referencing to relevant data and assessments contained in the Acoustic aspect chapter should also be included.		modelling established in Chapter 7: Noise and Vibration. The benthic and fish ecology surveys at the River Yare (Appendix 8I) indicate that there are no important marine ecological features that would be sensitive to such impacts. All other ecological features identified in this chapter are characteristic of terrestrial or freshwater environments and as such will not be exposed to underwater noise effects at the River Yare. An assessment of underwater noise and vibration has therefore not been undertaken in Chapter 7: Noise and Vibration. Assessment of terrestrial nature conservation features (water voles, breeding birds, bats) has a qualitative approach to noise and vibration. These features are either relatively insensitive to noise and/or the Principal Application Site has been determined to support low populations of local value only.
ID 8: The Inspectorate acknowledges the use of DMRB guidance to assign significance. However, the ES will also need to make clear in each case whether	PINS	Section 8.4 of this chapter sets out the methodology used to determine the significance of predicted

Scoping Opinion Item	Consultee	Response
any residual effect is deemed to be 'significant' or 'not significant'. Where professional judgement has been used to determine significance, this should be stated.		impacts. Section 8.8 outlines the assessment of the Scheme and where expert judgment is applied it is stated.
ID 9: The Scoping Report does not contain detailed information with regard to any proposed surveys or data collection in respect of birds (with the exception of black redstarts) and designated sites, particularly bird species that may be using the River Yare that could be affected by the Proposed Development, including information on the tern species of the Outer Thames SPA. The Applicant should seek to agree the need (or otherwise) for any additional bird surveys and/or desk-based data required to inform an assessment of likely significant effects on bird species and designated sites with relevant consultation bodies, including Natural England and NCC's Ecologist. The Inspectorate acknowledges the intention to provide information in relation to HRA separate to the ES but include appropriate cross-referencing. The information in the ES should include an assessment of bird species and designated sites in respect of the EIA Regulations in addition to HRA matters.	PINS	Appendix 8D provides full details of breeding bird surveys undertaken in 2018 which were designed to inform assessment of bird features of designated sites. These included those for common tern using the River Yare extension of the Outer Thames Estuary SPA. The potential impacts on bird species, again including tern species, is presented in Section 8.8 of this chapter. The HRA carried out for the Scheme is presented in document reference 6.11.
All statutory designated sites of European and National Importance and protected species that are likely to be impacted by proposal have been identified.	Environment Agency	Sites of European Importance are fully assessed in the HRA (document reference 6.11) in addition to the detail provided throughout this chapter.
Surveys for Bats – App.1 identifies the need for further re-emergence and re-entry surveys to be completed before the demolition of suitable roosts sites	Environment Agency	Surveys for roosting bats are reported in Appendix 8G. Of the 33 buildings surveyed, 22

Scoping Opinion Item	Consultee	Response
(derelict buildings). We support this.		properties have been classified as having low potential to support roosting bats, and three properties and eight outbuildings have been classified as having negligible potential. See Sections 8.5 and 8.8 for full details.
Surveys for Water Vole – These will need to be carried out prior to work commencing. Water Vole populations will naturally fluctuate with seasonal differences, and the result is that Water vole may be present on a site one year and absent the next. Where any suitable habitat has been identified, or where there are records of water vole historically, a pre-work survey will be required during optimal survey season. Appropriate mitigation can them be put in place based on the results.	Environment Agency	Appendix 8F provides details of an updated water vole survey carried out in 2018. The requirement for mitigation and pre-construction survey for this species is discussed in Section 8.8.
Water Environment – The report identifies the requirement for an aquatic ecological assessment, which has not yet been undertaken. The assessment should include the potential for impact on migratory fish species which use the Yare through Breydon Water as the primary attractant flow into the inland river systems. Protected migratory species include European Eel, Smelt and River Lamprey. The potential impacts on surface water bodies detailed in this section should be used in the aquatic ecology assessment to establish the likely effects on fish, benthic invertebrates and aquatic ecosystems.	Environment Agency	Appendix 8I presents the survey report on benthic and fish ecology. No notable fish species were recorded. The assessment of impacts on benthic ecology and fish in Section 8.8 are also informed by Chapter 11: Water Environment.
It may be necessary (depending on the final timing of the work) to consider 'In combination' effects on migratory species with the Planned Crossing at	Environment Agency	The HRA carried out for the Scheme is presented as document reference 6.11 where the potential for in

Scoping Opinion Item	Consultee	Response
Lake Lothing in Lowestoft.		combination effects with the Lake Lothing Third crossing is considered.
The MMO welcomes the inclusion of future surveys for 'aquatic ecology' as identified in Table 19. Impacts on the benthic ecology from potential impacts from noise and vibration should be included in the ES.	Marine Management Organisation	Noted. The Applicant further consulted the MMO on the methodology for the benthic and fish ecology surveys (See Table 8.4).
Natural England advises that the potential impact of the proposal upon features of nature conservation interest and opportunities for habitat creation/enhancement should be included within this assessment in accordance with appropriate guidance on such matters. Guidelines for Ecological Impact Assessment (EcIA) have been developed by the Chartered Institute of Ecology and Environmental Management (CIEEM) and are available on their website. The National Planning Policy Framework sets out guidance in S.118 on how to take account of biodiversity interests in planning decisions and the framework that local authorities should provide to assist developers.	Natural England	These guidelines have been referred to in this chapter (see sections 8.4 and 8.3). Opportunities for enhancement in respect to habitats and species are discussed in section 8.8.
The ES should thoroughly assess the potential for the proposal to affect designated sites. European sites (e.g. designated Special Areas of Conservation and Special Protection Areas) fall within the scope of the Conservation of Habitats and Species Regulations 2017. In addition, paragraph 118 of the NPPF requires that potential Special Protection Areas, possible Special Areas of Conservation, listed or proposed Ramsar sites, and any site identified as being necessary to compensate for adverse impacts on classified, potential or possible SPAs,	Natural England	While designated sites are assessed in this chapter, a complete analysis of potential effects is given in the HRA (document reference 6.11).

Scoping Opinion Item	Consultee	Response
SACs and Ramsar sites be treated in the same way as classified sites. Under Regulation 63 of the Conservation of Habitats and Species Regulations 2017 an appropriate assessment needs to be undertaken in respect of any plan or project which is (a) likely to have a significant effect on a European site (either alone or in combination with other plans or projects) and (b) not directly connected with or necessary to the management of the site. Should a Likely Significant Effect on a European or Internationally designated site be identified or be uncertain, the competent authority (in this case the Local Planning Authority) may need to prepare an Appropriate Assessment, in addition to consideration of impacts through the EIA process.		
The development site is within close proximity to the following designated nature conservation sites: The Outer Thames Estuary Special Protection Area, Breydon Water Special Protection Area, Breydon Water Ramsar, Great Yarmouth North Denes Special Protection Area, Breydon Water Site of Special Scientific Interest, Great Yarmouth and North Denes Site of Special Scientific Interest, and within the proposed Outer Thames Estuary Special Protection Area.	Natural England	All sites are within the extended study area, while the Outer Thames Estuary SPA lies in the Main Study area (Section 8.6). These sites are considered within this Chapter in addition to the HRA (document reference 6.11).
The EIA will need to consider any impacts upon local wildlife and geological sites. Local Sites are identified by the local wildlife trust, geoconservation group or a local forum established for the purposes of identifying and selecting local sites. They are of county importance for wildlife or geodiversity.	Natural England	No non-statutory sites were identified within the Main or Broad study areas (Appendix 8B). Chapter 16: Geology and Soils identifies that there are no geological sites of relevance to the Scheme.
The ES should assess the impact of all	Natural	The Preliminary

Scoping Opinion Item	Consultee	Response
phases of the proposal on protected species (including, for example, great crested newts, reptiles, birds, water voles, badgers and bats). Natural England does not hold comprehensive information regarding the locations of species protected by law, but advises on the procedures and legislation relevant to such species. Records of protected species should be sought from appropriate local biological record centres, nature conservation organisations, groups and individuals; and consideration should be given to the wider context of the site for example in terms of habitat linkages and protected species populations in the wider area, to assist in the impact assessment.	England	Ecological Appraisal (PEA) (Appendix 8B) gathered records of protected species relevant to the Scheme including those from Norfolk Biological Information Service (NBIS). An updated PEA was undertaken in 2018 (Appendix 8C). This led to specific surveys for breeding birds, bats and water voles being undertaken (Appendices 8D to 8G).
In order to provide this information there may be a requirement for a survey at a particular time of year. Surveys should always be carried out in optimal survey time periods and to current guidance by suitably qualified and where necessary, licensed, consultants.	Natural England	As part of the desk study and baseline survey components of the assessment (Appendices 8B to 8I), detailed methodologies are provided which include overviews of survey timings and personnel undertaking them.
The ES should thoroughly assess the impact of the proposals on habitats and/or species listed as 'Habitats and Species of Principal Importance' within the England Biodiversity List, published under the requirements of S41 of the Natural Environment and Rural Communities (NERC) Act 2006. Section 40 of the NERC Act 2006 places a general duty on all public authorities, including local planning authorities, to conserve and enhance biodiversity.	Natural England	A Preliminary Ecological Appraisal (PEA) was undertaken in 2016 (Appendix 8B) which was updated in 2018 (Appendix 8C). A specific breeding bird survey was also carried out (Appendix 8D). Considering the habitats identified in Appendices 8B and 8C it was determined that it was not necessary to carry out botanical or

Scoping Opinion Item	Consultee	Response
		invertebrate surveys.
Natural England advises that a habitat survey (equivalent to Phase 2) is carried out on the site, in order to identify any important habitats present. In addition, ornithological, botanical and invertebrate surveys should be carried out at appropriate times in the year, to establish whether any scarce or priority species are present.	Natural England	As part of the desk study and baseline survey components of the assessment (Appendices 8B and 8C), relevant Habitats of Principal Importance (HPI) and Species of Principal Importance (SPI) were identified. Section 8.5 of this chapter summarises the baseline ecological environment, while section 8.8 assesses the effects on them from the Scheme. Appendices 8B to 8I include detailed methodologies are provided which include overviews of survey timings and personnel undertaking them with reference to relevant standards and guidance which indicate appropriate timeframes.
NCC considers that the environmental baseline data that is presented is appropriate. Some preliminary ecology surveys have been completed to date (Phase1, water voles and bats) and, although they were outside optimal seasons, NCC does not see that this is a particular constraint. The site has been assessed as being of low significance for bats, although it is noted that further bat emergence/returning surveys will be completed in due course for buildings that will need to be removed. Some signs of water voles have been identified within the footprint of the scheme and the	Norfolk County Council	Noted.

Scoping Opinion Item	Consultee	Response
report indicates further surveys will be completed in due course for this species, to determine if a protected species mitigation licence is required.		
NCC considers the data collected to date is appropriate. With the additional ecological work that is proposed, robust assessments of potential impacts will be able to be made. In terms of the assessments of impacts on ecology, the proposed assessment methodology is appropriate and consistent with industry guidelines and current best practice.	Norfolk County Council	Noted.
NCC notes that the potential SPA for the mouths of the rivers Yare and Bure (associated with the Outer Thames Estuary SPA) is being treated as if it were an SPA when considering ecological effects.	Norfolk County Council	The HRA (document reference 6.11) fully details the assessment of this site, including its recent extension.

Table 8.3: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
The Principal Application Site is within close proximity to designated sites and landscapes, namely: • Breydon Water Special Protection Area; • Breydon Water Ramsar; • Great Yarmouth and North Denes Special Protection Area; • Great Yarmouth and North Denes Site of Special Scientific Interest; • Breydon Water Site of Special Scientific Interest; and • The Broads National Park.	Natural England	The HRA (document reference 6.11) for the Scheme assesses all relevant Natura 2000 sites. These sites are also detailed in Section 8.5 of this chapter.

8.4.4 Table 8.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

8.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 8.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
Natural England	Call between WSP's Environment Lead and Natural England's Sustainable Environment Lead Adviser.	19/10/2018; telephone call	Discussion on scope of the aquatic surveys.
Natural England	Correspondence between WSP's Environment Lead and Natural England's Sustainable Environment Lead Adviser.	20/11/2018; Email	Response to request for review of methodology for pre-construction monitoring surveys of aquatic ecology. The Marine Lead Adviser for Norfolk and Suffolk Team comments that surveys take place in the Outer Thames Estuary Special Protection Area (SPA), given its extensions that take it into the Rivers Yare and Bure. The Outer Thames Estuary SPA is classified for red-throated diver, which peaks in numbers in January and February, and for common tern and little tern in the summer breeding season. A winter survey should, therefore, not disturb tern species but this should be considered for post-construction monitoring.

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			Confirmation is sought that this monitoring method will be repeated in the post-construction phase to fully assess impacts. There is a request to include sediment contaminants sampling, e.g. heavy metals and synthetic and non-synthetic compounds, such as polychlorinated biphenyl (PCB) analyses to identify and assess impacts of what may be mobilised from the sediment. There is a request to note any invasive or non-native species recorded during surveys and to adhere to the guidance on how to deal with any that are found. Appendix 11C presents the Sediment Transport Modelling for the Scheme which is assessed in Chapter 11: Road Drainage and the Water Environment. Chapter 11 includes assessment of contaminants bound to sediments such as heavy metals and other compounds. These documents are referred to in this chapter where relevant. The potential presence of non-native or invasive species are disused in Appendixes 8B and C for the terrestrial and freshwater environments and in

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			appendix 8I for the marine environment. Any post-consent monitoring deemed required in the SPA will consider the potential for disturbance to designated features. Monitoring requirements as presented in Section 8.8 of this chapter have been informed by likely impacts on sensitive receptors.
Marine Management Organisation	Correspondence between WSP's Environment Lead and MMO's Marine Licensing Case Officer.	Email; 09/11/2018	MMO was consulted upon the methodology for the benthic and fish surveys. MMO required changes and clarifications including: • grab sample methodology; • further detail on stations used for grab and wall samples; • clarification on the tidal range of the sampling, clarification on data analysis; • recommendation that total length of all fin fish is recorded; • recommendation that measurements for fin fish are taken in half centimetres and that crayfish, shrimps, crabs, prawns and lobsters (Decapoda) are measured to the nearest millimetre; • clarification on what time of year the trawl

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			• sampling is scheduled to take place; • acknowledgement of the limitations in the use of a 2m beam trawl to characterise larger fish/pelagic species. These comments informed the final methodology and analysis, as presented in Appendix 8I.

Likely Significant Effects

Construction Phase

8.4.6 The following likely significant effects have been assessed in this chapter:

- Killing, injuring and disturbance of protected species during construction;
- Temporary reduction in water quality through sedimentation caused by construction works within the River Yare, with consequent effects upon habitats, aquatic species and conservation designations;
- Contamination of watercourses through accidental spillage of fuels/chemicals or as a result of mobilisation of existing ground contamination with consequent effects upon aquatic habitats, aquatic species and conservation designations;
- Potential contamination of nearby habitats, watercourses and designated sites as a result of a reduction in air quality (including construction related dust);
- Disturbance through construction noise and vibration; and
- Floodlighting used during night work, causing disturbance or severance of regular commuting routes or foraging areas.

Operation Phase

8.4.7 The following likely significant effects have been assessed in this Chapter:

- Fragmentation of retained habitats and/or severance of wildlife corridors, foraging routes or territories;
- Contamination of watercourses and/or waterbodies associated with road related runoff. Consequent effects upon aquatic habitats, aquatic species and conservation designations;
- Disturbance through operational noise and vibration; and
- Disturbance of nocturnal animals where road lighting introduces a new light source.

Extent of the Study Area

8.4.8 The study area for the assessment is comprised of three different levels as informed by legislation and guidance (see Section 8.3):

- Main – 500 m from the Principal Application Site boundary (presented in Figure 8.1). This study area has been used for assessing habitats and suitability for protected species (hereafter referred to as 'Main Study Area').
- Broad – 2 km from the Principal Application Site boundary (presented in Figure 8.1). This study area is used for a desk study of international and national statutory nature conservation designations, non-statutory nature conservation designations, and records of protected and notable habitats and species (hereafter referred to as 'Broad Study Area').
- Extended – up to 30 km from the Principal Application Site boundary (presented in Figure 8.2). This study area has been used to extend the Broad Study Area where there are potential hydrological connections present to statutory designated sites. This definition is considered to encompass all relevant Special Protection Areas (SPAs) which are designated for bird interests. Birds are mobile in nature and certain SPA features may be found with regularity in areas outside of the site boundary but functionally linked to it. This also takes into account international nature conservation designations where bats are listed as a qualifying species which are again notably mobile. This study area is hereafter referred to as 'Extended Study Area'.

8.4.9 The definitions of the above study areas are based on a precautionary basis on the Principal Application Site. With regards to the consideration of the Scheme in this Chapter, the scope of the assessment for both the

construction and operational phases considers the Principal Application Site only. The Satellite Application Sites have not been considered, as works here are deemed to be of a negligible duration and extent, and involve areas of negligible nature conservation value (see Annex A of Appendix 8C for brief ecological descriptions of the Satellite Application Sites).

Method of Baseline Data Collation

Desk Study

8.4.10 As reported in Appendix 8B, the Norfolk Biodiversity Information Service (NBIS) was consulted to gather information on records of species and nature conservation designations from within the study area.

8.4.11 A review of the Multi-Agency Geographic Information for the Countryside (MAGIC) online resource was also undertaken to gather information on statutory nature conservation designations within the study area.

Surveys

Preliminary Ecological Appraisal

8.4.12 A walkover survey, undertaken broadly in accordance with Phase 1 habitat survey methodology (JNCC, 2007) (Ref 8.2) was carried out on 28th and 29th September 2016 to form the basis of the PEA. Habitat types were identified and mapped, with target notes made to identify features of interest. The suitability of habitats within the site to support legally protected, valuable or controlled species was assessed with incidental field signs or sightings of species recorded as seen (Appendix 8B).

8.4.13 After publication of the PEA, the Scheme underwent minor alterations in its design. An update to the field survey component of the PEA was therefore carried out in July 2018. This update included a Habitat Survey and a Protected Species Assessment (Appendix 8C).

8.4.14 In addition to habitat identification and mapping as part of the PEA, a detailed arboricultural assessment has been prepared (Appendix 8H).

Breeding Bird Surveys

8.4.15 Two discrete components of the surveys of breeding birds were undertaken:

- Breeding bird registration mapping; and
- Vantage point surveys.

8.4.16 Registration mapping involved standard territory (registration) mapping techniques as detailed in Bird Monitoring Methods (Ref 8.3) and the national black redstart survey methodology (Ref 8.4).

8.4.17 This method is based on the observation that many species during the breeding season are territorial. This is found particularly amongst passerines, where territories are often marked by conspicuous song, display, and periodic disputes with neighbouring individuals. The survey area for the survey is indicated in Figure 8.5, presented in Volume III. Four survey visits were made in May and June 2018 (Appendix 8D).

8.4.18 The Vantage Point Survey was designed to quantify the level of flight activity of common tern, which qualifies as a feature of the Breydon Water SPA, and their distribution over the survey area. Focal counts of activity of other waterbirds relevant to the SPA and non-waterbirds considered to be of conservation concern were also undertaken.

8.4.19 The Vantage Point Survey involved standard counts and activity and height categories as detailed within 'Recommended bird survey methods to inform impact assessment of onshore wind farms' (Ref 8.5), as recommended by Natural England in Guidance Note TIN069 (Ref 8.6). The location of the vantage point for the survey is also indicted in Figure 8.5 (Volume III).

Bat Surveys

8.4.20 Bat activity surveys were undertaken in August 2017 and repeated in July 2018 based on recommended methods published in Bat Conservation Trust Guidelines (Collins, 2016) (Ref 8.7). Two walked transects routes were designed to cover the west and east side of river Yare. The routes covered the majority of the site and incorporated all assessed built structures as well as adjacent habitats that may be used by bats for foraging and commuting (Appendix 8E). These transects are shown in Figure 8.3 (Volume III).

8.4.21 Bat activity surveys are undertaken in order to observe, listen for and record bats in flight away from their roost, commuting, feeding or socialising at dusk and dawn. Hand-held Batbox Duet detectors and a Song Meter SM4BAT FS recorder were used. During these walked transects, surveyors walked at a constant speed, recording information on any bats seen or heard on detectors. Information recorded included bat species, behaviour, flight direction, number of bats and number of passes. Surveyors stopped at pre-determined "listening points" along each transect for 3-5 minutes to record bat activity at a single location. Each walked transect was undertaken by two experienced ecologists.

8.4.22 Sounds recorded with the Song Meter SM4BAT FS during the surveys were analysed using AnalookW software to confirm the species of bats recorded and their activity. In case of doubt on the species, a bat calls guide (Russ,

2012) (Ref 8.8) was used to help the identification. Bat activity levels were assessed in terms of the number of bat passes occurring.

8.4.23 Buildings were subject to an internal and external inspection to determine their potential to support roosting bats in November 2018 (Appendix 8G). The inspections were carried out in accordance with current best practice guidance (Collins, 2016) (Ref 8.7). Ladders, close focusing binoculars, a high-powered torch, and an endoscope were used to identify and assess any potential roost features and to look for evidence of roosting bats.

8.4.24 Potential roost features on a building may include raised or missing roof tiles, ridge tiles, lead flashing or hanging tiles, and gaps under soffit boxing or within brickwork (this list is not exhaustive). Evidence of bats and their roosts include the presence of droppings, stain or grease marks, feeding remains, or the bats themselves. All of these were considered as part of the surveys of these buildings.

Water Vole Surveys

8.4.25 A survey was undertaken in August 2017 to search for evidence of water vole. The areas surveyed for water voles are shown in Figure 8.4. Ditches included after changes in the Scheme alignment were surveyed in September 2018. Ditches surveyed in 2017 were resurveyed as well as ditches to the north of William Adams Way and those parallel to the A47.

8.4.26 The surveys followed standard methods described in The Water Vole Mitigation Handbook (Dean *et al.,* 2016) (Ref 8.9) and were undertaken under suitable conditions by experienced surveyors. The surveys were carried out during the water vole breeding season (March to October), which is an optimal survey time for this species.

8.4.27 Where accessible, the banks of the watercourses were surveyed from within the channel. Surveyors systematically searched along each bank and any evidence of water vole was recorded when found. Where surveyors were unable to access the watercourse channel, evidence was searched for from the top of the banks, using binoculars as required.

Benthic Ecology and Fish Survey

8.4.28 The primary objective of the survey was to provide a robust biological baseline data set and to characterise the subtidal and intertidal benthic and fish communities in the region of the River Yare (Appendix 8I). Surveys were conducted using industry standard, repeatable methodologies to ensure comparability with studies elsewhere or future studies in the region. Benthic macrobiota communities were assessed through grab sampling, whilst larger epibenthic invertebrates and fish were assessed from trawl samples. Intertidal fouling communities on the walls were examined through quadrats

and wall scrape samples. Samples were analysed to provide data on the flora and fauna, sediment types, and habitats within the study area.

8.4.29 In order to sample benthic communities and sediments, six benthic grab stations were established in the primary impact area for the Scheme. These impact stations were termed G01-G06. For comparative purposes, two reference grab stations were also established (RG01 and RG02), one upstream and one downstream of the Scheme, respectively (Appendix 8I).

8.4.30 The wall fouling communities were assessed at four stations within the impact area and two reference sites. The walls were assessed at upper shore level in the algal zone.

8.4.31 To gain an understanding of the potential use of the estuary by fish and of epifaunal invertebrates, four trawl stations were established: two parallel trawls within the impact area, and two reference sites (RT01 and RT02), one upstream and one downstream of the Scheme. All sampling stations are indicated in Figure 1 of Appendix 8I.

8.4.32 The survey was conducted on 30th and 31st January 2019. These dates were chosen to coincide with vessel availability and suitable neap tides, providing increased duration of slack water in an effort to minimise the impact of water currents on the sampling operations.

Assessment Methodology

8.4.33 For the construction and operation phases, for each potentially significant effect that has been assessed, the methodology is based on the methods outlined in the following guidance:

- DMRB Volume 11, Section 3, Part 4 Ecology and Nature Conservation;
- IAN 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment, Highways Agency (2010) (Ref 8.10); and
- Guidelines for Ecological Impact Assessment in the United Kingdom and Ireland, CIEEM (2018) (Ref 8.1).

8.4.34 The overarching EIA methodology for the Scheme is defined in Chapter 4: Approach to EIA. The methodology applied in this chapter is however specific to ecology and in part, deviates from that given in Chapter 4: Approach to EIA. Characterisation of ecological impact is a process that starts with the 'evaluation of ecological resources', which identifies the most valuable resources that may be impacted by the Scheme.

Significance Criteria

8.4.35 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Scheme and the sensitivity of the affected receptor, as well as a number of other factors that are outlined in more detail in Chapter 4: Approach to EIA.

8.4.36 The value given to an ecological receptor takes into account any statutory or non-statutory designations, the intrinsic value of the receptor and whether it supports legally protected or notable species. Consideration has been given to the value of the species or habitat and its conservation status at a geographic level taking population size, life cycle, rarity and/or distribution into account. Each ecological resource has been assessed as being valuable, or potentially valuable, within a geographic frame of reference as set out in Table 1 of IAN 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment. The resource valuation has been further informed by CIEEM Guidelines (Ref 8.1).

8.4.37 The approach to determining the nature conservation value and/or sensitivity of each ecological feature is outlined in Table 8.5Table 8.5: below.

Table 8.5: Value of Ecological Features

Value	Description
International or European Value	Natura 2000 sites including: Sites of Community Importance (SCIs); SPAs; potential SPAs (pSPAs); SACs; candidate or possible SACs (cSACs or pSACs); and Wetlands of International Importance (Ramsar sites). Biogenetic Reserves, World Heritage Sites and Biosphere Reserves. Areas which meet the published selection criteria for those sites listed above but which are not themselves designated as such. Resident, or regularly occurring, populations of species which may be considered at an International or European level where: • The loss of these populations would adversely affect the conservation status or distribution of the species at this geographic scale; or • The population forms a critical part of a wider population at this scale; or • The species is at a critical phase of its life cycle at this scale.
UK or	Designated sites including: SSSIs; Marine Protected Areas (MPAs)

Value	Description
National Value	including Marine Conservation Zones (MCZs); and National Nature Reserves (NNRs). Areas which meet the published selection criteria e.g. JNCC (1998) for those sites listed above but which are not themselves designated as such. Areas of key/priority habitats identified in the UK Biodiversity Action Plan (BAP), including those published in accordance with section 41 of the Natural Environment and Rural Communities Act (2006) and those considered to be of principal importance for the conservation of biodiversity. Areas of Ancient Woodland e.g. woodland listed within the Ancient Woodland Inventory. Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level where: • The loss of these populations would adversely affect the conservation status or distribution of the species at this scale; or • The population forms a critical part of a wider population at this scale; or • The species is at a critical phase of its life cycle at this scale.
Regional Value	Areas of key/priority habitats identified in the Regional BAP (where available); areas of key/priority habitat identified as being of Regional value in the appropriate Natural Area Profile (or equivalent); areas that have been identified by regional plans or strategies as areas for restoration or re-creation of priority habitats (for example, East of England Biodiversity Forum); and areas of key/priority habitat listed within the Highways Agency BAP. Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level and key/priority species listed within the Highways Agency BAP where: • The loss of these populations would adversely affect the conservation status or distribution of the species at this scale; or • The population forms a critical part of a wider population; or • The species is at a critical phase of its life cycle.
County or	Designated sites including: Sites of Nature Conservation Importance

Value	Description
Unitary Authority Area Value	(SNCIs); County Wildlife Sites (CWSs); and Local Nature Reserves (LNRs) designated in the county or unitary authority area context. Areas which meet the published selection criteria for those sites listed above but which are not themselves designated as such. Areas of key/priority habitats identified in the Local BAP; and areas of habitat identified in the appropriate Natural Area Profile (or equivalent). Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level where: • The loss of these populations would adversely affect the conservation status or distribution of the species across the County or Unitary Authority Area; or • The population forms a critical part of a wider population; or • The species is at a critical phase of its life cycle.
Local Value	Designated sites including: LNRs designated in the local context. Trees that are protected by Tree Preservation Orders (TPOs). Areas of habitat; or populations/communities of species considered to appreciably enrich the habitat resource within the local context (such as veteran trees), including features of value for migration, dispersal or genetic exchange.
Negligible	Features or habitats that do not have an appreciable ecological value.

8.4.38 Once the evaluation of ecological resources has been carried out, the assessment identifies potential biophysical changes arising from proposed activities during the construction and operation of the Scheme that may affect receptors. In accordance with the DMRB and CIEEM, this takes account of embedded mitigation measures only (i.e. in the absence of any other mitigation), thus providing clear information regarding the unmitigated impacts to inform the identification of appropriate mitigation or compensation requirements.

8.4.39 In accordance with DMRB and IAN 130/10, deer and invasive non-native species (INNS) were not considered in the ecological assessment due to their lack of conservation status. Such species are however considered in the Outline CoCP (document reference 6.16) in terms of appropriate measures to be taken in relation to such species during construction of the Scheme, while their presence or potential presence is considered in Appendices 8B, 8C and 8I.

8.4.40 Characterisation of the magnitude of ecological impacts upon each receptor requires the determination of a range of parameters as shown in Table 8.6 (developed from IAN 130/10) to inform the determination of impact significance. These criteria take account of both direct loss of habitat and ecological resources through land take, and perceived indirect impacts such as pollution and habitat fragmentation.

Table 8.6: Value of Ecological Features: Characterisation of Magnitude Ecological Impacts on each Feature

Impact Character	Description
SI – Sign	Positive (Beneficial) or Negative (Adverse)
PO – Probability of Occurring	Certain, Probable, Unlikely
CO – Complexity	Direct, Indirect, Cumulative
EC – Extent	Area measures and percentage of total (e.g. area of habitat/ territory lost)
SZ – Size	Description of level of severity of influence (e.g. complete loss, number of animals affected)
RE – Reversibility	Reversible or Not Reversible (can the effect be reversed, whether or not this is planned?)
DU – Duration	Permanent (P) or Temporary (T) in ecological terms. Where differing timescales are determined in relation to the life-cycle of the receptor, these should be defined
TF – Timing and Frequency	Important seasonal and/or life-cycle constraints and any relationship with frequency considered

8.4.41 Having characterised impacts, proposals for mitigation, compensation and enhancement have been considered, with the aim of avoiding or reducing the significance of impacts. Subsequent to the mitigation proposals, the overall residual significance of impacts on each receptor has been assessed.

Effect Significance

8.4.42 Using the receptor values ascertained from Table 1 of IAN 130/10 and the characterisation impact (Table 8.6), it is possible to assign an overall significance. Based on the findings of the assessments, mitigation measures leading to avoidance, reduction or compensation of adverse effects have been identified prior to an evaluation of the residual effects of impacts.

8.4.43 Table 3 of IAN 130/10 illustrates the approach taken to relating significant impacts at different levels of value. The following terms have been used to

define the significance of the effects identified, which are adapted from both IAN 130/10 and CIEEM (Ref 8.1):

- Major effect: where the Scheme could be expected to have a fundamental effect (either positive or negative) on receptors;
- Moderate effect: where the Scheme could be expected to have a noticeable effect (either positive or negative) on receptors;
- Minor effect: where the Scheme could be expected to result in a small, barely noticeable effect (either positive or negative) on receptors; and
- Negligible: where no discernible effect is expected as a result of the Scheme on receptors.
- Neutral: where no pathway for effect can be distinguished.

8.4.44 Effects deemed to be of moderate or major significance are considered to be significant effects in EIA terms. Effects of minor or negligible significance are not considered significant.

8.5 Baseline Conditions

8.5.1 This section reviews the ecology baseline of the Scheme in terms of designated sites, habitats and species. Firstly, an overview of desk-based studies is presented followed by the survey outcomes.

8.5.2 A desk study and PEA (Appendix 8B), a PEA update (Appendix 8C) and surveys of particular species (Appendices 8D – 8I) have been undertaken to identify changes to known biodiversity resources and include both designated and non-designated sites.

Desk-based Study

Designated Sites

8.5.3 The desk-based search established that there is one internationally designated statutory nature conservation site within the Main Study Area. This is the Outer Thames Estuary SPA (see Figure 8.6). It covers an area of c. 3,924km^2 designated for the protection of wintering red-throated diver. This area supports the largest aggregations of wintering red-throated diver in the UK, 38% of the GB population. Foraging areas protected for little tern *Sternula albifrons* and common tern *Sterna hirundo*, enhance the protection afforded to their feeding and nesting areas in the adjacent coastal SPAs.

8.5.4 It is noted that the River Yare and the River Bure are now included within the Outer Thames Estuary SPA. An extension was proposed in 2016 and

formally implemented in 2017. The reason for the inclusion of the River Yare channel in the extended SPA, to abut the eastern boundary of the existing Breydon Water SPA, and the lower River Bure, was to provide continuous SPA coverage for common terns foraging from the latter SPA. In the Scoping Report the following additional designated sites within the Extended Study Area were identified as requiring consideration:

- Breydon Water SPA, Ramsar and SSSI, located approximately 2.2km to the north/northwest of the Scheme;
- Great Yarmouth North Denes SPA and SSSI, located approximately 3.2km north/northeast of the Scheme; and
- The Broads National Park, located approximately 1km to the northwest of the Scheme.

8.5.5 There are no non-statutory designated sites within the Main or Broad Study Areas. Breydon Water, located approximately 2.2 km to the north/northwest of the Scheme is also designated as an RSPB Reserve.

Species Records

8.5.6 A review of desk study data has established records of the following protected species within the Broad Study Area:

- Records of seven species of bat (common pipistrelle *Pipistrellus*, soprano pipistrelle *Pipistrellus pygmaeus*, Nathusius' pipistrelle *Pipistrellus nathusii*, Daubenton's bat *Myotis daubentonii*, noctule *Nyctlus noctula*, serotine *Eptesicus serotinus* and brown long-eared bat *Plectous auritis*). Brown long-eared bat, noctule and soprano pipistrelle are also listed as target species on the Norfolk LBAP;
- Records of otter *Lutra*, water vole *Arvicola amphibius* and badger *Meles*. Otter and water vole are also both included on the Norfolk LBAP; and
- Records of natterjack toad *Epidelea camita*, common lizard *Zootoca vivipara* and slow worm *Anguis fragilis*; and
- A large number of bird species, including 50 species listed on Schedule 1 of the WCA 1981 (as amended) which are protected at all times of the year. Sixteen species of bird are included on the Norfolk LBAP, including little tern and swift *Apus*.

8.5.7 The desk study data also included records of several priority species (S41 NERC Act as amended) that have been recorded within the Broad Survey Area. These include European hedgehog *Erinaceous europaeus*, brown hare *Lepus europaeus*, common toad *Bufo* and goat moth *Cossus*. These

species are afforded no formal protection within the UK but should be taken into consideration during the planning phase where relevant.

Outcomes of Surveys

Habitats

8.5.8 The type and extent of habitats identified within the Principal Application Site are described in Table 8.7 and shown in Appendices 8B and 8C. Additional information is taken from the Detailed Arboricultural Report (Appendix 8H).

Table 8.7: Habitats Present in the Principal Application Site

Habitat	Description
Amenity grassland	There were various sections of amenity grassland throughout the survey area. These areas were short-cropped and regularly managed with ruderal vegetation encroaching along some edges.
Allotments	The area to the east of Suffolk Road contains several allotments which, in addition to scattered native tree species, contained varieties of arable crops and introduced garden plants.
Hardstanding and Buildings	The area to the east of the River Yare is well built up with roads, private housing and commercial warehouses. Butterfly bush *Buddleja davidii*, creeping thistle *Cirsium arvense* and ragwort *Jacobaea vulgaris* were seen to be growing amongst the concrete.
Hedgerow	There are several species-poor hedgerows surrounding properties east of the River Yare. No important hedgerows are present.
Ditch	The north and west of Southtown Common is bordered by a ditch containing standing water. The banks are covered by common nettle *Uritca dioica*, bramble *Rubus fruticosus*, great willowherb *Epilobium hirsutum*, dog rose *Rosa canina,* and creeping thistle. To the north of William Adams Way and to the west of Suffolk road, is a wet ditch and associated scrub habitat. The ditch passes under William Adams Way and runs north away from the road. The area around the ditch contains willow Salix sp., great willowherb, bramble, common nettle, hawthorn *Crataegus monogyna*, poplar *Populus* sp., field bindweed *Convolvulus arvensis,* and hogweed *Heracleum sphondylium*.
River	The proposed Scheme will cross the River Yare. At this location the river is tidally influenced. Mud and silt, typically

Habitat	Description
	associated with this habitat are likely to support benthic invertebrate communities and fish stocks. Common terns *Sterna hirundo* are known to forage on the River Yare. This stretch of the Yare is in use as a working port.
Scattered trees	There are linear sections of woodland running adjacent to the road across the Principal Application Site. The section to the north-west of the roundabout comprises semi-mature ash *Fraxinus excelsior*, willow *Salix* spp., oak *Quercus robur* and hawthorn *Crataegus monogyna*. Woodland also occurs adjacent to the eastern side for the A47 north and south of the roundabout. The southern section was described in the 2016 survey as dense continuous scrub but has matured since this time. Both sections of woodland have similar structure, with a dense understorey dominated by blackthorn *Prunus spinosa*, hawthorn and bramble *Rubus fruticosus* agg. Taller willow and birch *Betula* spp. dominate the canopy layer. The arboricultural assessment (Appendix 8H) recorded two high quality features, namely two examples of late mature weeping willow.

Species

8.5.9 A summary of the results of surveys of species assessed is provided in Table 8.8.

Table 8.8: Field Study Findings for Species Assessed

Species	Description
Benthic and Fish Ecology	The subtidal sediment was mixed, with sand, clay and varying proportions of stone and shell, allowing the development of both infaunal and epibiota communities. Infaunal populations were characterised by varying proportions of common cirratulid, spionid and oligochaete worms in moderate to high numbers, together with typical estuarine bivalves and amphipod crustaceans. About half of the samples were of relatively low diversity and may have been affected by dredging for navigation purposes; these samples were less influenced by gravel components and belonged to the SS.SMu.SMuVS biotope complex. Other samples represented communities within this complex that were more diverse, but still difficult to assign at biotope level, as well as relatively typical examples of the widespread estuarine, shallow mud biotope (SS.SMu.SMuVS.AphTubi). There was a transition between these infaunal communities and those that had more epibiota and

Species	Description
	belonged to the complex SS.SMx.SMxVS. Of these, one community could be named at biotope level: SS.SMx.SMxVS.CreMed. In most mixed substratum samples, epibiota were dominated by barnacles and sea anemones, with encrusting Bryozoa. Although some of the benthic community compositions may suggest the need for re-evaluation of the biotope classification, it is unlikely that any would be considered of particular conservation value (Appendix 8I). The trawl data provide a view of the larger, mobile organisms that pass over the sediment. There were large numbers of brown shrimp (*Crangon crangon*), which may be considered of commercial importance. The gobies, which dominated the trawl data, are widespread and a common component of estuaries, although the distribution of *Pomatoschistus lozanoi* in the North Sea and estuarine habitats was relatively recently recognised (Ref 8.11). Commercially important fish (three flatfish species) were found in low numbers. Only the mid and upper shore biotopes were examined on the walls. The upper shore green algal zone was unusual in its dominance of *Blidingia minima* and similar to a soft rock biotope, LR.FLR.Lic.Bli, but on hard artificial substrata. The mid shore represented typical moderate exposure fucoid barnacle mozaics (LR.MLR.BF.FvesB), which are widespread nationally. The dominant barnacle was the Australasian species *Austrominius modestus*, which is now abundant in estuarine habitats, nationally (Ref 8.12). Although the wider environment is classified as a priority habitat, estuaries, the biological communities identified within the Scheme impact zone are of limited conservation value (Appendix 8I). The construction and maintenance of the Scheme will have little impact relative to the pressures already present due to habitat modification. The main conservation interest is commercially important fish, which appear to use the area in low numbers, and brown shrimp.
Bats	13 structures were assessed for their suitability to support roosting bats during August 2017 (described within the Protected Species Survey Report, presented in Appendix 8E). Ten were assessed as having Low Roost Suitability, and two as having Negligible Roost Suitability. One building was inaccessible. Foraging habitats such as open water, domestic gardens and allotments within the vicinity of the Scheme were fragmented and unconnected. This foraging habitat is of low suitability for use by foraging and commuting bats. As presented in Appendix 8E, two transects were undertaken in July and August 2017. No bats were recorded along Transect 1. This was likely to be a result of the absence of vegetation and high levels of artificial lighting. One species of bat, common pipistrelle, was

Species	Description
	recorded along Transect 2. Four commuting passes were recorded along the northern edge of Southtown Common, where it meets William Adams Way. No bat foraging activity was recorded. These transects were again undertaken in July 2018. Transect 1 conformed to previous survey results with no bat activity recorded. Two species of bat, common pipistrelle and a bat in the genus *Nyctalus*, were recorded along transect 1. Five commuting passes of common pispistrelle were recorded, three of these occurred along the northern edge of Southtown Common, one where Queen Anne's road joins Southtown road near the River Yare, and a final pass at the western-most extent of Queen Anne's road. This final location is where a single commuting pass of a *Nyctalus* species was recorded. No bat foraging activity was recorded. Further surveys of buildings for potential bat roosts were carried out in November 2018 as recommended in the PEA update (Appendix 8C). Of the 33 buildings surveyed in November 2018, 22 have been classified as having low potential to support roosting bats and 11 have been classified as having negligible potential, including eight outbuildings (Appendix 8G). External areas of 22 of the buildings due for demolition, contain features with potential to support roosting bats, and any future destruction of those areas will adversely impact bat roosts if present. Buildings classified as having negligible bat roost potential contain no potential roost features and so need no further survey. Buildings classified as having low bat roost potential offer limited potential to support roosts of opportunistic bats of the more common species associated with urban environments.
Water vole	A ditch is present on the northern and western edge of Southtown Common. A water vole survey, undertaken in August 2017 (described within the Protected Species Survey Report, presented in Appendix 8E), recorded feeding remains and water vole droppings along this section of the ditch. Although the ditch continues to the north of William Adams Way, this could not be surveyed as access to the channel and banks could not be safely achieved. Further surveys for water vole were undertaken following a change in the scheme alignment since the previous surveys were undertaken (Appendix 8F). Ditches included after changes in the Scheme alignment were surveyed in September 2018. Ditches surveyed in 2017 were resurveyed as well as ditches to the north of William Adams Way and those parallel to the A47. Feeding remains, droppings and borrows were recorded both within water course previously surveyed and newly surveyed ditches to the North of William Adams

Species	Description
	Way.
Breeding birds	Observations of bird activity during the breeding bird survey indicated that 33 species recorded were confirmed and/or considered to be probable/possible breeding species. Two species were not considered to be breeding in the Principal Application Site but were seen flying over the Site (Appendix 8D). Black Redstart, a Schedule 1 species of the Wildlife & Countryside Act 1981 (as amended), was observed during the first survey visit. It was considered that two to three territories were present in the Principal Application Site. Of the other breeding/probable/possible breeding species, the Principal Application Site supported six bird species (14 pairs of Herring Gull, four Starling nesting sites, one Song Thrush territory, seven pairs of House Sparrow, five Dunnock territories and one pair of Linnet) that are recognised for their conservation value by being UK BAP listed species and Principal Species of Importance (Section 41 NERC Act 2006). During vantage point surveys of the River Yare, there were no observations made of the common tern, the main target species of the survey. There were also no observations of any other waterbirds that qualify as features of the Breydon Water SPA or Outer Thames Estuary SPA (Appendix 8D).

8.5.10 Appendices 8B, 8C and 8E have established that effects on certain ecological features are not likely and these have not been considered further in this assessment. Table 8.9 summarises these features and the justifications for the decisions made.

Table 8.9: Findings for Species Scoped out of the Assessment

Species	Description
Badgers	No evidence of badger was recorded during the survey work undertaken. There are no habitats suitable for badger within the Principal Application Site. Accordingly, no further surveys were undertaken for this species.
Otter	The main channel of the River Yare, through the centre of the Principal Application site, is canalised and with no suitable locations for otter holts. It is therefore unlikely that this species could be affected by the Scheme and no further surveys were undertaken for this species.
Other mammals	The habitats within the Principal Application site, including residential gardens and an area of allotments on Queen Anne's Road are suitable habitat for hedgehog, although no

Species	Description
	evidence of hedgehog was recorded during the survey work undertaken. Further surveys for hedgehogs were not undertaken.
Amphibians	There is a small pond located roughly within the centre of the Principal Application Site, adjacent to William Adams Way and Queen Anne's Road (approximate Ordnance Survey grid reference: TG523058). The pond and the surrounding habitat, which comprises grassland, scrub and woodland, is suitable for amphibians. In addition, a ditch is present within the Survey Area, located on the northern and western edge of Southtown Common. At the time of survey, the ditch contained standing water. The ditch and adjacent terrestrial habitat within Southtown Common is also suitable for amphibians. Both the pond and the ditch were subject to a Habitat Suitability Index (HSI) assessment in September 2016 to assess suitability for great crested newts *Triturus cristatus*. The ditch scored 0.49 and the pond scored 0.52 which corresponds as 'poor' and 'below average' suitability. These scores indicate that great crested newts are unlikely be present in these waterbodies, and thus further surveys have not been undertaken for this species nor any other amphibian.
Reptiles	The majority of habitats within the Principal Application Site comprise either short or open sward grassland, or concrete urban areas which are of negligible value for reptiles. The allotments south of Queen Anne's Road (approximate Ordnance Survey grid reference: TG523058) provide suitable habitat for reptiles, including a mix of tall ruderal vegetation and long sward grassland, with areas of compost and logs which could be used as refugia. However, this habitat is limited in extent, subject to frequent disturbance and surrounded by entirely by urban development with no connectivity to other suitable habitats within the wider area. Accordingly, the suitability of this habitat for reptiles is limited such that should reptiles be present, it is likely that they will occur in low numbers if present. Measures to mitigate the impact of the Scheme on reptiles are included within the ES. Baseline surveys for reptiles have not been undertaken.

Future Baseline

Overview

8.5.11 The EIA Regulations require consideration of the likely evolution of the baseline conditions over time, without the implementation of the Scheme.

8.5.12 Climate change is the single most prevalent factor when attempting to predict the future baseline of an ecosystem or species community. Climate change affects ecology via multiple pathways. Impacts on species are considered to include changes in distribution and abundance, the timing of seasonal events and habitat use, and, as a consequence, there are likely to be changes in the composition of plant and animal communities. Habitats and ecosystems are also likely to change in character.

8.5.13 To assess the potential impacts of climate change on ecological features is problematic as species trends in distribution and population size are influenced by other factors. These include environmental considerations (such as atmospheric pollution and land use) and population biology (such as density dependence). These different factors can work in combination to bring about change. A recent review (Ref 8.13) presents studies which summarise key research on the impacts of climate change on habitats and species in the UK. This concludes that there is strong evidence that climate change is affecting UK biodiversity. Importantly, impacts are expected to increase as the magnitude of climate change increases.

8.5.14 The distributions of many species are shifting northwards, including some species which have colonised the UK from mainland Europe, while some species are seen to be utilising habitats at a higher altitude than known previously.

8.5.15 With regard to the key ecological features known to be present in the Principal Application Site, it is difficult to predict with considerable confidence as to their likely response to climatic change. However, the following section presents known information on the medium and long-term trends in distribution and abundance for such features.

Habitats

8.5.16 Grassland habitats are not widespread in the Principal Application Site. Such areas are, however, considered to be highly sensitive to changes in rainfall. An increase in summer drought conditions has the potential to lead to a decline in wet grassland communities including rush pastures and water meadows. Woodlands are also considerably sensitive to drought conditions. Increased frequency of droughts may lead to a change in species composition in woodland extents.

Breeding Birds

8.5.17 The British Trust for Ornithology breeding farmland bird index (Ref 8.25) shows a decline of 56% since 1970. This pattern of long-term decline has been apparent for many years. However, the breeding bird community within the Principal Application Site is more characteristic of urbanised habitats which are not exposed to such steep declines.

Bats

8.5.18 The Bat Conservation Trust (Ref 8.14) examined trends in 11 species compared to a baseline year of 1999. This found that these species were either stable or increasing. Climate change may however affect bat populations through changes in their annual hibernation cycle, breeding success and food availability.

Water Vole

8.5.19 Water vole populations are in major decline; the species used to be found in nearly every waterway in England, Scotland and Wales but is now thought to have been lost in up to 90% of these sites. Threats include habitat loss and fragmentation, water pollution, and predation by American mink *Neovison vison* in the last 30 years. Reduced water flow in watercourses would have adverse consequences for water vole populations.

Summary

8.5.20 Whilst there may be some changes in species populations and distribution in the longer term, land management is likely to have a greater influence on biodiversity over much of the study area within the timescale of construction of the Scheme, which is when the majority of effects from the Scheme would occur. It is considered that land use is likely to be the key predictor of species distributions over the lifetime of the Scheme, given that the majority of habitats affected by the works are urban habitats.

8.5.21 To provide information on medium-term changes in species distribution, and due to the mobile nature of several species of conservation concern which may be impacted by the Scheme, the pre-construction surveys secured in by the Outline Code of Construction Practice will aim to locate potential new activity on site, inform detailed works methodologies, including works scheduling, determine whether or not a Natural England protected species licence would be required for works to commence, and/or to assess the need for further mitigation.

8.6 Sensitive Receptors

8.6.1 Table 8.10 presents the sensitive receptors which have been assessed in this chapter and their deemed importance / value.

8.6.2 A screening study, to inform a Habitats Regulations Assessment of the effects of the Scheme on Internationally Designated sites identified in Section 8.5 is presented in the HRA Report (document reference 6.11). This identifies that likely significant effects on European sites (Breydon Water SPA and Ramsar, and the Outer Thames Estuary SPA) could not be screened out. However, following completion of Stage 2 of the report there were considered to be no adverse effects on site integrity on any European site.

8.6.3 Assessment of effects on the Breydon Water SPA and Ramsar and the Outer Thames Estuary SPA is presented in this chapter in an EIA context. These sites are either overlapping (Outer Thames Estuary SPA) or with a potential functional linkage (Breydon Water SPA and Ramsar) with the Application Site. Effects on other designated sites are not considered here as they are screened out in stage 1 of the HRA and/or have no established pathway of effect established for the [purposes of this assessment. The Scheme is considered to have a negligible impact on these sites during both the construction and operational phase. Full details are provided in the HRA (document reference 6.11).

Table 8.10: Sensitive Nature Conservation Receptors.

Receptor	Importance / Value	Impacts Assessed - Construction						Impacts Assessed - Operation			
		Water quality through sedimentation	Watercourse contamination through pollution	Watercourse and habitat contamination through reduction in air quality	Disturbance through noise and vibration	Killing, disturbance of protected species	Floodlighting disturbance	Habitat fragmentation	Watercourse contamination from runoff	Disturbance through noise and vibration	Disturbance through road lighting
Outer Thames Estuary SPA	International	✓	✓	✓	✓	×	×	✓	✓	✓	×
Breydon Water SPA	International	✓	✓	✓	✓	×	×	✓	✓	✓	×

Receptor	Importance / Value	Impacts Assessed - Construction						Impacts Assessed - Operation			
		Water quality through sedimentation	Watercourse contamination through pollution	Watercourse and habitat contamination through reduction in air quality	Disturbance through noise and vibration	Killing, disturbance of protected species	Floodlighting disturbance	Habitat fragmentation	Watercourse contamination from runoff	Disturbance through noise and vibration	Disturbance through road lighting
/ Ramsar / SSSI											
Benthic ecology and fish	Local	✓	✓	✓	✓	✓	×	✓	✓	✓	×
Water vole	National	✓	✓	✓	✓	✓	×	✓	✓	✓	×
Bats	Local	×	×	×	✓	✓	✓	✓	×	✓	✓
Breeding birds	Local	×	×	×	✓	✓	×	✓	×	✓	×

8.7 Establishing the Scenario for Assessment

Construction Phase

8.7.1 Chapter 2: Description of Scheme presents full detail of the Scheme. In summary, the Scheme involves the construction, operation and maintenance of the new crossing of the River Yare in Great Yarmouth. The Scheme consists of a new dual carriageway road across the river, linking the A47 at Harfrey's Roundabout on the western side to the A1243 South Denes Road on the eastern side. The Scheme will feature an opening span double leaf bascule bridge across the river, which may involve the construction of two new 'knuckles' that extend the quay wall into the river. The Scheme will also have a clear span over Southtown Road on the western side of the river as it rises to the crest of the new crossing.

8.7.2 Baseline ecological surveys and the assessment present in this chapter has focused on the Principal Application Site.

8.7.3 Key aspects of the construction phase that have the potential to impact ecological features are:

- Construction of bascule bridge potentially requiring new temporary or permanent “knuckle” walls or cofferdams in the waterway to accommodate their construction;
- Creation of temporary construction sites and accesses from the public highway;
- Demolition of a number of existing residential, and commercial and business properties;
- Provision of vessel waiting facilities to the north and south of the new crossing, either as floating pontoons or additional fendering to the existing berths, including any dredging and quay strengthening works that may be required; and
- Disturbances, specifically through excavation or dewatering, that could result in adverse impacts to water resources, and ecological receptors that rely upon them.

8.7.4 Details regarding the embedded mitigation measures for the construction phase are presented in the Outline Code of Construction Practice (CoCP) (document reference 6.16). The Outline CoCP includes details regarding the management of accidental spillages, the control of runoff from temporary construction compound, areas of stockpiling, the disposal of contaminated sediments, as well as information regarding training and monitoring procedures during construction. The full CoCP, to be secured through the DCO via a Requirement, will be developed in accordance with the Outline CoCP. Measures with respect to nature conservation include:

- For advanced works such as site clearance activities, ecological mitigation to be undertaken prior to the main start of works supervised by suitably qualified specialists.
- Provision for site clearance to take place outside the bird breeding season (March-September inclusive) or, if this not possible, include measures, including ornithological survey as necessary, to ensure breeding birds remain unaffected by the de-vegetation and demolition activities.
- Temporary drainage arrangements to be constructed ahead of the construction works commencing to ensure that surface runoff will not directly enter existing water courses.
- Pre-construction surveys for water voles to confirm continued presence (two surveys between April and October).
- Protection of maintained water vole habitat alongside watercourses through construction buffering of 3-5m.

- Provision for pre-construction emergence / re-entry survey for bats of 22 properties due for demolition where the potential for a roost has not unequivocally been ruled out (Appendix 8G).

- Landscaping works will be undertaken as soon as practicable upon completion of the earthworks. No works will take place within the root protection zone of any retained trees and all trees will be protected according to measures to be set out in an Arboricultural Method Statement which shall form part of the full CoCP and which shall be in accordance with the Outline Arboricultural Method Statement included within Annex A of Appendix 8H.

- Use of artificial lighting during construction to be kept to a minimum to minimise the risk of effects on foraging and commuting bats. Where temporary artificial lighting is used, only the immediate area of works shall be illuminated by using as sharp an angle of lighting as possible and avoiding light being directed at, or close to adjacent vegetation. Shields or hoods shall be used to control or restrict the area to be lit.

- De-vegetation and demolition activities to avoid disturbing black redstart during the breeding season to ensure legal compliance is maintained. If construction overlaps with the breeding season, then the actual nest sites will be identified before work commences and a suitable sized exclusion zone established around the nesting area.

- Should any part of the River Yare need to be impounded during construction then fish translocation is to be carried out to remove fish from the impoundment and return them back to the river. The translocation of fish would be carried out by suitable trained fisheries scientists/aquatic ecologists. Any such operation will need careful co-ordination with the operation to set-up and drain the impoundment. Once the water within the impoundment has been lowered to a suitable level (approx. 0.5 m), fish would be translocated by netting. During the netting process the water level would be gradually and continuously reduced. The intake of the pump/s used to lower the water levels within the impoundment, prior to the translocation of fish, would be covered with mesh to prevent the entrainment of fish.

8.7.5 A series of recommendations with regards mitigation and monitoring of birds have been made in Appendix 8D. These proposed measures have been reviewed, leading to a selection that are considered relevant the status of species present and considered to be proportional to the likely impacts of the Scheme as defined in this chapter. These include both embedded measures as detailed above (and provided in the Outline CoCP) and additional mitigation as determined in Section 8 of the Chapter.

Operation Phase

8.7.6 A full description of the Scheme is included in Chapter 2: Description of the Scheme. It is anticipated that the proposed double leaf bascule bridge will be operated on demand for commercial vessels and by agreement for recreational vessels at set times when requested in advance. The double leaf bascule bridge is expected to be operational 24 hours per day and 365 days per year.

8.7.7 Whilst the opening arrangements for the double leaf bascule bridge have yet to be agreed, it is envisaged that the bridge will open on average an estimated 15 times a day. Modelling has assumed that each opening will take approximately 5.5 minutes including vessel passage time, meaning that the crossing will be closed to traffic for approximately 82 minutes on a typical day.

8.7.8 Maintenance of the Scheme will be the responsibility of NCC as the Highway Authority, and will involve routine, planned maintenance and system checks, as well as reactive maintenance and repairs.

8.8 Assessment of Effects, Mitigation and Residual Effects

Construction Phase

Temporary reduction in water quality through sedimentation caused by construction works within the River Yare

Statutory Protected Sites

8.8.1 A limited degree of land take is required for the Scheme from within the extension to the Outer Thames Estuary SPA. The degree of overlap of the Principal Application site and the SPA is 3.7 Ha, representing a tiny fraction of the total SPA area (3,924 km^2). The movement of sediments is considered in Chapter 11: Road Drainage and Water Environment and the Sediment Transport Assessment (Appendix 11C). The analysis in Appendix 11C shows that the presence of the Scheme would increase the scour and deposition close to the Scheme. The modelling suggests there would be small impacts in the engineered channel up to Haven Bridge (north of the Principal Application Site, immediately south of Breydon Water), however the additional scoured material remains in the channel. There would be a negligible change in the sediment regime of the lake due to the presence of the Scheme. The Scheme would have no impact on the tidal parameters of the Breydon Water SPA estuary. Appendix 11C further details that there would be no additional material transported into the engineered channel within the Outer Thames Estuary SPA due to the presence of the Scheme's

Bridge. Therefore, no change to the overall dredging regime in the harbour would be needed.

8.8.2 Chapter 11: Road Drainage and Water Environment reveals that the River Yare is subject to increased sediment levels during large tidal flows, and where sediment entering the watercourse will be dispersed quickly through the tidal flow regime. Sediment loads are unlikely to be sufficient to significantly affect the intertidal regime when they eventually settle out. The magnitude of change prior to mitigation is therefore considered to be Minor Adverse. The conclusion reached with regards Breydon Water SPA and Ramsar and Outer Thames Estuary SPA in Chapter 11 is that sediment loads are unlikely to be sufficient to impact on the characteristics and intertidal regime.

8.8.3 The value of both the Outer Thames Estuary SPA and Breydon Water SPA and Ramsar are deemed to be International. However, the features of both statutory sites are not considered to have any notable interaction with the Scheme. Impact magnitude is therefore concluded to be reversible, local in spatial extent, and of temporary duration with respect to the Outer Thames Estuary SPA. With regards to Breydon Water SPA and Ramsar, Impact magnitude is concluded to be of an unlikely occurrence, in addition being reversible, local in spatial extent, and of temporary duration. It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of additional mitigation measures.

Benthic Ecology and Fish

8.8.4 The biological communities identified within the Scheme impact zone are of limited conservation value (Appendix 8I). The construction of the Scheme is considered to have little impact relative to the pressures already present due to habitat modification. The main conservation interest is commercially important fish, which appear to use the area in low numbers, and brown shrimp.

8.8.5 The value of benthic ecology and fish is considered to be Local. Considering that sediment loads are unlikely to be sufficient to significantly affect the intertidal regime when they eventually settle out (Chapter 11: Road Drainage and Water Environment), the impact magnitude is concluded to be reversible, local in spatial extent and of temporary duration. It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of additional mitigation measures.

Water Vole

8.8.6 Water voles are present in the watercourses west of the River Yare within the Principal Application Site.

8.8.7 Chapter 11: Road Drainage and Water Environment assesses the potential effects during construction through the potential for sediment to be washed into these watercourses, temporarily increasing turbidity and affecting water quality. It considers that impacts could occur through sediment taking longer to settle out or be dispersed through normal processes. Water voles are however commonly found in watercourses with turbid water and high nutrient levels and are known not to be particularly sensitive to changes in water quality. The magnitude of effect is considered to be a local spatial extent, reversible and of a temporary duration. It is therefore concluded that there is likely to be a **minor effect (not significant)** prior to the implementation of additional mitigation measures.

Mitigation

8.8.8 No further mitigation or enhancement measures have been identified at this stage, beyond the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16) and its subsequent development.

Residual Effects

8.8.9 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

<u>Contamination of watercourses through accidental spillage of fuels/chemicals or as a result of mobilisation of existing ground contamination</u>

8.8.10 The release of hydrocarbons into on-site drainage systems or from direct runoff and infiltration to groundwater is the second most common form of pollution after increased sediment loading. This is likely to increase during the construction period due to a large number of vehicles, including heavy vehicles, accessing the site, refuelling of vehicles and plant, leakage from oil/fuel storage tanks and accidental spillages.

8.8.11 As detailed in Chapter 11: Road Drainage and Water Environment, hydrocarbons form a film on the surface of the water body, deplete oxygen levels and can be toxic to freshwater fish. Even at very low concentrations, the film can negatively impact on the visual appearance of the water body. The impact will be direct and temporary - water quality within the affected water body will improve over time and distance as pollutants disperse and are treated by natural processes.

Statutory Protected Sites

8.8.12 The Scheme involves works within, and in close proximity to, the River Yare (and therefore the Outer Thames Estuary SPA). The measures included within the Outline CoCP (document reference 6.16) will reduce the exposure

through the duration of the works. Following the measures set out in the Outline CoCP, accidental spillages are considered unlikely. Even in the unlikely event of contamination, it is considered that Breydon Water SPA and Ramsar will not be exposed to any effects (Chapter 11: Water Environment).

8.8.13 The value of both the Outer Thames Estuary SPA and Breydon Water SPA and Ramsar are deemed to be International. Considering the absence of relevant features of either Breydon Water SPA and Ramsar and the Outer Thames Estuary SPA within the Principal Application Site and that measures included in the Outline CoCP significantly reduce the potential for contamination spreading to those sites, impact magnitude is concluded to be of an unlikely probability, reversible, local in spatial extent, and of temporary duration. It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of additional mitigation measures.

Benthic and Fish Ecology

8.8.14 The benthic and fish communities identified within the Scheme are considered to be of Local value only (Table 8.10). As the magnitude of the effect is considered to be of an unlikely probability, permanent, local in spatial extent, and of temporary duration due to measures included in the Outline CoCP explained above, it is therefore concluded that there would be a **negligible effect (not significant)** prior to the implementation of mitigation measures.

Water Vole

8.8.15 Water voles are present in the watercourses west of the River Yare within the Principal Application Site, and this species is considered to be of National value.

8.8.16 Contaminants or spillages entering the smaller watercourses in close proximity to the Scheme could have a more significant impact as contaminants may take longer to be dispersed or diluted through normal processes. However, it should be noted that the risk of pollution already exists in these waterbodies due to urban and highway runoff. In addition, the measures included in the Outline CoCP determine that the potential for increased risks from construction run off on water voles is low. Therefore, the magnitude of the effect is considered to be of an unlikely probability, reversible, local in spatial extent, and of temporary duration. It is therefore concluded that there would be a **minor effect (not significant)** prior to the implementation of additional mitigation measures.

Mitigation

8.8.17 No additional mitigation or enhancement measures have been identified at this stage, beyond the embedded mitigation measures that will be

implemented through the Outline CoCP (document reference 6.16) and its subsequent development.

Residual Effects

8.8.18 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Potential contamination of nearby habitats, watercourses and designated sites as a result of a reduction in air quality

8.8.19 Construction works have the potential to generate fugitive dust emissions during earthworks and construction activities, as well as from the trackout of dust and dirt by vehicles onto public highways. Chapter 6: Air Quality provides a full overview of the scenario for assessment with respect to air quality.

Statutory Protected Sites

8.8.20 The construction phase air quality assessment has demonstrated that, in the absence of mitigation, the scale and nature of the Scheme construction, including demolition, represent a high risk of dust related impacts. The highest risk sensitive receptors are those located within 50m and downwind of potential dust-generating activities. It is therefore evident that the River Yare extension to the Outer Thames Estuary SPA is the only statutory site that will likely be exposed to any impacts. Breydon Water SPA is 1.8 km distant from the Application Site. Measures will be implemented and secured via the Outline CoCP to prevent or minimise potential fugitive dust emissions. With these measures in place, the residual dust impact will be, at worst, slight adverse at the highest risk receptors. As such Chapter 6: Air Quality concludes that impacts are expected to be intermittent and temporary for the duration of the respective activities only and would not constitute a significant environmental effect.

8.8.21 The Scheme is therefore not expected to have a significant environmental effect on Unit 10 of the Breydon Water SPA, Ramsar and SSSI site or the Outer Thames Estuary SPA. In any case, protected features of the Outer Thames Estuary SPA with overlaps with the Principal Application Site are not likely to be exposed to any air quality issues during construction. Common tern is a plunge dive forager on fish, and was not recorded within the Principal Application Site (Appendix 8D). Red-throated diver is present in offshore areas of the SPA, for which the designated habitat (sublittoral sediment) is not considered sensitive to changes in NO_x concentrations or Nitrogen deposition (N-deposition).

8.8.22 The value of both the Outer Thames Estuary SPA and Breydon Water SPA and Ramsar are deemed to be International. Considering the absence of relevant features of either Breydon Water SPA and Ramsar or the Outer Thames Estuary SPA within the Principal Application Site, impact magnitude is concluded to be reversible, local in spatial extent, and of temporary duration. It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of additional mitigation measures.

Benthic and Fish Ecology

8.8.23 Although the River Yare was not directly assessed in Chapter 6: Air Quality, it is expected that the results of the assessment carried out for Breydon Water will be consistent and apply to the Outer Thames Estuary SPA in that there is no anticipated environmental effect on the basis that the same mitigation measures would apply. As benthic ecology and fish are considered to be of Local value, there is likely to be a **negligible effect (not significant)** prior to the implementation of mitigation measures.

Water Vole

8.8.24 Water voles are present in the watercourses west of the River Yare within the Principal Application Site and this species is considered to be of National value.

8.8.25 No significant local air quality effects associated with the construction of the Scheme are predicted (Chapter 6: Air Quality). Therefore, it is considered to be of an unlikely probability that there would be impacts of any magnitude on water vole populations, which in any case would be of a local spatial extent and temporary duration. It is therefore concluded that there would be a **negligible effect (not significant)** prior to the implementation of additional mitigation measures.

Mitigation

8.8.26 No further mitigation or enhancement measures have been identified at this stage, beyond the embedded mitigation measures that will be implemented

through the Outline CoCP (document reference 6.16) and its subsequent development.

Residual Effects

8.8.27 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Disturbance effects of noise and vibration during construction

8.8.28 Noise and vibration from the construction phase of the Scheme has the potential to disturb or displace nature conservation sensitive receptors. Chapter 7: Noise and Vibration is referred to below in order to determine the potential for impacts. The Outline CoCP sets out the framework to produce a full CoCP to include mitigation measures which would control noise emissions from the construction site throughout the delivery of the Scheme.

Statutory Sites

8.8.29 Chapter 7: Noise and Vibration presents an assessment of predicted construction noise levels at the Outer Thames Estuary SPA. Noise levels predicted through the process outlined in Chapter 7 for the Outer Thames Estuary are considered to be very conservative. With respect to the geographical location of the plant, the full complement of plant for each phase is assumed to operate together at a single point at the shortest distance between the construction area and the Outer Thames Estuary SPA, i.e. the river's edge. In practice, the plant items identified for each stage will move around the site, operating at different times, for different durations and at different locations on any one day for the duration of the works. As a consequence, noise levels at any location considered in Chapter 7 may vary considerably day-on-day.

8.8.30 Chapter 7 presents noise levels for seven phases of construction with peak levels reaching 104 dB for the East Abutment Combi-Wall while the works at the East Bascule Pit Combi-Wall are predicted to reach 103 db. These areas are immediately adjacent to the River Yare extension of the Outer Thames Estuary SPA. As detailed by Cutts (Ref 8.16) who investigated noise disturbance on waterbirds, auditory disturbance qualifies when it is a sudden noise event over 60 dB (at the birds not the source) or a more prolonged noise of over 72 dB. While the noise predicted for the construction phase of the Scheme is periodically over this level, there is considered to be limited exposure to features of the SPA. Red-throated diver and little tern are not likely to occur in the vicinity of the Scheme due to habitat preferences of the former and limited foraging range of the latter species. Common tern does have potential to occur in the River Yare (and is the species for which the SPA extension is designated). Furthermore, surveys for the Scheme specifically to determine the potential effects at the Principal Application Site did not record any common tern individuals (Appendix 8D).

8.8.31 Breydon Water SPA and Ramsar lies 1.8 km distant from the Application Site and is therefore not considered likely to be exposed to any increases in noise and vibration above the current baseline as a result of the construction of the Scheme.

8.8.32 The value of both the Outer Thames Estuary SPA and Breydon Water SPA and Ramsar are deemed to be International. Considering the absence of relevant features of either Breydon Water SPA and Ramsar and the Outer Thames Estuary SPA within the Principal Application Site, impact magnitude is concluded to be reversible, local in spatial extent, and of temporary duration. It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of mitigation measures.

Benthic and Fish Ecology

8.8.33 Benthic ecology and fish receptors are considered to be of low importance. Although the wider environment is classified as a priority habitat, estuaries, the biological communities identified within the Scheme impact zone are of limited conservation value. The construction and maintenance of the Scheme will have little impact relative to the pressures already present due to habitat modification. The main conservation interest is commercially important fish, which appear to use the area in low numbers, and brown shrimp.

8.8.34 Noise from the construction phase from the Scheme, although reaching up to 104 dB in the Application Site included areas at the River Yare. (Chapter 7: Noise and Vibration). With appropriate mitigation in place, including compliance with the CoCP, a reduction in noise of as much as 10dB can typically be achieved.

8.8.35 Fish and shellfish behavioural responses to underwater noise are highly dependent on a number of factors such as the type of fish/shellfish, its sex, age and condition, as well as other stressors to which the fish is or has been exposed. For example, it would be expected that smaller fish might show behavioural responses at slightly lower levels. In addition to this, the response of the fish will depend on the reasons and drivers for the fish being in the area. Construction related underwater noise will represent a temporary, short to medium term duration and will affect a very small proportion of habitats present in the wider River Yare environment.

8.8.36 Vibration effects are mostly associated with piling activities during construction and the worst-case vibration levels with respect to the Outer Thames Estuary SPA (i.e. the river Yare) is also presented in Chapter 7: Noise and Vibration.

8.8.37 Benthic ecology and fish are considered to be of Local value. It is predicted that the impacts will be **negligible (not significant)** prior to the implementation of additional mitigation measures.

Water voles

8.8.38 Water voles are present in watercourses in the west of the Principal Application Site. All watercourses this species has been located in either border or are adjacent to the existing road network so that they are currently exposed to a baseline of noise and vibration. In addition, it is noted that water voles are present at sites distant from the extensive bridge works where noise and vibration during construction can be expected to be greater (Chapter 7: Noise and Vibration).

8.8.39 Measures incorporated in the CoCP will include the protection of water vole habitat through appropriate buffering of terrestrial habitat either side of watercourses. Noise disturbance is in general, considered in most cases, unlikely to have a significant effect on water voles (Ref 8.9). On this basis the effects on water vole, which is deemed to be a receptor of National value, are expected to be direct, of a local spatial extent and temporary duration. It is therefore concluded that there would be a **minor effect (not significant)** prior to the implementation of additional mitigation measures.

Bats

8.8.40 The potential for bat roosts has been ruled out with the exception of 22 properties, with those remaining considered to have low potential (Appendix 8G). Adjacent habitat was categorised as being of negligible to moderate value for foraging or commuting bats, with moderate value areas restricted to allotment areas opposite the properties at Queen Anne's Road (Appendix 8G). The activity surveys showed that one species of bat (common pipistrelle) uses the site for commuting and/or foraging. The field survey showed that the bat population within the site consists of a low number of a single bat species.

8.8.41 Considering these results, the Principal Application Site is assessed as being of overall Local value in terms of the conservation of foraging and commuting bats. While the potential for a bat roost cannot be unequivocally ruled out in 22 properties, it is considered unlikely. The Principal Application Site is therefore considered to be of Local value for bats in terms of all relevant components of their ecology.

8.8.42 Noise effects have the potential to impair foraging of bat species. Noise monitoring locations assessed in Chapter 7: Noise and Vibration include L02 and L04 which are in the vicinity of buildings where the potential for presence of bat roosts have not been completely ruled out. Large or very large noise impacts are considered likely for certain phases of the Schemes construction. However, considering the extant level of noise pollution from traffic detailed in Chapter 7 are in the vicinity of 65 – 79 dB the magnitude of change is not dramatic. This extant noise is also part of the consideration

made when determining that there is, at best, a low level of potential of a roost being present.

8.8.43 Prior to the implementation of mitigation measures, impacts are predicted to be minor adverse through being of a local spatial extent, intermittent nature, medium term duration and low reversibility. It is predicted that the impacts will affect the receptor directly and be **negligible (not significant)** prior to the implementation of additional mitigation measures.

Breeding birds

8.8.44 Of the 33 species recorded as breeding (confirmed, probable and possible) in 2018 within the Scheme survey area (Figure 8.5), seven were covered by one or more of the range of criteria relating to conservation value referred to in Appendix 8D. These species, with the exception of black redstart, are common and widespread (albeit declining) species that would be expected to occur in an urban environment.

8.8.45 Two to three territories of black redstart were found to be present within the Principal Application Site (Appendix 8D). This species is a rare breeder in Norfolk with up to six territories in 2016, while nationally there were 18 to 58 pairs (Ref 8.18). Black redstart is therefore considered to be of Regional value. This species is, however, particularly tolerant of noise and vibration (Ref 8.19). The other six species also include those that thrive in urban environments (herring gull *larus argentatus*, starling *Sturnus vulgaris*, song thrush *Turdus philomelos*, house sparrow *Passer domesticus* and dunnock *Prunella modularis*). A single pair of linnet *Linaria cannabina* were also recorded, a species typical of farmland and heathland but readily adapt to urban edge habitat.

8.8.46 Effects of construction noise and vibration are predicted to be of a local spatial extent, and short-term duration for breeding birds. It is predicted that the impacts will affect the receptor directly and be **negligible (not significant)** prior to the implementation of additional mitigation measures.

Mitigation

8.8.47 No further mitigation or enhancement measures have been identified at this stage, beyond the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16) and its subsequent development.

Residual Effects

8.8.48 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Killing, injuring and disturbance of protected species during construction

Benthic and Fish Ecology

8.8.49 No protected or notable species (such as migratory fish) were recorded in the benthic ecology and fish surveys (Appendix 8I). There is potential for construction to require temporary dewatering of the River Yare and hence impoundment of fish. The Outline CoCP includes provision for addressing this aspect should it occur, through appropriate supervised translocation (see section 8.7). It is therefore concluded that there would be a **neutral effect (not significant)**.

Water Voles

8.8.50 Feeding remains, droppings and burrows of water voles were recorded in 2018 for both the water course previously surveyed, and newly surveyed ditches to the North of William Adams Way (Appendix 8F). A total of six watercourses were identified and surveyed within the Principal Application Site, with three of these found to be supporting the species. These are water courses 1, 2 and 4, which are indicated in Figure 8.4.

8.8.51 Considering the presence of a viable population within the study area, water vole is considered to be of National value.

8.8.52 As detailed in Section 8.7, all ecological works through the Outline CoCP will be completed in advance of construction works under the supervision of suitably qualified specialists. Water vole habitat that will be maintained in the Principal Application Site will be protected through appropriate buffering.

8.8.53 Work that directly impacts upon protected species, including water vole, will be subject to a mitigation or conservation licence(s) from Natural England to avoid an offence under the Wildlife and Countryside Act 1981 (as amended). Where required, these licences will be in place prior to the commencement of work, and work will be undertaken in line with the mitigation requirements and conditions of the licence(s). Consultation with Natural England by the Applicant is however ongoing, in order to endeavour to secure a Letter of No Impediment (LONI) (Ref 8.20) regarding water voles.

8.8.54 As illustrated on the General Arrangement Plan for the Scheme (document reference 2.2), realignment of the eastern and northern sections of watercourse 1 is proposed. The northern section of watercourse 1 supported water voles as detailed in Figure 8.7 and Appendix 8F. The other watercourse that will be directly affected by the Scheme is watercourse 3. However, this watercourse was found to be of poor habitat suitability for water voles and did not support the species. Watercourse 2 will be subject to desilting works which are not expected to disturb water voles if they are undertaken with appropriate timing (i.e. when they are least active over

winter months). Desilting works can be undertaken in parallel with enhancement mitigation (see below).

8.8.55 With respect to direct impacts on water voles through killing, injuring and disturbance it is expected that the embedded mitigation measures through the Outline CoCP will prevent significant effects on the population with the exception of the northern section of watercourse 1.

8.8.56 Work that directly impacts upon protected species, including water vole, will be subject to a mitigation or conservation licence(s) from Natural England to avoid an offence under the Wildlife and Countryside Act 1981 (as amended). Where required, these licences will be in place prior to the commencement of work, and work will be undertaken in line with the mitigation requirements and conditions of the licence(s). Consultation with Natural England by the Applicant is however ongoing, in order to endeavour to secure a Letter of No Impediment (LONI) (Ref 8.20) regarding water voles.

8.8.57 The potential impacts on water voles at watercourse 1 are considered to be direct on an approximately 100 m stretch of habitat which would likely result in the loss of habitat in the medium term. Although there is a known extent of additional available habitat for water voles that is hydrologically linked to watercourse 1 (inside and outside of the Principal Application Site) it is considered that the impacts constitute a **moderate adverse effect (significant)** prior to the implementation of additional mitigation measures.

Bats

8.8.58 As reported in Appendix 8E, all structures assessed were considered to have a low potential of supporting a bat roost from visual inspection work. The low level of bat activity recorded during the transect surveys suggests that the likelihood of a roost being present within the Principal Application Site is low. The activity surveys showed that one species of bat (common pipistrelle) uses the site for commuting and/or foraging. The field survey showed that the bat population within the site consists of a low number of a single bat species.

8.8.59 Subsequent surveys of 33 buildings and structures within the Principal Application site in November 2018 (Appendix 8G) determined that external areas of the 22 buildings due for demolition contain features with potential to support roosting bats. They were however categorised as having low potential while a further 11 buildings have been classified as having negligible potential, including eight outbuildings.

8.8.60 Prior to the onset of demolition activities, a single emergence / re-entry survey is secured in the Outline CoCP of the 22 properties categorised as being of low potential to support a bat roost. In the event of a bat roost being located during the pre-construction emergence / re-entry surveys, a mitigation licence will be sought from Natural England.

8.8.61 Adjacent habitat was categorised as being of negligible to moderate value for foraging or commuting bats with moderate value areas restricted to allotment areas opposite the properties at Queen Anne's Road (Appendix 8G). When considering embedded mitigation measures, including landscaping, there is considerable potential to increase foraging opportunities for bat species.

8.8.62 Considering these results, the Principal Application Site is assessed as being of overall Local value in terms of the conservation of foraging and commuting bats. While the potential for a bat roost cannot be unequivocally ruled out in 22 properties, it is considered unlikely. The Principal Application Site is therefore considered to be of Local value for bats in terms of all relevant components of their ecology.

8.8.63 Prior to the implementation of mitigation measures impacts are predicted to be adverse through a local spatial extent, medium term duration and low reversibility. It is predicted that the impacts will affect the receptor directly and will constitute a **minor adverse effect (not significant)**.

Breeding Birds

8.8.64 Of the 33 species recorded as breeding (confirmed, probable and possible) in 2018 within the Principal Application Site (Figure 8.5), seven were covered by one or more of the range of criteria relating to conservation value referred to in Appendix 8D. All of these species, with the exception of black redstart, are common and widespread (albeit declining) species that would be expected to occur in an urban environment. Only black redstart is listed on Schedule 1 of WCA 1981 (as amended) with the remaining species (herring gull, starling, song thrush, house sparrow, dunnock, linnet) being either listed on either S41 or the Red List of Birds of Conservation Concern (Ref 8.17). No species of conservation interest directly utilised the aquatic habitats within the Scheme study area, with no common tern (a feature of Breydon Water SPA) recorded foraging on the River Yare.

8.8.65 Considering these results, the Principal Application Site is assessed as being, in general, of Local value in terms of the conservation of breeding birds. As detailed in Section 8.7, all ecological works will be carried out in accordance with a CoCP. Where possible, ecological and cultural heritage works will be completed in advance of construction works under the supervision of suitably qualified specialists. In order to ensure compliance with the WCA 1981 (as amended) the Outline CoCP includes provision for site clearance to take place outside the birds' breeding season (March-September inclusive), or, if this not possible, include measures to ensure breeding birds remain unaffected by the de-vegetation and demolition activities.

8.8.66 With respect to impacts on the breeding birds (with the exception of black redstart which is assessed independently below) they are predicted to be of a local spatial extent and short term duration when considering the implication of embedded mitigation. It is predicted that the impacts will affect the receptor directly, though be **negligible (not significant)** prior to the implementation of mitigation measures.

8.8.67 Two to three territories of black redstart were found to be present within the Principal Application Site (Appendix 8D). This species is a rare breeder in Norfolk with up to six territories in 2016, while nationally there were 18 to 58 pairs (Ref 8.18). Black redstart is therefore considered to be of Regional value.

8.8.68 Embedded mitigation secured in the Outline CoCP includes various measures relevant to this species including avoidance of disturbance in the breeding season. Nevertheless, there remains potential for loss or disturbance of this species from the Principal Application Site. Black redstart is, however, a bird that thrives in urban environments (Ref 8.19), so it is considered that alternative areas adjacent to the Principal Application Site would be available.

8.8.69 It is predicted that the impacts will affect the receptor directly, and be of local spatial extent and short term duration when considering the implication of embedded mitigation. It is predicted that this will constitute a **minor adverse effect (not significant)** prior to the implementation of additional mitigation measures.

Mitigation

8.8.70 Mitigation is proposed with respect to water voles covering both monitoring protocols and active mitigation plans in addition to enhancement proposals. While impacts are considered non-significant for black redstart, mitigation measures outside of measures provided in the Outline CoCP are detailed here for this species.

8.8.71 Effects on watercourses in which water vole populations are present will be avoided, wherever possible. Where this is not possible (i.e. watercourse 1) it is necessary to design and implement a mitigation strategy to avoid an offence under the WCA 1981 (as amended). This mitigation strategy will incorporate a significant element of habitat enhancement to enable a conservation licence to be granted for the Scheme. The purpose of the mitigation strategy will be to set out measures to avoid the loss of water vole populations and prevent risk of killing or injury of individual water voles.

8.8.72 Table 8.11 presents a summary of the status of each water course and proposed mitigation measures. Watercourse 1 and 2 are divided into three and two subsections respectively following the habitat descriptions in Appendix 8F. These subsections are indicated in Figure 8.7.

Table 8.11: Summary of Water Vole Status in the Principal Application Site and Proposed Mitigation Measures

Water Course	Water Course Subsection	Habitat Quality	Water Vole Presence 2018	Scheme Impact	Proposed Mitigation
1	East	Good	No	Habitat lost	No water vole presence noted; pre-construction survey to determine if displacement activity required.
	North	Good	Yes	Habitat disturbed through realignment	Displacement of water voles required before realignment takes place.
	West	Poor	No	Partial disturbance through realignment	150m of watercourse available for extensive habitat enhancement (and protected through CoCP measures).
2	South	Moderate (east bank only)	Yes	Desilting operation required	Habitat to be protected through CoCP measures.
	North	Poor	No	Desilting operation required	100m of watercourse available for extensive habitat enhancement that can be undertaken in parallel to desilting works (and protected through CoCP measures).
3	-	Poor	No	Habitat lost	n/a

Water Course	Water Course Subsection	Habitat Quality	Water Vole Presence 2018	Scheme Impact	Proposed Mitigation
4	-	Moderate to good	Yes	None	Habitat to be protected through CoCP measures.
5	-	Moderate	No	None	Watercourse available for extensive habitat enhancement (and protected through CoCP measures).
6	-	Poor	No	None	Watercourse available for extensive habitat enhancement (and protected through CoCP measures).

8.8.73 Although water voles are currently present, this is a species that will readily move away from and re-occupy different areas of watercourses, so up-to-date survey information will be necessary to determine the requirement for a licence. This means that prior to construction works surveys for water voles should be undertaken within the Scheme and adjacent watercourses. This is presented in the Outline CoCP (document reference 6.16).

8.8.74 The mitigation protocol in the Outline CoCP includes the following broad steps:

- Where habitat cannot be retained, alternative habitat will be prepared and habitat enhanced appropriately in advance of the commencement of construction to support water voles if translocation might be required. To mitigate for the realignment works at watercourse 1, enhanced habitat in the northern subsection of watercourse 2 (which is directly connected to water course 1) will be provided. Following standard guidance, this site is less than 500 m from the affected habitat, not already supporting a water vole population, and is well connected to other suitable habitat. This receptor habitat will be enhanced to form a complex wetland habitat resource, as increased watercourse complexity has been shown to enable water voles to evade predators more effectively. It will aim to achieve an overall increase in habitat available in the local area for water voles. If

alternative habitats are required these would be located within the Application Site.

- Enhancement work would include: the planting of native wetland plants, reeds, grasses, rushes and sedges along new channels; and the removal of areas of dense woody vegetation on existing watercourses, to allow increased light to reach watercourses and thereby enable an increase in in-stream and marginal wetland plants. Work would also include restoration of water channels, with deepening or alteration of the bank profile where appropriate to maximise their suitability for water voles.

- Further enhancement of habitats for water voles will be provided in watercourses 5 and 6.

- Watercourse crossing points associated with the Scheme will be incorporated during detailed design to maximise permeability to water voles, with a preference for bridges rather than pipes or small culverts. The height of the structure above the water should be maximised and preferably an area of watercourse bank should also run through the structure.

- At watercourse 1 where realignment is required, water voles from within the construction footprint will be relocated to newly created or enhanced habitat in the receptor site. To reduce effects on the population of water voles and enable successful adaptation to the new environment the timing of works will need to coincide with seasonal periods when water voles are least likely to be breeding. Relocation of animals, if required, will need to be carried out between mid-March and mid-June, prior to the main breeding season.

- Following trapping out of all water voles from the construction footprint and before realignment works begin, a destructive search of the construction footprint should be carried out under the supervision of a suitably qualified ecologist. During the destructive search, suitable habitat (vegetation and burrows) should be progressively removed to capture any remaining water voles.

8.8.75 With regards black redstart, landscaping will be incorporated into detailed design (Appendix A to the Design Report; document reference 7.4) that focusses on this species which has a preference for open brownfield sites. Sections of the Principal Application Site will be reserved for the use of aggregates and low nutrient substrates in order to promote arid habitats. The area of habitat creation for black redstart need not be extensive; small roof areas of 25m^2 will readily be used (Ref 8.21). Nest boxes specifically suited to this species will also be provided within the design.

Residual Effects

8.8.76 Following consideration of the mitigation measures detailed above it is considered that impacts on water voles would be of local spatial extent, and short term duration. It is predicted that the impacts will affect the receptor directly and be **negligible adverse (not significant)**.

8.8.77 Following consideration of the mitigation measures detailed above it is considered that impacts on black redstart would be of local spatial extent, and short term duration. It is predicted that the impacts will affect the receptor directly and be **negligible adverse (not significant)**.

Monitoring

8.8.78 The water vole populations within retained or newly enhanced habitat will be monitored following construction of the Scheme to confirm if the relocation of the population has been a success. This would enable remedial measures to be implemented where necessary and is secured in the Outline CoCP (document reference 6.16).

Disturbance of nocturnal animals from construction lighting

Bats

8.8.79 Habitat within the Principal Application Site was categorised as being of negligible to moderate value for foraging or commuting bats, with moderate value areas restricted to allotment areas opposite the properties at Queen Anne's Road (Appendix 8G). The activity surveys showed that one species of bat (common pipistrelle) uses the site for commuting and/or foraging. The field survey showed that the bat population within the site consists of a low number of a single bat species. Common pipistrelle is considered to be one of the least sensitive species to lighting effects (Ref 8.23, Ref 8.24)

8.8.80 Considering these results, the Principal Application Site is assessed as being of overall Local value in terms of the conservation of foraging and commuting bats. To minimise the risk of effects on foraging and commuting bats, the use of artificial lighting during construction will be kept to a minimum as detailed in the Outline CoCP. Where temporary artificial lighting is used, only the immediate area of works shall be illuminated by using as sharp an angle of lighting as possible and avoiding light being directed at, or close to adjacent vegetation. Shields or hoods shall be used to control or restrict the area to be lit.

8.8.81 Impacts to bats from lighting are therefore predicted to be **negligible (not significant)**.

Mitigation

8.8.82 No further mitigation or enhancement measures have been identified.

Residual Effects

8.8.83 As no additional mitigation has been identified, residual effects are assessed to be the same as those described above.

Operational Phase

Fragmentation of retained habitats and/or severance of wildlife corridors, foraging routes or territories

8.8.84 The operational Scheme has the potential to provide a barrier to the movement of key species or fragment retained habitats within the Principal Application Site.

Statutory Sites

8.8.85 Vantage point surveys were undertaken in 2018, designed to determine the potential interaction between the Scheme and the common tern feature of the Breydon Water SPA. This species was unrecorded throughout, while no other species of conservation concern and/or species that would likely be affected by the presence of the operational Scheme were recorded (Appendix D). The potential impacts are considered to be of an unlikely probability of occurrence which would affect the receptor directly although of limited frequency.

8.8.86 It is therefore predicted that the impacts would be **negligible (not significant)** prior to the implementation of additional operational phase mitigation measures.

Benthic and Fish Ecology

8.8.87 As detailed in Appendix 8I, benthic ecology and fish receptors are considered to be of low importance. Although the wider environment is classified as a priority habitat, estuaries, the biological communities identified within the Scheme impact zone are of limited conservation value. The operation of the Scheme will have little impact relative to the pressures already present due to habitat modification. The main conservation interest is commercially important fish, which appear to use the area in low numbers, and brown shrimp, which will not be affected by operation of the bridge.

8.8.88 Benthic ecology and fish are considered to be of Local value. It is predicted that the impacts will be **negligible (not significant)** prior to the implementation of additional operational phase mitigation measures.

Water Vole

8.8.89 An extensive mitigation programme (through both the CoCP and additional mitigation measures) is proposed with respect to the water vole population present within the Principal Application Site. This will be designed to secure the water vole population and prevent any severance of water vole territories or foraging habitat.

8.8.90 It is not anticipated that any operational activities will directly affect the water vole population within the Principal Application Site. The watercourses are already subject to general maintenance activities and it is considered that no activities from the operational Scheme would lead to any habitat fragmentation or severance.

8.8.91 Water voles are considered to be of National value. It is predicted that the impacts will be **negligible (not significant)** prior to the implementation of additional operational phase mitigation measures.

Bats

8.8.92 Habitat within the Principal Application Site was categorised as being of negligible to moderate value for foraging or commuting bats, with moderate value areas restricted to allotment areas opposite the properties at Queen Anne's Road (Appendix 8G). The activity surveys showed that one species of bat (common pipistrelle) uses the site for commuting and/or foraging. The field survey showed that the bat population within the site consists of a low number of a single bat species.

8.8.93 The operation of the Scheme has the potential to fragment the limited foraging of bats present within the Principal Application Site. Considering the low level of activity recorded within the Principal Application Site and the recorded presence of a single species only, it is anticipated that this that there is a very low potential to materially affect the status of bat populations.

8.8.94 Considering these results, the Principal Application Site is assessed as being of overall Local value in terms of the conservation of foraging and commuting bats. Prior to the implementation of additional operational phase mitigation measures, impacts are predicted to be **negligible (not significant)**.

Breeding Birds

8.8.95 The Scheme area is assessed as being, in general, of Local value in terms of the conservation of breeding birds. The operational Scheme is not expected to lead to any pathway of effect in terms of fragmentation or severance of habitat for breeding birds or their territories.

8.8.96 Prior to the implementation of additional operational phase mitigation measures impacts are predicted to be **negligible (not significant)**.

Mitigation

8.8.97 No further mitigation or enhancement measures have been identified for the operational phase.

Residual Effects

8.8.98 As no additional mitigation has been identified, residual effects are assessed to be the same as those described above.

Contamination of watercourses and/or waterbodies associated with road related runoff

8.8.99 Surface water runoff has the potential to contain silts and hydrocarbons that are washed off hard paved areas and vehicular areas. These can increase water turbidity, deplete oxygen levels and be toxic to the aquatic environment. Uncontrolled discharge via infiltration to ground can also cause permanent deterioration of groundwater quality.

8.8.100 The Scheme will increase traffic flows in the immediate vicinity but in part will simply divert existing traffic from existing routes, and this therefore will not lead to any significant increase in highway discharges where the Annual Average Daily Traffic (AADT) traffic flow remains in the same category used in the HAWRAT assessment tool (Chapter 11: Water Environment).

Statutory Protected Sites

8.8.101 The Scheme involves works within and in close proximity to the River Yare (and therefore the Outer Thames Estuary SPA). Contaminants released into the watercourses in the vicinity of the Scheme could be transported downstream to impact on the water quality of drains and dykes within the marshland south of Breydon Water and within the wider urban area of Great Yarmouth. Given the size of the catchment, the contaminants would have been sufficiently diluted and dispersed before reaching these watercourses, and it is unlikely the discharges would have any significant effect on the water quality compared with current discharges from the wider urban area.

8.8.102 The value of both the Outer Thames Estuary SPA and Breydon Water SPA and Ramsar are deemed to be International. Considering that this chapter has established the absence of relevant features of either Breydon Water SPA and Ramsar and the Outer Thames Estuary SPA within the Principal Application Site, impact magnitude is concluded to be of an unlikely probability, reversible, local in spatial extent and of temporary duration. No change is predicted to the River Yare or to the Breydon Water SPA and

Ramsar, which are in hydraulic connection with the Yare (Chapter 11: Water Environment), from any runoff contaminants.

8.8.103 It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of additional operational phase mitigation measures.

Benthic and Fish Ecology

8.8.104 The benthic and fish communities identified within the Scheme are considered to be of Local value only (Appendix 8I). No change is predicted to the River Yare or to the Breydon Water SPA and Ramsar, which are in hydraulic connection with the Yare (Chapter 11: Water Environment), from any runoff contaminants.

8.8.105 It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of additional operational phase mitigation measures.

Water Vole

8.8.106 Water voles are present in the watercourses west of the River Yare within the Principal Application Site and this species is considered to be of National value.

8.8.107 Given the risk of pollution already exists due to existing highway discharges, runoff from the Scheme is unlikely to cause significant deterioration in water quality of the Internal Drainage Board (IDB) drains, even if runoff is discharged untreated (which with the implementation of mitigation measures is unlikely). The drained area represents a very small proportion of the catchment of these drains (approximately 1.5%) therefore these discharges are highly unlikely to have a significant effect on the overall water quality (Chapter 11: Water Environment).

8.8.108 It is therefore concluded that there is likely to be a **negligible (not significant)** prior to the implementation of additional operational phase mitigation measures.

Mitigation

8.8.109 No further mitigation or enhancement measures have been identified.

Residual Effects

8.8.110 As no additional mitigation has been identified residual effects are assessed to be the same as those described above.

Disturbance effects of noise and vibration during operation

8.8.111 Noise and vibration from the operational phase of the Scheme has the potential to disturb or displace sensitive receptors. Chapter 7: Noise and Vibration is referred to below in order to determine the potential for impacts.

Statutory Sites

8.8.112 The operational noise study area detailed in in Chapter 7: Noise and Vibration includes both Breydon Water SPA/Ramsar/SSSI and the Outer Thames Estuary SPA. This concludes that under a short term scenario (to 2023) the magnitude of impact from operational noise effects would be no change for Breydon Water and negligible adverse for the Outer Thames Estuary. The magnitude of impact under a long-term scenario would be negligible adverse for both sites.

8.8.113 The value of both the Outer Thames Estuary SPA and Breydon Water SPA and Ramsar are deemed to be International. Considering that this chapter has established the absence of relevant features of either Breydon Water SPA/Ramsar or the Outer Thames Estuary SPA within the Principal Application Site, impact magnitude is concluded to be of an unlikely probability, and of a local spatial extent. It is therefore concluded that there is likely to be a **negligible effect (not significant)** prior to the implementation of additional operational phase mitigation measures.

Benthic and Fish Ecology

8.8.114 The assessment in Chapter 7: Noise and Vibration of the impacts of operational noise includes that of the Outer Thames Estuary SPA. This is in essence the River Yare habitat, which forms the habitat that supports the benthic and fish ecology receptors assessed. Noise and vibration from the operational phase from the Scheme is not expected to result in any significant effects on the SPA with short-term and long-term effects considered negligible adverse.

8.8.115 Benthic ecology and fish are considered to be of Local value (Appendix 8I). It is predicted that the impacts will be **negligible (not significant)** prior to the implementation of operational phase mitigation measures.

Water Vole

8.8.116 Water voles are present in watercourses in the west of the Principal Application Site. All watercourses this species has been located in are adjacent to the existing road network, and so they are currently exposed to a baseline of noise and vibration. Noise disturbance is in general, considered in most cases, unlikely to have a significant effect on water voles (Ref 8.9).

8.8.117 On this basis the effects on water voles, which is deemed to be a receptor of National value, are expected to be direct, of a local spatial extent, and permanent duration. It is therefore concluded that there would be a **minor effect (not significant)** prior to the implementation of additional operational phase mitigation measures.

Bats

8.8.118 The potential for bat roosts has been ruled out with the exception of 22 properties, which are considered to have low potential (Appendix 8G). Adjacent habitat was categorised as being of negligible to moderate value for foraging or commuting bats, with moderate value areas restricted to allotment areas opposite the properties at Queen Anne's Road (Appendix 8G). The activity surveys showed that one species of bat (common pipistrelle) uses the site for commuting and/or foraging. The field survey showed that the bat population within the site consists of a low number of a single bat species.

8.8.119 Considering these results, the Principal Application Site is assessed as being of overall Local value in terms of the conservation of foraging and commuting bats. While the potential for a bat roost cannot be unequivocally ruled out in 22 properties, it is considered unlikely. The Principal Application Site is therefore considered to be of Local value for bats in terms of all relevant components of their ecology.

8.8.120 Considering the Local value of bat populations at the Principal Application Site and the current urban environment of the Scheme already being exposed to levels of noise and disturbance, it is considered that operational activities that will directly affect bat populations are unlikely.

8.8.121 Prior to the implementation of additional operational phase mitigation measures, impacts are predicted to be adverse through a local spatial extent, medium term duration, and low reversibility. It is predicted that the impacts will affect the receptor directly and be **negligible (not significant)**.

Breeding Birds

8.8.122 Of the 33 species recorded as breeding (confirmed, probable and possible) in 2018 within the Scheme survey area (Figure 8.5), seven were covered by one or more of the range of criteria relating to conservation value referred to in Appendix 8D. All of these species, with the exception of black redstart, are common and widespread (albeit declining) species that would be expected to occur in an urban environment.

8.8.123 Two to three territories of black redstart were found to be present within the Principal Application Site (Appendix 8D). This species is a rare breeder in Norfolk with up to six territories in 2016, while nationally there were 18 to 58 pairs (Ref 8.18). Black redstart is therefore considered to be of Regional

value. This species is, however, particularly tolerant of noise and vibration (Ref 8.19). The other six species also include those that thrive in urban environments (herring gull, starling, song thrush, house sparrow and dunnock). A single pair of linnet were also recorded, a species typical of farmland and heathland but readily adapt to urban edge habitat.

8.8.124 Effects of operation noise and vibrations are predicted to be of a local spatial extent and long-term duration for breeding birds. It is predicted that the impacts will affect the receptor directly and be **negligible (not significant)** prior to the implementation of operational phase mitigation measures.

Disturbance of nocturnal animals where road lighting introduces a new light source

8.8.125 Lighting on the approaches of the Scheme would result in the replacement of existing lighting adjacent to the River Yare; there is no proposed lighting on the bridge span over the River Yare (Chapter 10: Townscape and Visual).

Bats

8.8.126 Habitat within the Principal Application Site was categorised as being of negligible to moderate value for foraging or commuting bats, with moderate value areas restricted to allotment areas opposite the properties at Queen Anne's Road (Appendix 8G). The activity surveys showed that one species of bat (common pipistrelle) uses the site for commuting and/or foraging. The field survey showed that the bat population within the site consists of a low number of a single bat species.

8.8.127 Considering these results, the Principal Application Site is assessed as being of overall Local value in terms of the conservation of foraging and commuting bats.

8.8.128 Lighting has the potential to interrupt communication, foraging and reproduction of bats. However, the only species recorded at the Principal Application Site, common pipistrelle, is one of the least sensitive (Ref 8.23, Ref 8.24). Prior to the implementation of additional operational phase mitigation measures impacts are predicted to be **negligible (not significant)**.

Mitigation

8.8.129 No further mitigation or enhancement measures have been identified.

Residual Effects

8.8.130 As no additional mitigation has been identified residual effects are assessed to be the same as those described above.

8.9 Limitations and Assumptions

Benthic Ecology and Fish

8.9.1 The MMO noted that a 2m beam trawl targets small and juvenile fish. The MMO considers that the limitations in the use of a 2m beam trawl to characterise larger fish/pelagic species should be acknowledged in the ES and any subsequent analysis of the trawl data (Table 8.4). On the basis of the detail presented in the following paragraphs data obtained is considered robust.

8.9.2 Trawl sampling was conducted at four stations, primarily to characterise larger or highly mobile epibenthos that may not be adequately sampled through grab sampling (Appendix 8I). The use of a 2m beam trawl may select against larger fish and pelagic species but for sampling epibenthos it is considered the most suitable method (Ref 8.22). To fully characterise fish communities, a larger trawl and regular surveys over an extended period would have been necessary, which were outside the deemed scope of study carried out to inform this chapter. However, the limited fish data that were collected have been fully detailed in Appendix 8I.

8.9.3 The main constraint of the surveys related to the tides. Since the river channel is highly modified and there is a large volume of freshwater flow, the water currents in the channel are very strong. This had the potential to drag the grab during deployment which could prevent it from striking the riverbed squarely, leading to inadequate samples or a misfire. The survey was therefore scheduled for neap tides when this effect is minimised. However, grab sampling could only be undertaken in the period around slack water, which, in the River Yare, lasts for around 1-1.5 hours either side of the turn of the tide and lasts slightly longer on low tides than high tides due to the water flowing downstream resisting the incoming water. Once the grab started to drift during deployment, sampling was paused until the next slack water period.

8.9.4 Additionally, the strong currents prevent the build-up of finer sediments meaning it was necessary to use a Hamon grab for sampling, which in turn affected the ultimate choice of vessel for the work (Appendix 8I).

Water Voles

8.9.5 The northern bank of watercourse 4 which borders Southtown Common Recreation Ground was inaccessible, and banks could not be examined thoroughly because of the presence of impenetrable vegetation covering the northern bank and deep water preventing the watercourse being crossed. Water voles were however confirmed as present on the opposite bank and

for the purposes of this assessment all components of this watercourse are considered to support the species.

8.9.6 The sections of the watercourses bordering the A47, which continue beyond the red line boundary, could not be accessed safely because of steep banks above deep water. This meant that surveys could not be carried out within the section of watercourses 100m south of the Scheme.

8.9.7 These limitations are not considered to provide a constraint to the conclusions made in this chapter. Precautionary methods of working with regards areas inaccessible to baseline survey work, if affected by the Scheme, have required assumption of water vole presence in order to act in a suitably precautionary fashion. These areas are however outside of those to be directly affected by any realignment works in the construction phase of the Scheme.

Bats

8.9.8 Appendix 8G details the surveys of buildings within the Principal Application Site for bat roosts. No access was granted to three properties while roof voids in a further four properties were not accessible. Emergence and re-entry surveys of the buildings will be undertaken to fill any gaps in the inspection survey data, as set out in the Outline CoCP.

Breeding Birds

8.9.9 Access for breeding bird surveys to some commercial and residential areas, as well certain habitats, was not possible. Therefore, the status of breeding birds and the assemblage present could not be determined. These areas are however limited in area and habitat quality for breeding birds. Sufficient embedded mitigation as secured in the Outline CoCP is in place for breeding birds.

8.9.10 It was recognised that the breeding bird survey was commenced in mid-May rather than in March to April as recommended in current guidance (Ref 8.3). Therefore, there is some potential for early breeding bird species and their territories to have been overlooked. However, considering the site was located in an urban environment, early breeding species of conservation interest, such as owl species, would not be present.

8.9.11 It was also recognised that the black redstart survey was commenced in mid-May rather than in mid-April as recommended in survey guidance (Ref 8.4). Therefore, some early breeding activity and territories may have been overlooked. However, the surveys did record the presence of multiple black redstarts, and the precautionary assumption was made that all three territories detected were active. Although the assessment concluded that

effects on this species are non-significant, specific mitigation measures are detailed in any event to enhance local habitats.

8.10 Summary

8.10.1 Table 8.13 presents a summary of the potential effects of the Scheme on ecological receptors. No habitats of ecological importance or with legal protection have been identified within the Principal Application Site.

8.10.2 An HRA has been undertaken (document reference 6.11) and this has concluded that no significant effects to the integrity of protected sites are likely as a result of the Scheme.

8.10.3 A water vole population was present in the watercourses within the Principal Application Site. The assessment has concluded that there would be no significant effect upon water voles with the mitigation measures proposed, which includes extensive enhancement of habitat which is currently considered to be of poor or sub-optimal quality for this species.

8.10.4 The breeding bird community was considered to be unexceptional within the Principal Application Site, with the exception of two to three territories of black redstart. The assessment has however concluded that there would be no significant effect from the Scheme upon breeding birds. Additional mitigation measures specifically targeted to the local environment for black redstart are however proposed.

8.10.5 Similarly, the benthic and fish community was identified as being of Local value only in the vicinity of the Principal Application Site, and no significant effects from the Scheme on these features are predicted.

8.10.6 The Site was considered to be of local importance only to both foraging and roosting bats. The potential for a bat roost in several properties due for demolition could not equivocally be ruled out; however, these properties were all considered to have low potential.

8.10.7 Emergence and re-entry surveys for bats at these properties are to take place prior to demolition. Such measures would be implemented within the full CoCP for the Scheme to ensure that appropriate focus is given to nature conservation resources during the construction period. Measures will also be implemented within the full CoCP to control and prevent the spread of Schedule 9 invasive plant species (and other non-native species).

8.10.8 The assessment has also considered the synergistic effects upon nature conservation resources (i.e. those where other environmental aspects may have an effect such as noise, water environment or air quality). As each assessment has concluded that there are no adverse effects after the deployment of mitigation measures, there are no synergistic effects when

both assessments are combined. Table 8.12 presents a summary of where synergistic effects have been considered in this chapter.

Table 8.12: Synergistic Effects

Receptors	Air Quality	Noise & Vibration	Nature Conservation	Cultural Heritage	Townscape	Water Environment	Flood Risk	People & Communities	Materials	Geology & Soils	Traffic & Transport	Notes
Statutory sites	Y	Y	n/a	N	N	Y	N	N	N	N	N	Effects of contamination of watercourses by virtue of both air and water pollution from the Scheme on statutory sites has been identified and assessed (paragraphs 8.8.12 to 8.8.13, 8.8.20 to 8.8.22). Effects on the Water Environment include those from sediment transport which has the potential to impact habitat and species present within statutory sites (paragraphs 8.8.2 to 8.8.3). The assessment has not identified any significant effect (in EIA terms) between air quality or water environment on statutory sites; therefore no mitigation measures are necessary. The effects of noise and vibration have been assessed within this

Receptors	Air Quality	Noise & Vibration	Nature Conservation	Cultural Heritage	Townscape	Water Environment	Flood Risk	People & Communities	Materials	Geology & Soils	Traffic & Transport	Notes
												chapter at paragraphs 8.8.29 to 8.8.32 and 8.8.101 to 8.8.103. This concludes no significant effects on statutory sites.
Benthic Ecology & Fish	Y	Y	n/a	N	N	Y	N	N	N	N	N	Effects of contamination of watercourses by virtue of both air and water pollution from the Scheme on benthic ecology and fish has been identified and assessed (paragraph 8.8.14). Effects on the Water Environment include those from sediment transport which has the potential to impact benthic ecology and fish (paragraphs 8.8.4 to 8.8.5). The assessment has not identified any significant effect (in EIA terms) between air quality or water environment and benthic ecology and fish; therefore no mitigation measures are necessary.

Receptors	Air Quality	Noise & Vibration	Nature Conservation	Cultural Heritage	Townscape	Water Environment	Flood Risk	People & Communities	Materials	Geology & Soils	Traffic & Transport	Notes
												The effects of noise and vibration have been assessed within this chapter at paragraphs 8.8.33 to 8.8.34 and 8.8.104 to 8.8.105. This concludes no significant effects on benthic ecology and fish.

Receptors	Air Quality	Noise & Vibration	Nature Conservation	Cultural Heritage	Townscape	Water Environment	Flood Risk	People & Communities	Materials	Geology & Soils	Traffic & Transport	Notes
Water Voles	Y	Y	n/a	N	N	Y	N	N	N	N	N	Effects of contamination of watercourses by virtue of both air and water pollution from the Scheme on water voles has been identified and assessed (paragraph 8.8.15 and 8.8.16). Effects in the water environment include those from sediment transport which has the potential to impact water voles (paragraphs 8.8.7 to 8.8.5). The assessment has not identified any significant effect (in EIA terms) between air quality or water environment and water voles; therefore no mitigation measures are necessary. The effects of noise and vibration have been assessed within this chapter at paragraphs 8.8.38 to 8.8.39 and 8.8.106 to 8.8.108. This

Receptors	Air Quality	Noise & Vibration	Nature Conservation	Cultural Heritage	Townscape	Water Environment	Flood Risk	People & Communities	Materials	Geology & Soils	Traffic & Transport	Notes
												concludes no significant effects on water voles.

Receptors	Air Quality	Noise & Vibration	Nature Conservation	Cultural Heritage	Townscape	Water Environment	Flood Risk	People & Communities	Materials	Geology & Soils	Traffic & Transport	Notes
Bats	N	Y	n/a	N	Y	N	N	N	N	N	N	The effects of noise and vibration have been assessed within this chapter at paragraphs 8.8.40 to 8.8.42 and 8.8.118 to 8.8.121. This concludes no significant effects on bats. Effects of lighting of the Scheme on bats have been included within the assessment in reference to Chapter 10: Townscape (see paragraphs 8.8.79 to 8.8.81 and 8.8.125 to 8.8.128). The assessment has not identified any significant effect between bats and lighting.
Breeding birds	N	Y	n/a	N	N	N	N	N	N	N	N	The effects of noise and vibration have been assessed within this chapter at paragraphs 8.8.44 to 8.8.45 and 8.8.122 to 8.8.123. This concludes no significant effects on breeding birds.

Table 8.13: Summary of Effects

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Temporary reduction in water quality through sedimentation caused by construction works within the River Yare.	Statutory sites	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Benthic ecology and fish	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Water voles	Minor - / T / D/ ST	n/a	Minor - / T / D/ ST
Contamination of watercourses through accidental spillage of fuels or chemicals, or as a result of mobilisation of existing ground contamination.	Statutory sites	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Benthic ecology and fish	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Water voles	Minor - / T / D/ ST	n/a	Minor - / T / D/ ST
Potential contamination of nearby habitats, watercourses and designated sites as a result	Statutory sites	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Benthic	Negligible	n/a	Negligible

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
of a reduction in air quality (including construction related dust).	ecology and fish	- / T / D/ ST		- / T / D/ ST
	Water voles	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
Disturbance effects of noise and vibration as a result of construction activities.	Statutory sites	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Benthic ecology and fish	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Water voles	Minor - / T / D/ ST	n/a	Minor - / T / D/ ST
	Bats	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
	Breeding birds	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
Killing, injuring and disturbance of protected species during construction.	Benthic ecology and fish	Neutral	n/a	Neutral
	Water	Moderate	Licenced conservation	Negligible

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	voles	- / T / D/ MT	protection works, receptor site enhancements, habitat permeability design, appropriate translocation where required.	- / T / D/ ST
	Breeding birds	Minor - / T / D/ ST	Landscaping designed to promote foraging opportunities for black redstart.	Negligible - / T / D/ ST
	Bats	Minor - / T / D/ MT	n/a	Minor - / T / D/ MT
Lighting used during night works (cause disturbance or severance of regular commuting routes or foraging areas).	Bats	Negligible - / T / D/ ST	n/a	Negligible - / T / D/ ST
Operational Phase				
Fragmentation of retained habitats and/or severance of wildlife corridors, foraging routes or territories.	Statutory sites	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
	Benthic ecology and fish	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	Water voles	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
	Bats	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
	Breeding birds	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
Contamination of watercourses and/or waterbodies associated with road related runoff.	Statutory sites	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
	Benthic ecology and fish	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
	Water voles	Minor - / P / D / LT	n/a	Minor - / P / D / LT
Disturbance through noise and vibration.	Statutory sites	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
	Benthic ecology and fish	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
	Water	Minor	n/a	Minor

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	voles	- / P / D / LT		- / P / D / LT
	Breeding birds	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT
Disturbance of nocturnal animals where road lighting introduces a new light source.	Bats	Negligible - / P / D / LT	n/a	Negligible - / P / D / LT

Key to table:

+ / - = Positive or Negative; P / T = Permanent or Temporary; D / I = Direct or Indirect; ST / MT / LT = Short-Term, Medium-Term or Long-Term; N/A = Not Applicable

8.11 References

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9 Cultural Heritage

9.1 Introduction

9.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Scheme upon cultural heritage. The assessment examines four topic areas:

- Archaeological assets: materials created or modified by past human activities, which include a wide range of visible and below ground artefacts, field monuments, structures and landscape features. This includes areas which have been identified as being of archaeological potential;
- Built heritage assets: architectural, designated or other structures with historical value (significance), such as listed buildings;
- The historic landscapes; and
- Palaeoenvironmental assets.

9.1.2 The chapter describes the assessment methodology, the baseline conditions at the Application Site and in the surrounding area, and any primary and tertiary mitigation adopted for the purposes of the assessment It provides a summary of the likely significant effects taking into account national legislation, and describes the further mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

9.1.3 This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES with particular reference to Chapters 10 and Appendices 9A, 9B and 9C. It is supported by Figures 9.1 to 9.3.

9.2 Competent Expert

9.2.1 The cultural heritage lead is Alexandra Grassam, who holds a BA Hons in Archaeology and Prehistory from the University of Sheffield (1999 to 2002) and a MSc Professional Archaeology from the University of Oxford (2007). She has over 15 years' experience in the production of cultural heritage assessments and environmental impact assessments.

9.2.2 The chapter has been reviewed by Sally Hales who is Member of the Chartered Institute for Archaeologists'. She has BA Hons in Archaeology and a MA in Archaeology from University College London (1991 and 1993). She has 25 years' experience in heritage consultancy.

9.3 Legislation, Policy and Guidance Summary

9.3.1 Table 9.1 provides a summary of the assessment.

9.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 9A (document reference 6.2).

Table 9.1: Summary of Policy and Guidance

Policy/ Guidance	Summary	Chapter Reference
National Policy Statement for National Networks (NPS NN) (December 2014)	The Historic Environment is referred to in paragraphs 5.120 to 5.142 of the NPS NN. Paragraphs 5.120 and 5.121 present and introduction to the historic environment and provides a definition of it. The NPS NN identifies heritage assets as "*Those elements of the historic environment that hold value to this and future generations because of their historic, archaeological, architectural or artistic interest…. Heritage assets may be buildings, monuments, sites, places, areas or landscapes. The sum of the heritage interests that a heritage asset holds is referred to as its significance. Significance derives not only from a heritage asset's physical presence, but also from its setting [Setting of a heritage asset is the surroundings in which it is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be*	This chapter identifies all designated heritage assets within a 1km study area of the boundaries of the Principal Application Site and non-designated heritage assets within a 500m area. Designated and non-designated heritage assets are identified within a 250m study area of the Satellite Application Sites (see Section 9.5). Heritage assets identified as Sensitive Receptors are identified in Section 9.6 and the assessment of Effects, Mitigation and Residual Effects are presented in Section 9.8. In accordance with the guidance set out in the DMRB, the significance of effects is guided by the value of the heritage assets and the magnitude of impact. Effects on below-ground heritage assets

Policy/ Guidance	Summary	Chapter Reference
	neutral]" (Paragraph 5.122) "*Some heritage assets have a level of significance that justifies official designation* (Paragraph 5.123). *"Non-designated heritage assets… that are demonstrably equivalent significance to Scheduled Monuments, should be considered subject to the policies for designated heritage assets"* (Paragraph 5.124) "*The Secretary of State should also consider the impacts on other non-designated heritage assets (as identified either through the development plan process by local authorities, including 'local listing', or through the nationally significant infrastructure project examination and decision making process) on the basis of clear evidence that the assets have a significance that merit consideration in that process, even though those assets are of lesser value than designated heritage assets*." (Paragraph 5.125). *"Where the development is subject to EIA the applicant should undertake an assessment of any likely significant heritage impacts of the proposed project as part of*	are assessed in adherence to DMRB guidance, which is currently the only available guidance for this topic. The Historic Environment Desk-Based Assessment (Appendix 9B (document reference 6.2)) has identified all heritage assets (both designated and non-designated) in a 500m and 1km buffer of the Principal Application Site and 250m buffer of the Satellite Application Sites and presents the value of each (Appendix 9B (document reference 6.2) Section 5 and section 6). Heritage assets were identified from data provided by the Historic Environment Record, a review of historic maps held by Norfolk Archives and as result of the site walkover. The potential impacts and effects on all heritage assets is presented in Appendix 9B (document reference 6.2) Section 7. A statement of the level of substantial harm on designated assets it presented in Appendix 9B

Policy/ Guidance	Summary	Chapter Reference
	the Environmental Impact Assessment and describe these in the environmental statement." (Paragraph 5.126) "*The applicant should describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the asset's importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant Historic Environment Record should have been consulted and the heritage assets assessed using appropriate expertise. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, the applicant should include an appropriate desk-based assessment and, where necessary, a field evaluation* (Paragraph 5.127). Paragraph 5.128 sets out the parameters for the Secretary of State to identify and assess the particular significance of any heritage asset that may be affected. *"In considering the impact of a proposed development on any heritage assets, the Secretary of State should take into account the particular nature*	(document reference 6.2), Section 8. A summary of the value, and the potential impact and effects of the Scheme on all identified heritage assets in the study areas are reported and summarised and presented in Appendix 9B, Annex A (document reference 6.2). A Written Scheme of Investigation (WSI) is presented in document reference 6.9 and outlines how the evaluation of buried heritage assets would be undertaken to ensure any heritage assets that would be lost as result of the Scheme will be recorded.

Policy/ Guidance	Summary	Chapter Reference
	of the significance of the heritage asset and the value that they hold for this and future generations. This understanding should be used to avoid or minimise conflict between their conservation and any aspect of the proposal." (Paragraph 5.129). "*The Secretary of State should take into account the desirability of sustaining and, where appropriate, enhancing the significance of heritage assets, [and] the contribution of their settings"* (Paragraph 5.130) "*When considering the impact of a proposed development on the significance of a designated heritage asset, the Secretary of State should give great weight to the asset's conservation. The more important the asset, the greater the weight should be. Once lost, heritage assets cannot be replaced and their loss has a cultural, environmental, economic and social impact. Significance can be harmed or lost through alteration or destruction of the heritage asset or development within its setting. Given that heritage assets are irreplaceable, harm or loss affecting any designated heritage asset should require clear and convincing justification. Substantial harm to or loss of a grade II Listed*	

Policy/ Guidance	Summary	Chapter Reference
	Building or a grade II Registered Park or Garden should be exceptional. Substantial harm to or loss of designated assets of the highest significance, including World Heritage Sites, Scheduled Monuments, grade I and II Listed Buildings, Registered Battlefields, and grade I and II* Registered Parks and Gardens should be wholly exceptional*." (Paragraph 5.131). "*Any harmful impact on the significance of a designated heritage asset should be weighed against the public benefit of development, recognising that the greater the harm to the significance of the heritage asset, the greater the justification that will be needed for any loss."* (Paragraph 5.132). "*Where the proposed development will lead to substantial harm to or total loss of significance of a designated heritage asset, consent should be refused unless it can be demonstrated that the substantial harm or loss of significance is necessary in order to deliver substantial public benefits that outweigh that loss or harm*." (Paragraph 5.133). "*Where the proposed development will lead to less than substantial harm to the*	

Policy/ Guidance	Summary	Chapter Reference
	significance of a designated heritage asset, this harm should be weighed against the public benefits of the proposal, including securing its optimum viable use." (Paragraph 5.134). Paragraphs 5.135 and 5.137 relate to impacts on World Heritage Sites and Conservation Areas, and Paragraph 5.138 to assets that have been damaged or neglected. None are relevant to this assessment. "*Where the loss of significance of any heritage asset has been justified by the applicant based on the merits of the new development and the significance of the asset in question, the Secretary of State should consider imposing a requirement that the applicant will prevent the loss occurring until the relevant development or part of development has commenced"* (Paragraph 5.136). "*A documentary record of our past is not as valuable as retaining the heritage asset and therefore the ability to record evidence of the asset should not be a factor in deciding whether consent should be given*" (Paragraph 5.139).	

Policy/ Guidance	Summary	Chapter Reference
	"*Where the loss of the whole or part of a heritage asset's significance is justified, the Secretary of State should require the applicant to record and advance understanding of the significance of the heritage asset before it is lost (wholly or in part). The extent of the requirement should be proportionate to the importance and the impact*." (Paragraph 5.140) "*The Secretary of State may add requirements to the development consent order to ensure that this is undertaken in a timely manner in accordance with a WSI that meets the requirements of this section and has been agreed in writing with the relevant Local Authority (or, where the development is in English waters, with the Marine Management Organisation and English Heritage) and that the completion of the exercise is properly secured*." (Paragraph 5.141). "*Where there is a high probability that a development site may include as yet undiscovered heritage assets with archaeological interest, the Secretary of State should consider requirements to ensure that appropriate procedures are in place for the identification and treatment of such assets discovered during construction*." (Paragraph	

Policy/ Guidance	Summary	Chapter Reference
	5.142).	
National Planning Policy Framework (NPPF) (February 2019)	The Government issued the revised NPPF in February 2019 and further guidance is provided in the Planning Policy Guidance. Chapter 16 brings together the way plan making and decision making should adopt a positive strategy to ensure the conservation and enjoyment of the historic environment and how to approach consideration of the potential impacts of development on such assets. The NPPF supports and replicates the policies set out in NPS NN and are not repeated here.	Chapter 9 Cultural Heritage identifies all designated heritage assets within a 1km study area of the boundaries of the Principal Application Site and non-designated heritage assets within a 500m area. Designated and non-designated heritage assets are identified within a 250m study area of the Satellite Application Sites (*see Section 9.5*). Heritage assets identified as Sensitive Receptors are identified in *Section 9.6* and the assessment of Effects, Mitigation and Residual Effects are presented in *Section 9.8*. In accordance to the guidance set in the DMRB, the significance of effects is guided by the value of the heritage assets and the magnitude of impact. Effects on below-ground heritage assets are assessed in adherence to DMRB guidance, which is currently the only available guidance for this topic.

Policy/ Guidance	Summary	Chapter Reference
		The Historic Environment Desk-Based Assessment (Appendix 9B (document reference 6.2)) has identified all heritage assets (both designated and non-designated) in a 500m and 1km buffer of the Principal Application Site and 250m buffer of the Satellite Application Sites and presents the value of each (Appendix 9B Section 5 and section 6 (document reference 6.2)). The potential impacts and effects on all heritage assets is presented in Appendix 9B Section 7. A statement of the level of substantial harm on designated assets it presented in Appendix 9B (document reference 6.2), Section 8. A summary of the value, and the potential impact and effects of the Scheme on all identified heritage assets in the study areas are reported and summarised and presented in Appendix 9B, Annex A (document reference 6.2). A WSI is presented in document reference 6.9 and outlines how

Policy/ Guidance	Summary	Chapter Reference
		the evaluation of buried heritage assets would be undertaken to ensure any heritage assets that would be lost as result of the Scheme will be recorded.
National Policy Statement for Ports	The NPS for Ports states the requirements for Port and related infrastructure. It follows closely the NPS NN and NPPF and requires the applicant to provide a description of the significance of affected heritage assets affected by a scheme and the level of detail should be proportionate to the importance of the heritage asset.	Chapter 9 Cultural Heritage identifies all designated heritage assets within a 1km study area of the boundaries of the Principal Application Site and non-designated heritage assets within a 500m area. Designated and non-designated heritage assets are identified within a 250m study area of the Satellite Application Sites (see Section 9.5). Heritage assets identified as Sensitive Receptors are identified in Section 9.6 and the assessment of Effects, Mitigation and Residual Effects are presented in Section 9.8. In accordance to the guidance set in the DMRB, the significance of effects is guided by the value of the heritage assets and the magnitude of impact.

Policy/ Guidance	Summary	Chapter Reference
		Effects on below-ground heritage assets are assessed in adherence to DMRB guidance, which is currently the only available guidance for this topic. The Historic Environment Desk-Based Assessment (Appendix 9B (document reference 6.2)) has identified all heritage assets (both designated and non-designated) in a 500m and 1km buffer of the Principal Application Site and 250m buffer of the Satellite Application Sites and presents the value of each (Appendix 9B Section 5 and Section 6 (document reference 6.2)). The potential impacts and effects on all heritage assets is presented in Appendix 9B, Section 7 (document reference 6.2). A statement of the level of substantial harm on designated assets it presented in Appendix 9B, Section 8 (document reference 6.2). A summary of the value, and the potential impact and effects of the Scheme on all identified heritage assets in the study

Policy/ Guidance	Summary	Chapter Reference
		areas are reported and summarised and presented in Appendix 9B, Annex A (document reference 6.2). A WSI is presented in document reference 6.9 and outlines how the evaluation of buried heritage assets would be undertaken to ensure any heritage assets that would be lost as result of the Scheme will be recorded.
DMRB, Volume 11, Section 3, Part 2; Appendix 8 (DMRB: HA208/07)	The advice note sets out the framework for the environmental assessment process in relation to cultural heritage. The resource is sub-divided into three sub-topics: archaeological remains, historic buildings and historic landscapes (set out in detail in Annexes 5, 6 and 7). The guidance sets out the mechanism for assessing value/importance of assets, magnitudes of impacts and resultant significance of effects.	The chapter follows the assessment framework set out in the DMRB for cultural heritage. The methodology for assessment used in this chapter is outlined in Section 9.4.
Historic England The Setting of Heritage Assets Historic Environment Good Practice Advice in Planning Policy Notes 3 (second edition)	The purpose of the good practice advice is to give assistance and provide guidance concerning the assessment of the setting of heritage assets. It states the statutory obligation on decision-makers to have special regard to the	The approach to assessment of settings and the impacts and effects on heritage assets follows the guidance provided in the document.

Policy/ Guidance	Summary	Chapter Reference
	desirability of preserving listed buildings and their settings. It also sets out the policy objectives in respect to NPPF.	The guidance has been used to adopt a stepped approach for settings assessment, which is presented as a summary in Section 9.4 and in detail in Appendix 9B, Annex C (document reference 6.2).

9.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

9.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

9.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

9.4.3 Table 9.2 and 9.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 9.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
The Inspectorate notes the potential for impacts on buried archaeological resources. Where relevant, the ES should take into account guidance contained in Historic England's guidance documents 'Preserving Archaeological Remains'3. Note also Historic	PINS ID2	The assessment has taken into account the Historic England guidance documents as requested (Appendix 9A) (document reference 6.2). The guidance will be more relevant after the archaeological evaluations set out in the WSI (document reference 6.9) have concluded and to inform any subsequent programmes of mitigation.

Scoping Opinion Item	Consultee	Response
England's revised Good Practice Advice note 3 'The Setting of Heritage Assets'.		
No justification is given for the extent of the study area used to assess the baseline conditions in the Scoping Report. Paragraph 6.5.23 of the Scoping Report explains what factors will be taken into account to derive the study area for the ES; however, no specific extent(s) are proposed in this paragraph. Paragraph 6.5.1 of the Scoping Report and Appendix G (Heritage Desk Study) describe two study areas: 500m for non-designated assets and 1km for designated assets. Figure 3 (Environmental Constraints Plan) identifies listed buildings and scheduled monuments within 2km. The ES should provide a robust justification as to why the chosen study area is appropriate and sufficient to capture all heritage assets which could experience impacts, including impacts on setting – taking into account for example, visual intrusion and or increased noise emissions. The chosen study area(s) should also be clearly	PINS ID3	The study area for designated heritage assets is 1km around the Principal Application Site and 500m for non-designated heritage assets. A study area of 250m has been applied around the Satellite Application Sites for designated and non-designated heritage assets. These study areas were presented in the Scoping Report and in the PEIR and have attracted no comments. The extent of the 1km study area was reviewed against the Zone of Theoretical Visibility (Figure 10.2) and during the site walk over survey. It was judged that due to the broadly level topography in the wider area, the distance and all the intervening visual barriers, no designated assets beyond the 1km Study Area would be adversely impacted through a change in setting. A search of the Norfolk Historic Environment Record (NHER) for a 500m study area returned 135 non-designated heritage assets, comprising of find-spots, monuments and built heritage assets. The quantity of data to inform the baseline was judged to be appropriate in order to adequately identify all buried heritage assets within the Principal Application Site and to be able to assess the potential for additional currently unknown assets based on the evidence from the surrounding environment. Due to the small size and scale of the

Scoping Opinion Item	Consultee	Response
defined in the ES. Effort should be made to seek agreement with relevant consultation bodies regarding the appropriate study area.		VMS that would be installed in the Satellite Application Site and the limited potential for ground disturbance associated with their construction, the 250m study area is judged to have provided sufficient baseline data in order to fully assess the potential impacts and effects.
The baseline data on non-designated heritage assets appears to have been drawn from the Norfolk Heritage Explorer, an online abridged version of the Norfolk Historic Environment Record. This is an incomplete selected dataset and is not suitable for use in the planning process. The Cultural Heritage desk-based assessment to be included within the ES must derive the baseline data from the full and unabridged Norfolk Historic Environment Record.	PINS ID4	A full search of the NHER database was undertaken in May 2018 for the unabridged records to support the updated Historic Desk-Based Assessment. An additional search of the NHER database was undertaken in February 2019 for records around the Satellite Application Sites.
The Cultural Heritage aspect chapter of the ES should identify appropriate heritage-specific viewpoints/receptors and include an assessment of visual impacts on designated heritage assets. Any visualisations required for this assessment but produced as part of the Townscape and Visual Impact assessment should be clearly cross-referenced in the Cultural Heritage aspect chapter. The	PINS ID5	Chapter 9: Cultural Heritage identifies three shared viewpoints with Chapter 10: Townscape and Visual. Viewpoint 8 assesses views close to the Grade II Listed Building Gas Holder, Viewpoint 10 from the Gorleston Extension Conservation Area and Viewpoint 11 from the North Quay South Quay Conservation Area. These were agreed with the NCC's Acting Historic Environment Team Leader (Strategy and Advice) (as noted in Table 9.4). The Cultural Heritage Walkover over survey extended over a 1km boundary around the boundary of the Principal

Scoping Opinion Item	Consultee	Response
authors of both aspect chapters should ensure the selected viewpoints and any visualisations are appropriate for the purposes of the impact assessment. Efforts should be made to agree viewpoints with relevant consultation bodies, including GYBC and NCC's Historic Environment Team. In addition to visual impacts, the Scoping Report acknowledges that there may be adverse effects on settings due to an increase in noise associated with the Proposed Development. However, the ES should also describe and assess other environmental factors arising from the Proposed Development **that may affect the settings of cultural heritage assets, for example lighting and traffic. Appropriat**e cross-referencing to the information and assessments contained in other relevant aspect chapters of the ES should be included in the Cultural Heritage aspect chapter.		Application Site. The locations of designated heritage assets and views back towards the Principal Application Site were assessed from street level and from Public Rights of Way. The Cultural Heritage Assessment was undertaken in reference to the Zone of Theoretical Influence model (Figure 10.2) which has established where the Scheme would be visible when both the bridge is both open and closed. Chapter 9: Cultural Heritage has taken account of other environmental factors arising from the Scheme assessed and reported elsewhere in the ES (see paragraph 9.4.29).
The Scoping Report does not clearly state whether all fieldwork described will be undertaken to inform the ES, as a number of recommendations/ options	PINS ID6	Intrusive field work in the form of an evaluation is not feasible at this stage due to the Scheme containing properties, highways and a working port area. The constraints have been outlined with NCC as part of the

Scoping Opinion Item	Consultee	Response
are included. It is noted that Section 8 of Appendix G to the Scoping Report also includes further recommendations, including fieldwork. The scope and methodology of any archaeological investigations undertaken to inform the impact assessment should be detailed in the ES and/or associated Technical Appendix. The Applicant should also seek agreement with Norfolk Historic Environment Team regarding any intrusive archaeological surveys.		consultation and there is an agreement to postpone the evaluation to post-consent and pre-construction. The approach to the scope of the evaluation is presented in the WSI (document reference 6.9) and secured in Requirement 12, Schedule 2 of the draft DCO (document reference 3.1).
The Inspectorate acknowledges the use of DMRB guidance to assign significance as per Table 25 of the Scoping Report. However, the ES must make clear in each case whether any residual effect is deemed to be 'significant' or 'not significant'. Where professional judgement has been used to determine significance, this should be stated.	PINS ID7	The Historic Environment Desk-Based Assessment (HEDBA) assesses and presents the impacts and effects on all heritage assets, regardless of whether they are 'significant' or 'not significant', both before and after mitigation. Chapter 9 summarises relevant information and identifies both 'significant' or 'not significant' effects.

Table 9.3: *Summary of Section 42 Responses Received*

Section 42 Item	Consultee	Response
The impact of the height of the bridge (in both a closed and open position) on the significance of the monument should be considered. It would be	Historic England	The assessment has assessed the impact of the bridge in both the closed and open position (Section 9.8, Appendix 9B, Section 8.5 (document reference 6.2)). The assessment has utilised the Zone of Theoretical

Section 42 Item	Consultee	Response
helpful for the impact of both bridge design options to be assessed against the listed heritage assets that have been suggested as being potentially affected. The design should aim to avoid or minimise any harm in line with planning policy. The scale and size of the proposed bridge and associated work would give it a greater prominence. The visual impact of this needs to be fully assessed and it is not possible to do this until the photomontages have been produced illustrating the view of the bridge from around the surrounding heritage assets.		Influence model. This modelled the potential visibility of the scheme and the bridge in both the open and closed position up to 2km from the Principal Application Site (see Chapter 10: Townscape and Visual). The results are supported by the walkover survey.
We would suggest that a number of additional viewpoints are included from: St Nicholas Hospital, from the southern end of the Seafront Conservation Area and views from both up and down the River Yare. In line with the advice in the National Planning Policy Framework (NPPF), we would expect a thorough assessment of the likely effects which the proposed development might have upon those elements which contribute to the significance of these assets.	Historic England	The location of the St Nicholas' Hospital and the Seafront Conservation Area (including the southern end) was visited in August 2018 and views from these locations back to the Principal Application Site were assessed. The views both up and down the River Yare (from the western bank in Principal Application Site, and from points north in Great Yarmouth and south towards Gorleston) were also assessed during the site visit in August. An assessment of the impact on St Nicholas' Hospital is provided in the HEDBA (Appendix 9B (document reference 6.2)). There was no intervisibility in views identified from the southern end of the Seafront Conservation Area.

Section 42 Item	Consultee	Response
		Where relevant to specific heritage assets, the views up and down the River Yare are reported in the chapter and the HEDBA (in relation to the impacts on the North Quay South Quay Conservation Areas).
Paragraph 9.4.10 mentions that the remains of boats dating to the Medieval period were found approximately 3m below the current ground level, indicating that there is potential for buried medieval deposits to survive within the area of the proposed development. It is important to note that geophysical survey techniques cannot readily identify buried wooden remains such as boats.	Historic England	The WSI (document reference 6.9) sets out the requirement for a programme of archaeological evaluation in the form of trial trench evaluation and additional geoarchaeological assessments. Due to the urban environment and high potential for deeply stratified remains, geophysical survey is not proposed.
Paragraph 9.4.27 states that minerogenic alluvial deposits are of low palaeoenvironmental potential. Although this is largely true for organic remains, these deposits can preserve micro-remains such as foraminifera and ostracods that can help to place the changes in the landscape into context by providing information about past water temperatures, water quality and salinity. It would be useful to state if this information is of value for the deposits in question.	Historic England	The minerogenic alluvial deposits are reported in this chapter as the Breydon Formation – alluvium (Holocene). Table 9.10 records the deposit as of medium geoarchaeological potential. It has been identified as a potential sensitive receptor (see Section 9.6) and the potential effects are reported in Section 9.8.

Section 42 Item	Consultee	Response
Paragraph 9.5.18 discusses the potential for palaeoenvironmental remains of interest to be impacted by the proposed development, and it was stated that the foundations for the bascule bridge would fully penetrate the Holocene and late Pleistocene deposits. It is stated that where necessary, archaeological recording of selected retained or new core samples will be undertaken following the desk-based assessment. This approach is sensible, allowing existing information to be reviewed in the first instance in order to identify any gaps in the understanding, before new cores can then be collected and assessed.	Historic England	The WSI (document reference 6.9) sets out the requirement for a programme of archaeological evaluation in the form of trial trench evaluation and additional geoarchaeological assessments. This will be supplemented by detailed method statements to be produced in consultation with NCC's Archaeology Team and Historic England.
It is noted in paragraph 9.6.3 that intrusive investigations will be challenging in and around the River Yare due to the waterlogged conditions and depths of deposits. We would suggest a programme of borehole collection/assessment and deposit modelling combined with the palaeoenvironmental mitigation would provide useful information to investigate the archaeological potential in	Historic England	The WSI (document reference 6.9) sets out the requirement for a programme of archaeological evaluation in the form of trial trench evaluation and additional geoarchaeological borehole collection/assessments. This will be supplemented by detailed method statements to be produced in consultation with NCC's Archaeology Team and Historic England.

Section 42 Item	Consultee	Response
this area.		
We agree with the statements asserted in paragraphs 9.4.31 states that where peat deposits are present they will be of high geoarchaeological potential and 9.4.52 states that there is reasonable potential to uncover previously unknown heritage assets within the study area, and if discovered these assets would be of up to high value. This document does not mention that there will be the potential to collect new cores for archaeological assessments, which was stated in the main PEIR document in Section 9.5.18. The position of geotechnical cores will relate to the engineering requirements and not specifically archaeology. Additional cores may be required to fill in the gaps in the understanding to ensure that the impact of the proposed development is mitigated. A separate method statement will also be needed, presenting the techniques, approaches and materials that will be assessed if deposits of archaeological interest are encountered, both in terms of the palaeoenvironmental remains and dating	Historic England	The WSI (document reference 6.9) sets out the requirement for a programme of archaeological evaluation in the form of trial trench evaluation and additional geoarchaeological borehole collection/assessments. This will be supplemented by detailed method statements to be produced in consultation with NCC's Archaeology Team and Historic England.

Section 42 Item	Consultee	Response
techniques that can be applied.		

9.4.4 Table 9.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

9.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 9.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
NCC	Acting Historic Environment Team Leader (Strategy and Advice)	15/10/218 – Meeting via telephone to discuss scope of assessments require, to identify any additional assets which require scoping in for assessment following submission of the scoping report and the approach to intrusive evaluations	The scope of the assessment work was discussed, focusing on the assets which require assessment. Additional non-designated built heritage assets within the Principal Application Site were scoped in for assessment. There was also a discussion on the timescales for any intrusive investigation work and it was agreed that in this instance this could be undertaken post-decision if the DCO is made, given the constraints of the site.
NCC	Acting Historic Environment Team Leader (Strategy and Advice)	19/02/2019 – via email, response to review of updated HEDBA	NCC stated in the email that "[t]*he revised DBA rightly acknowledges that there is potential for buried archaeological and palaeoenvironmental remains but that the potential and significance of these is difficult/impossible to fully*

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			determine at present. However, I think it would be worth stating a bit more clearly in the relevant sections of the DBA that the potential below-ground archaeological remains could include wooden structural remains associated with former river frontages and/or maritime vessel remains associated within the former river channel. It is certainly worth making reference to this in Section 1.5 as this currently reads as though there isn't really any potential for pre-19th century buried archaeological remains. *The assessment of the impact on the setting of designated heritage assets is appropriate given the currently available information but may need to be reviewed once the design of the bridge structure is finalised*". The comments received from NCC have been accepted and addressed in the final version of the HEDBA.
Historic England	Assistant	08/03/2019 –	The letter provides

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
	Inspector of Historic Buildings and Areas	letter attached to email, response to review of updated HEDBA	detailed comments on the archaeology and Historic Built Environment. It is also repeats comments provided in response to S42 Responses (see Table 9.3). The additional key points raised are as follows. The potential for archaeological deposits to be found in the Happisburgh Glacigenic Formation is low, but it should be noted that if found they have the potential to be of high or very high significance. The palaeoenvironmental potential of the Breydon Formation alluvial deposits discussed in Section 4.7.8 should also be considered as alluvial deposits have the potential to preserve information about past climate and environmental change as well as the source, quality and temperature of the water, as evidence through the presence of micro-remains (e.g. diatoms, foraminifera). Any Palaeolithic remains that are discovered have the potential to be of very high (internationally

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			significant). The potential for the preservation of organic remains, structures and deposits needs to be considered (e.g. fish traps, boats, timbers posts, trackways). The letter also notes that the significance of heritage assets "*has been identified however, we are concerned that due to the bridge design not being finalised that the impact cannot be fully assessed and that some of the conclusions drawn are premature*." The HEDBA was completed following the setting of the design parameters for the bridge design. The impacts and effects reported in Chapter 9 and in Appendix 9B (document reference 6.2) are based on the assessment of the parameters for the bridge design set out in Chapter 2.

Insignificant Effects

9.4.6 The HEDBA has assessed the value, impacts and effects on all heritage assets in relation to the Scheme (Appendix 9B (document reference 6.2)). Based on the assessment, the following effects on receptors have been

identified as insignificant and have therefore not been assessed further in this Chapter:

- Effects from direct physical impacts on the following below ground non-designated heritage assets within the Principal Application Site: The Route of Norfolk and Suffolk Joint Railway (HER 13575), Routes of Great Yarmouth urban railways (HER 13576), Site of World War II defences (HER 27697), Site of a 20th century timber yard and saw mill (WSP15), Site of World War II craters (HER 27700, 43589, and 43741), Site of World War II anti invasion defences at Southtown (HER 42355 and 42353); and Site of World War II road blocks (HER 43304). The sensitivity of these assets is negligible and while the magnitude of change would be major, the effect would be direct, permanent, long-term **slight adverse** (**not significant**) during construction;

- Effects on the setting of the Grade II Listed Dolphin Public House (NHLE 1096829). The asset is located outside of the Principal Application Site and there will be no direct physical impacts. The assessment of the setting has concluded it represents a negligible contribution to the value of the asset. The sensitivity of the asset is medium and the magnitude of change negligible, therefore there will be a **neutral** effect during construction and operation;

- Effects on the setting of the Grade II Scenic Railway Roller Coaster at Great Yarmouth (NHLE 1436976). Due to the distance (c. 600m) and presence of buildings between the Principal Application Site and the Rollercoaster, the two are not intervisible at ground level, where the setting is judged to be significant. The Scheme would be visible during the operation of the Roller Coaster; however, the views are fleeting and are combined with many other landmarks across the town. These views are not judged to contribute to the significance of the asset. The sensitivity of the asset is medium and the magnitude of change negligible, therefore there will be a **neutral** effect during construction and operation;

- Effects on the setting of the St Nicholas Hospital Block Asset Group (Grade II* Listed Buildings NHLE 1245983 and 1245984, and Grade II Listed Buildings 1245982, 1245985 and 1245986). The impact of the Scheme during the operation period is judged to be negligible due to very limited intervisibility. The elements that are potentially visible would not change the setting in a way that would alter the contribution of the setting to the importance of the asset group. The sensitivity of the assets are high and the magnitude of change slight adverse, therefore there will be a direct, temporary, short-term **slight adverse (not significant)** effect during construction. During operation, the magnitude of change would be direct, permanent, long-term negligible, however the effects would remain **slight adverse (not significant)** due to their high value;

- Effects on the setting of the Camperdown Conservation Area. The occasional visibility of the bridge when it is raised would not impact on the elements of the setting which contribute to the importance of the Camperdown Conservation Area. The sensitivity of the asset is medium and the magnitude of change during construction negligible, and no-change during operation. The effects would be **neutral**;

- Effects on the setting of the Hall Quay South Quay Conservation Area. The boundary of the Hall Quay South Quay Conservation Area is located approximately 900m from the Principal Application Site. The operation of the Scheme will result in a minor change in a one of 11 key views from the Conservation Area, south from Hall Quay South Quay Road along the River Yare. The Scheme would not visible from anywhere else within the Conservation Area. The Scheme will not impact on the elements of the setting of the Conservation Area which contribute to its value, and some beneficial impacts will be delivered due to the reduction in traffic volumes using Hall Quay and South Quay. As such, the impact is judged to be negligible. The sensitivity of the asset is high and the magnitude of change during construction and operation negligible, therefore there will be a direct, permanent, long-term **slight adverse (not significant)** effect;

- Effects on the setting of the Gorleston Extension Conservation Area. The sensitivity of the asset is medium and the magnitude of change negligible during construction and operation. Therefore, the effects would therefore be **neutral**;

- Effects on the setting of the non-designated Fish Wharf 1877 Extension Building (WSP01). The sensitivity of the asset is low and the magnitude of change during construction and operation negligible. Therefore, the effects would therefore be **neutral**;

- Effects on the setting of the non-designated late 19th century terraces off Southtown Road (WSP03) and St Anne's Road (WSP05). The assets are of low sensitivity and the magnitude of change minor adverse. Therefore, the significance of effect is **slight adverse (not significant)**;

- Effects resulting from the installation of VMS in Satellite Application Sites. The Satellite Application Site on North Quay is located 30m from an extant section of the Scheduled Monument, although the due to size of the VMS compared to the monument, the impacts on the setting are judged to be minor. The sensitivity of the asset is high and the magnitude of change minor during construction and operation. Therefore, the effects would therefore be direct, permanent, long-term **slight adverse** (**not significant**). The Grade I Listed Building The Tolhouse (NHLE 1245560) is located approximately 50m from the Satellite Application Site on Yarmouth Way. The position of the VMS would result limited intervisibility between the asset and the VMS and there will be negligible impact on the

setting of Grade I Listed Building. As the sensitivity of the asset is high and the magnitude of change negligible, the effects would be direct, permanent, long-term **slight adverse** (**not significant**). The sensitivity of the non-designated assets below ground assets predicted to be present within the Satellite Application Sites vary from medium to negligible, however the impacts are anticipated to be minor to negligible due to the limited amount of the ground disturbance required for the installation of VMS and the likelihood that the locations have already been disturbed. The effects are likely to be **neutral** to direct, permanent, long-term **slight adverse** (**not significant**); and

- Effects on the Historic Landscape Character. The Historic Landscape Character is of late-19th century to modern date and is of low to negligible value. The magnitude of change would be minor and the effects would be direct, permanent, long-term **slight adverse** (**not significant**).

Likely Significant Effects

Construction Phase

9.4.7 The following likely significant effects have been assessed in this chapter:

- Effects on non-designated below ground heritage assets in the Principal Application Site from a loss of all or part of the assets (Site of late 19th century icehouse and three salt stores (HER 55685), Wharf side Buildings (WSP09), Site of late 19th century Fish Wharf (WSP10), The Site of three buildings on west side of Southtown Road (WSP11, WSP12 and WSP13), Site of 19th century house (WSP08) and Site of Marsh House (WSP14));
- Effects on currently unknown below ground heritage assets in the Principal Application Site;
- Effects on Paleoenvironmental deposits in the Principal Application Site;
- Effects on two non-designated built heritage assets within the Principal Application Site (Late 19th century terraced buildings on Queen Anne's Road (WSP04) and Southtown Road (WSP06)); and
- Effects on the setting of two designated heritage assets outside of the Principal Application Site (The Grade I listed Nelson's Monument (NHLE 1246057) and Grade II Listed Gas Holder (NHLE 1096789)).

Operational Phase

9.4.8 The following likely significant effects that have been assessed in this chapter:

- Effects on below ground assets and palaeoenvironmental remains due to a change in hydrology; and
- Effects on the setting of two designated heritage assets outside of the Principal Application Site (The Grade I listed Nelson's Monument (NHLE 1246057) and Grade II Listed Gas Holder (NHLE 1096789)).

Extent of the Study Area

9.4.9 The study area which has been adopted for the assessment of cultural heritage features extends to:

- 1km around the Principal Application Site for designated heritage assets (World Heritage Sites, Scheduled Monuments, Listed Buildings, Registered Park and Gardens, Registered Battlefields and Conservation Areas), presented in Figure 9.1;
- 500m around the Principal Application Site for non-designated heritage assets, presented in Figure 9.2; and
- 250m around the Satellite Application Site for designated and non-designated heritage assets presented in Figures 9.1 and 9.2.

9.4.10 The extent of the 1km study area was reviewed against the Zone of Theoretical Visibility (Figure 10.2) and during the site walk over survey. It was judged that due to the broadly level topography in the wider area, the distance and all the intervening visual barriers, no designated assets beyond the 1km Study Area would be adversely impacted through a change in setting.

9.4.11 A search of the NHER for a 500m Study Area returned 135 non-designated heritage assets, comprising of findspots, monuments and built heritage assets. The quantity of data to inform the baseline was judged to be appropriate in order to adequately identify all below ground heritage assets within the Principal Application Site and to be able to assess the potential for additional currently unknown assets based on the evidence from the surrounding environment based on knowledge and experience of similar schemes.

9.4.12 Due to the small size and scale of the VMS that would be installed in the Satellite Application Site and the limited potential for ground disturbance associated with their construction, the 250m Study Area is judged to have provided sufficient baseline data in order to fully assess the potential impacts and effects based on experience of similar schemes.

Method of Baseline Data Collation

Desk Study

9.4.13 The identification and description of the baseline environment has used data from the following sources:

- Data has been gathered on designated heritage assets from the National Heritage List for England (NHLE);
- Full and unabridged details of non-designated heritage assets have been gathered from the NHER;
- Information on Conservation Areas held by Great Yarmouth Borough Council (Ref 26.10);
- A preliminary assessment of the potential of the study area presented in the HEDBA (WSP 2017);
- A detailed HEDBA, presented in Appendix 9B (document reference 6.2); and
- Geoarchaeological Study (Wessex Archaeology 2018), presented in Appendix 9C (document reference 6.2).

Site Visit

9.4.14 A site visit was undertaken on the 31st July and 1st August 2018. The purpose of the site visit was to establish if there are any currently unrecorded heritage assets within the Scheme footprint and to undertake an assessment of the impact of the Scheme on the settings of heritage assets both in the Scheme and in a 1km study area. The locations of the VMS were also visited.

Geoarchaeological Assessment

9.4.15 A geoarchaeological borehole review and deposit modelling was undertaken by Wessex Archaeology in September 2018. The aim of the review was to identify any potentially important geological deposits of archaeological value. The report is presented in Appendix 9C (document reference 6.2).

Assessment Methodology

9.4.16 The assessment has involved reference to Annexes 5, 6 and 7 of the DMRB, HA208/07 (Ref. 9.1) including consideration of the value of cultural heritage assets, examination of the magnitude of impact and assessment of the significance of effect of the Scheme. A separate methodology is applied for the assessment of settings, which is set out in detail below.

Significance Criteria

9.4.17 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Scheme and the sensitivity of the affected receptor, as well as a number of other factors that are outlined in more detail in Chapter 4: Approach to EIA.

Value of Cultural Heritage Assets

9.4.18 Assessment of the value of cultural heritage assets has involved consideration of the heritage interest of the asset to this and future generations. That interest may be archaeological, architectural, artistic or historic, and may derive not only from the asset's physical presence, but also from its setting, and from individual or group qualities, either directly or potentially. These are professional judgements based on experience of similar schemes, but they are also guided by legislation, national policies, acknowledged standards, designations, criteria and priorities. The assessment of value (also referred to as significance) was undertaken in line with DMRB guidance (Ref. 9.1), and in compliance with the NPS NN (Ref. 9.2) and the NPPF (Ref. 9.3) and the relevant professional guidelines set out in Appendix 9A (document reference 6.2).

9.4.19 The DMRB recommends the adoption of six ratings for value in relation to archaeological remains and built heritage: very high, high, medium, low, negligible and unknown. Definitions for each rating are outlined in Table 9.5.

Table 9.5: Factors for Assessing the Value of Heritage Assets

Value/ Sensitivity	Criteria: Built Heritage	Criteria: Archaeology
Very High	• Structures inscribed as of universal importance as World Heritage Sites; • Other buildings of recognised international importance.	• World Heritage Sites (including nominated sites); • Assets of acknowledged international importance; • Assets that can contribute significantly to acknowledged international research objectives.

Value/ Sensitivity	Criteria: Built Heritage	Criteria: Archaeology
High	• Scheduled Monuments with standing remains; • Grade I and II* Listed Buildings; • Other listed buildings that can be shown to have exceptional qualities in their fabric or historical associations not adequately reflected in the category; • Conservation Areas containing very important buildings; • Undesignated structures of clear national importance.	• Scheduled Monuments (including proposed sites); • Undesignated assets of schedulable quality and importance; • Assets that can contribute significantly to acknowledged national research objectives.
Medium	• Grade II Listed Buildings; • Historic (unlisted) buildings that can be shown to have exceptional qualities in their fabric or historical associations; • Conservation Areas containing buildings which contribute significantly to their historic character; • Historic Townscape or built-up areas with important historic integrity in their buildings, or built settings (e.g. including street furniture and other structures).	• Designated or undesignated assets that contribute to regional research objectives.
Low	• Locally Listed Buildings; • Historic (unlisted) buildings of modest quality in their fabric or historical association; • Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings (e.g.	• Designated and undesignated assets of local importance; • Assets compromised by poor preservation and/or poor survival of contextual associations;

Value/ Sensitivity	Criteria: Built Heritage	Criteria: Archaeology
	including street furniture and other structures).	• Assets of limited value, but with potential to contribute to local research objectives.
Negligible	• Buildings of no architectural or historical note; buildings of an intrusive character.	• Assets with very little or no surviving archaeological interest.
Unknown	• Buildings with some hidden (i.e. inaccessible) potential for historic significance.	• The value of the Site has not been ascertained.

Magnitude of Impact

9.4.20 Assessment of the magnitude of impact of the Scheme on cultural heritage assets has considered the degree of change that would be experienced by the asset and its setting if the Scheme were to be completed as compared with a 'do nothing' situation.

9.4.21 The DMRB recommends the adoption of five ratings for magnitude of impact: no change, negligible, minor adverse, moderate and major. Factors for assessing the magnitude of impact are summarised in Table 9.6.

Table 9.6: Factors for Assessing the Magnitude of Impact

Magnitude of Impact	Example
Major	Change to most or all aspects of a cultural heritage asset, such that the resource is totally altered. Comprehensive changes to setting.
Moderate	Clear alteration to many aspects of a cultural heritage asset. Considerable change to setting that affect the character of the asset.
Minor	Slight alteration to cultural heritage asset. Sight alteration to setting.
Negligible	Very minor changes to cultural heritage assets and their setting.
No Change	No change to cultural heritage assets and their setting.

Setting Assessment

9.4.22 In order to determine the magnitude of impact and the significance of effects on a heritage asset due to a change in setting during construction and operation, an assessment is required in order to determine how the setting contributes to the significance of the heritage asset.

9.4.23 The definition of setting used here is taken from the NN NPS (see footnote 96) and the NPPF: "*The surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral".*' Historic England in their Setting of Heritage Assets: Historic Environment Good Practice Advice in Planning (Ref. 9.4) that the importance of setting lies in what it contributes to the significance of the heritage asset. This depends on a wide range of physical elements within, as well as perceptual and associational attributes pertaining to, the heritage asset's surroundings.

9.4.24 Historic England discusses several other general considerations including: cumulative change; change over time; appreciating setting; below ground assets and setting; designated settings; setting and urban design; and setting and economic and social viability and has provided a stepped approach to the assessment and importance of setting to heritage assets. Following Step 1, which is the initial identification of the heritage assets the subsequent steps comprise:

- Step 2: Assessing whether, how and to what degree the settings make a contribution to the cultural heritage significance of the heritage assets.
- Step 3: Assessing the effect of a proposed development on the setting, and the resulting implications for the cultural heritage significance of the heritage asset(s).
- Step 4: Maximising enhancement and minimising harm (mitigation).

9.4.25 Step 2: In assessing whether, how and to what degree the settings make a contribution to the cultural heritage significance of the heritage assets, a number of potential attributes of a setting are considered.

9.4.26 The attributes of setting contribute to its sensitivity and its contribution to the significance of the asset. Table 9.7 presents examples of definitions for the sensitivity of settings but these should not be seen as exhaustive.

Table 9.7: Step 2 - Definitions of Sensitivity for the Settings of Heritage Assets

Examples of Sensitivity of Settings	Contribution to Significance of the Asset
A defined setting that is contemporary with and historically and functionally linked with the heritage asset, may contain other heritage assets of international or national importance, has a very high degree of indivisibility with the asset and makes a very substantial contribution to both the significance of the heritage asset and to the understanding and appreciation of the significance of the asset	Very substantial (very high)
Contemporary with and historically and functionally linked with the heritage asset, with minor alterations (in extent and/or character), has a high degree of intervisibility with the asset and which makes a substantial contribution to both the significance of the heritage asset and to the understanding and appreciation of the significance of the asset.	Substantial (high)
Contemporary with and/or historically and/or functionally linked with the heritage asset but with alterations which may detract from the understanding of the heritage asset, and/or with a moderate degree of indivisibility with the asset and/or which makes a moderate contribution to the significance of the heritage asset and/or a moderate contribution to the understanding and appreciation of the significance of the asset.	Moderate (medium)
Largely altered so that there is very little evidence of contemporaneous and/or historic and/or functional links with the heritage asset, and/or with a low degree of intervisibility with the asset and/or which makes a minor contribution to both the significance of the heritage asset and to the understanding and appreciation of the significance of the asset.	Minor (low)

9.4.27 Step 3: Having assessed the contribution of the setting to the cultural heritage significance of the asset, the effect of a proposed development on the setting is determined by consideration of the potential attributes of a proposed development affecting setting. The attributes of the Scheme considered include, but are not limited to the following:

- The location and siting of the Scheme:
  - Proximity to asset;
  - Extent;
  - Position in relation to landform;

- Degree to which location will physically or visually isolate asset;
- Position in relation to key views.

- The form and appearance of the Scheme:
  - Prominence, dominance, or conspicuousness;
  - Competition with or distraction from the asset;
  - Dimensions, scale and massing;
  - Proportions;
  - Visual permeability;
  - Materials (texture, colour, reflectiveness, etc.);
  - Architectural style or design;
  - Introduction of movement or activity;
  - Diurnal or seasonal change;
  - Other effects of the Scheme; and
- Longer term of consequential effects of the Scheme:
  - Changes to ownership arrangements;
  - Economic and social viability; and
  - Communal and social viability.

9.4.28 The assessment of impact also takes into account and assesses other environmental factors arising from the Scheme reported elsewhere in the ES that may affect the settings of cultural heritage assets. Other environmental factors considered comprise changes in lighting and visibility (based on the results of assessment reported in Chapter 10: Townscape and Visual), noise levels and from vibration (Chapter 7: Noise and Vibration), pollution and air quality (Chapter 6: Air Quality), and alterations in traffic volumes (Chapter 17: Traffic and Transport).

9.4.29 The assessment takes into account that changes may occur to the settings of an asset that neither affect their contribution to the cultural heritage significance of the asset, nor the extent to which its cultural heritage value can be experienced. In such instances, it has been considered that there is no impact upon setting.

Assessment of Harm

9.4.30 Once the sensitivity and contribution of the setting has been determined and the potential attributes of a proposed development identified, the level of harm or beneficial impact of a proposed development needs to be evaluated. The NPS NN and NPPF outline the requirement to assess the magnitude of harm on the historic environment resulting from a development. Substantial harm to or loss of a Grade II Listed Building or a Grade II Registered Park or Garden should be exceptional. Substantial harm to or loss of designated assets of the highest significance, including World Heritage Sites, Scheduled Monuments, Grade I and II* Listed Buildings, Registered Battlefields, and Grade I and II* Registered Parks and Gardens should be wholly exceptional.

9.4.31 Justification for any harm should be clear and convincing. Where any harm to the significance of a designated heritage asset would be less than substantial, the harm should be weighed against the public benefits of the proposal. Proposals involving substantial harm to (or total loss of) significance should be refused unless it can be demonstrated that the harm or loss is necessary to achieve substantial public benefit that outweighs that harm or loss.

9.4.32 Guidance for the assessment for substantial harm is provided National Planning Policy Guidance 2014 *Conserving and Enhancing the Historic Environment*. This states that the assessment of magnitude of harm is determined by the impact of the development on the value and significance of the heritage asset. The value of the asset is drawn from its architectural, historic, archaeological, and artistic interest, and also by the contribution of the asset's setting.

9.4.33 The Scheme will not have a direct, physical impact on any designated heritage assets. Any harm will therefore result from a change in the asset's setting, where the setting can be demonstrated to contribute to the value of asset.

9.4.34 The assessment of the magnitude of harm is not dependent on overall value or importance of the heritage asset but reflects the magnitude of impacts on those elements which contribute to the asset's importance. The assessment for magnitude of harm is based on professional judgement but must take into regard the policies set out in NPS NN and NPPF. An assessment of harm is expressed on a three-point scale: Minor Harm and Harm (both constitute "Less than Substantial Harm") and Substantial Harm.

9.4.35 A professional judgement for Minor Harm can be drawn from the conclusion that contribution of the setting of the cultural heritage asset to its overall value is slightly degraded as a result of the development, but without adversely affecting the interpretability of the asset and its setting. The characteristics of historic value can still be readily appreciated, the changes

do not strongly conflict with the character of the site, and could be easily reversed to approximate the pre-development conditions. Minor Harm corresponds with Slight Adverse effects for EIA and is therefore not significant.

9.4.36 A professional judgement for Harm can be made when the contribution of the setting of the cultural heritage asset to its overall value is reduced appreciably as a result of the development. Relevant setting characteristics can still be appreciated but less readily. The definition of Harm broadly corresponds to a Moderate Adverse effect, and therefore is a significant effect for EIA, however it would still be deemed to be Less Than Substantial Harm for compliance with the policies in NPS NN and NPPF.

9.4.37 The conclusion of Substantial Harm may be drawn when it can be demonstrated that the contribution of the setting of the cultural heritage asset to its overall value is effectively lost or substantially reduced as a result of the development, the relationship between the asset and its setting is no longer readily appreciable. This aligns with a Large and Very Large effect and therefore for EIA would be a significant effect.

Effect Significance

9.4.38 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme. The significance level attributed to each effect has been assessed based on the magnitude of change on heritage assets and their setting due to the Scheme and the sensitivity of the affected receptor, as well as a number of other factors that are outlined in more detail in Chapter 4: Approach to EIA.

9.4.39 Assessment of the significance of effect of the Scheme on cultural heritage assets and their setting combines the value of the resource and the magnitude of the impact for each cultural heritage asset. The assessment of significance of effect on designated heritage assets also includes the assessment of the level of harm.

9.4.40 The DMRB recommends the adoption of five ratings for significance of effect: neutral, slight, moderate, large and very large. For the purposes of this assessment, effects deemed to be of moderate, large or very large significance are deemed to be significant effects. Effects deemed to be of neutral or slight significance are deemed not to be significant effects. The matrix for establishing significance of effect matrix is summarised in Table 9.8.

Table 9.8: Significance of Effect on Cultural Heritage Effects

Magnitude of Impact	Major	Neutral	Slight	Moderate / Large	Large / Very Large	Very Large
	Moderate	Neutral	Slight	Moderate / Slight	Moderate / Large	Large / Very Large
	Minor	Neutral	Slight / Neutral	Slight	Moderate	Moderate / Large
	Negligible	Neutral	Slight / Neutral	Slight / Neutral	Slight	Moderate / Slight
	No Change	Neutral	Neutral	Slight / Neutral	Slight / Neutral	Slight
		Negligible	Low	Medium	High	Very High
		Value				

9.5 Baseline Conditions

Introduction

9.5.1 The baseline conditions reported in this Chapter 9 comprise a summary of the archaeological and historic background of the Application Sites and presents the value of the historic environment resource relevant to the assessment. A detailed historic environment baseline is provided in the HEDBA (Appendix 9B (document reference 6.2)).

9.5.2 A gazetteer of all the heritage assets in the study areas is presented in Appendix 9B Annex A (document reference 6.2) and includes the sensitivity/importance of each asset, along with the impact and effect of the Scheme. The contents of the gazetteer have been drawn from Historic England's NHLE (pre-fixed by NHLE and from the NHER (pre-fixed by NHER. It also includes heritage assets identified during the EIA (pre-fixed by WSP).

Archaeological and Historic Background

9.5.3 There is very little evidence for prehistoric settlement activity around the Principal Application Site. Where Great Yarmouth now stands started out as the mouth of a large estuary. Since the last Ice Age, a southerly coastal current has laid a spit of sand across the north of the estuary, from the north end to the south. The sand spit blocked off the estuary, leading to the

formation of the peat in the Broads. The sand spit was breached by the sea, and left as either a low tidal island or a shoal until about 1,300 years ago, gradually rising to become permanently dry. This is now the area known as South Denes.

9.5.4 The only evidence currently for prehistoric activity in Great Yarmouth is provided by a single find of a Neolithic scraper (NHER 12936), recovered at the junction of Boundary Road and Suffolk Road, adjacent to the Principal Application Boundary.

9.5.5 The inclusion of Great Yarmouth (then known just as Yarmouth) in the Domesday Book of 1086 indicates the presence of a settlement here prior to the Norman conquest. Excavations have identified Fuller's Hill, located approximately 2km north of the Principal Application Site, as the likely location of the later Saxon settlement (e.g. NHER 32585). In 1208, Great Yarmouth received its town charter and the settlement expanded rapidly. The economy of the town was driven by fishing, and by the end of the 13th century, three ecclesiastical centres had been established within the town, including the Dominican or Blackfriars Friary, located approximately 450m north of the Main Application Site (NHER 4266). The extent of the medieval town is represented by the well-preserved remains of the defence walls (NHLE 1003782) which is designated as a Scheduled Monument. Construction of the walls began in the late 13th century, although they have been subjected to periodic remodelling, including during the refortification of the town in the 17th century during the Civil War.

9.5.6 Settlement was not limited to the walled town in the medieval period. A settlement known as Southtown was established on the western side of the River Yare. Approximately 250m to the south of the Principal Application Site are the remains of the house of the Austin Friars comprising a church, priory and leper hospital located on Burnt Lane (NHER 60531). This friary was founded in the 13th century, although the earliest known buildings date to the 15th century. Much of the priory has been destroyed, although the west gate is recorded to have still been standing up to the beginning of the last century.

9.5.7 In 2013, a watching brief revealed beam slots and post holes associated with a late medieval timber-framed building located on Burnt Lane (NHER 60518), approximately 450m south of the Principal Application Site. Finds recovered from these features included late medieval brick, roof tile and wall plaster that could be high status.

9.5.8 Great Yarmouth underwent considerable redevelopment and expansion during the post-medieval period. The area east of the River Yare lies in the area known as South Denes, which was occupied by a Naval base until the mid-19th century. Early 19th century mapping shows the spit of land to the east of the river and south of Great Yarmouth as forming the Naval base.

There are a number of military structures along the coastline apparent, including the site of the South Star Battery (NHER 4238) approximately 250m to the east of the Principal Application Site. Other heritage assets in the Study Area associated with the Naval base are the Grade I Listed Nelsons Monument (NHLE 1246057), also known as the Norfolk Pillar, and the Grade II* and Grade II buildings forming St Nicholas Hospital, located 350m north-west (Main Entrance Range (NHLE 1245984) Main Block (NHLE 1245983), walls and railings (NHLE 1245986) and South Block (NHLE 1245985)).

9.5.9 The majority of the non-designated heritage assets in the Study Area relate to the post-medieval period, primarily the late 18th to 19th centuries, and include villas, a lodge, mileposts and boundary posts and two churches. There are also industrial areas with railways, a coal power station, gas works, potteries, fish curing works, workshop ranges, utility blocks and a rope walk.

9.5.10 Cartographic sources from 1818 and 1850 identify three buildings on the west bank of the river that fall within the Principal Application Site. No function for the buildings are recorded.

9.5.11 Proposals to develop the east side of the river as Fish Wharf began in the mid-19th century and a plan held by the Norfolk Archives from 1866 shows how the area was to be set out. This included three covered markets structures along the river side. To the east of the markets, ran the urban tramway (NHER 13576), and then a set of areas earmarked for “swills and packages”. The northern plot is marked as ‘site of Refreshment Room’, which later was occupied by the Dolphin Public House (NHLE 1096829). East of these, the land was divided into 39 plots to be let as fishing trade premises. The proposed layout of the Fish Wharfs on this plan is reflect on the subsequent Ordnance Survey (OS) maps and therefore are assumed to have been built to the plan.

9.5.12 Due to the success of the market, proposals were soon made for an extension, with the addition of another building along the river side. The latter half the 19th century also saw the development of terraced housing on the west side of the river. The terraced housing along Southtown Road have a date stone of 1873. The west of the Principal Application Site is occupied primarily by fields which are criss-crossed by drainage channels. The later mapping also shows the route of a tramway running north-south along Southtown Road. Other features of note on the later maps are the Icehouses (NHER 55685), located to the eastern side of the Principal Application Site, and the Gas Works, located to the east (NHLE 1096789).

Summary of Heritage Assets

9.5.13 No World Heritage Sites, Registered Battlefields, Registered Parks or Gardens or Protected Wreck sites have been identified within the Study Areas.

Principal Application Site

9.5.14 The Grade II listed Dolphin Public House (NHLE 1096829), an early 20th century building, is located adjacent to the Principal Application Site. The Scheme would therefore have no direct physical impacts Dolphin Public House. The impacts on the setting has been assessed (Appendix 9B (document reference 6.2)) and there will not be significant effects.

9.5.15 Designated heritage assets (see Figure 9.1) in the wider (1 km) Study Area consist of:

- Four Scheduled Monuments:
  - Town Walls (NHLE 1003782);
  - Nos 6, 7, and 8, Row 111 South Quay (NHLE 1003958, and also Grade II Listed Building NHLE 1245916);
  - Merchant's House, Row 117, South Quay (NHLE 1004020, see also Grade II* below); and
  - Greyfriars Franciscan Friary (NHLE 1017910).
- Four Grade I Listed Buildings:
  - The Tolhouse (NHLE 1245560);
  - Remains of the Church of the Greyfriars (NHLE 1245915);
  - St Georges Theatre (NHLE 1245919); and
  - Nelson's Monument (NHLE 1246057).
- Eight Grade II* Listed Buildings:
  - Great Yarmouth Potteries (NHLE 1245561);
  - Custom House (NHLE 1245800);
  - 25, South Quay (NHLE 1245803);
  - Old Merchant House (NHLE 1245917, see also Scheduled Monument above);

- The Hippodrome (NHLE 1245922);
- St Nicholas Hospital Main Entrance Range (NHLE 1245984);
- Old White Lion Public House (NHLE 1271278); and
- The Winter Gardens (NHLE 1271608).

- 102 Grade II Listed Buildings, including:
  - Hotels and Public Houses;
  - Residential properties;
  - Churches;
  - Public and Leisure facilities; and
  - Industrial buildings.
- Six Conservation Areas:
  - Camperdown;
  - Gorleston Extension;
  - King Street;
  - Seafront;
  - Hall Quay and South Quay; and
  - St George's.

9.5.16 There are 135 non-designated heritage assets recorded in the 500m study area (see Figure 9.2). Of these, 122 are recorded on the NHER and the vast majority of these assets represent World War II structures, camps and bomb crater sites, with the remaining sites comprising finds and structures which reflect the important Naval and shipping history of the town. The majority of the remaining recorded assets date to the post medieval period. Within the wider study there is evidence of buried urban and riverfront remains dating to the Medieval period, as well as a single findspot of a Neolithic scraper (HER 12936).

9.5.17 The assessment has identified fifteen additional non-designated heritage assets within and immediately around the Principal Application Site based on an assessment of historic mapping and completion of the site walkover. On the east side of the Scheme they relate to the historic Fish Wharf area (WSP01, WSP09 and WSP10), while on the east they are 19th century

residential properties (WSP03 to WSP08, WSP11 to WSP13, WSP15), a former Maltings building (WSP02) and the site of early 20th century timber yard and saw mill (WSP14).

Below Ground Remains within the Principal Application Site

9.5.18 A total of 126 below ground heritage assets are recorded within the 500m Study Area. These comprise one designated heritage asset (Scheduled Monument) (Town Wall, NHLE 1003782), 110 non-designated heritage assets recorded on the NHER as monuments or findspots, and 15 non-designated heritage assets have been identified from historic mapping.

9.5.19 18 below ground heritage assets are recorded within the Principal Application Site:

- Site of late 19th century icehouse and three salt stores (HER 55685);
- Site of late 19th century Fish Wharf (WSP10);
- Site of wharf side buildings (WSP09);
- The Site of three buildings on west side of Southtown Road (WSP11, WSP12 and WSP13);
- Site of 19th century house (WSP08);
- Site of Marsh House (WSP14);
- The Route of Norfolk and Suffolk Joint Railway (HER 13575);
- Routes of Great Yarmouth urban railways (HER 13576);
- Site of a 20th century timber yard and saw mill (WSP15);
- Site of World War II defences (HER 27697);
- Site of World War II craters (HER 27700, 43589, and 43741);
- Site of World War II anti invasion defences at Southtown (HER 42355 and 42353); and
- Site of World War II road blocks (HER 43304).

9.5.20 The Icehouse and Three Salt Stores (HER 56658), Site of Wharf Side Buildings (WSP09), and Site of Fish Wharf Buildings (WSP09) all relate to the fishing industry and the development of the South Denes area to support this industry. The remains therefore have historical and archaeological value as evidence for growth, development and subsequent decline of a local economy. Any structural remains found would also have architectural value. Any remains found are likely to be of low value.

9.5.21 The historic mapping shows the site of three buildings on Southtown which appear to predate the later 19th century expansion into this area (WSP11 to WSP13). The site of a property on the west side of Southtown Road (WSP08) and Marsh House (WSP14) are shown on the 1883 OS map, located at the north-west end of the Principal Application Site, however both had gone by the 1940s. They therefore have the potential to provide archaeological and historical evidence for the nature of land-use and occupation in the area between the settlement cores of Southtown and Gorleston. Any structural remains could potentially have some architectural value too. Any remains identified would likely be of low value.

9.5.22 The site of the 20th century timber yard and saw mill (WSP15), and the routes of the two urban railways (HER 13575 and HER 13576), and the World War II (HER 27697, HER 27700, HER 43589, HER 43741, HER 42355, HER 42353 and HER 43304) are all judged to be of negligible value as they would provide very limited archaeological, historical or architectural information.

9.5.23 There is a potential for currently unknown below ground heritage assets within the Principal Application Site. Although a Neolithic flint scraper was found adjacent to the Principal Application Site, this represents a single stray find spot. The potential for below-ground archaeological remains from the Prehistoric and Roman periods is judged to be low due to the limited evidence from this period around the Principal Application Site. There is, however, the potential for deeply stratified paleoenvironmental remains associated with these periods. If present, such remains would be of medium or high value, depending on preservation and extent, based on their archaeological value.

9.5.24 The Scheme is located outside of the known medieval settlements of Great Yarmouth and Southtown. The west side of the river lay between the settlements of Southtown and Gorleston and likely formed part of the rural landscape supporting these settlements. There is a potential, therefore, for remains associated with agriculture or maritime activity (including remains of former quaysides, wharfs and potentially vessels) to be present, although the level of impact on any remains from this period from later development is currently unknown. The historic mapping from the early 1800s indicates the presence of up to three buildings alongside Southtown Road, which are replaced by terraced buildings by the late 19th century, and it is assumed that any remains have now been destroyed.

9.5.25 The east side of the river occupies the area known as South Denes, which formed gradually from a sandbank and remained free from development until the mid-19th century, being occupied prior to this by a Naval base. If present, such remains would range from low to high value, depending on preservation and extent, from derived from archaeological and historical interest.

9.5.26 The east side of the river saw rapid development in the later 19th century and 20th century and now forms a densely occupied residential area. The west side is still an operating wharf, although most of the late 18th and early 19th century buildings have been removed. Industrial and modern remains would be of negligible to medium value, derived from archaeological and historical interest.

Palaeoenvironmental Deposits

9.5.27 An assessment of the palaeoenvironmental resource has been undertaken by Wessex Archaeology and is presented in full in Appendix 9C (document reference 6.2).

9.5.28 A total of 48 geotechnical borehole logs were reviewed as part of the borehole review, with the aim of identifying deposits of potential geoarchaeological significance within the Scheme. A deposit model was produced based on 14 of the boreholes which captures the stratigraphy within 50 m of the present ground level which includes the full depth potentially impacted by pile foundations associated with the bridge structure. Outline descriptions based on preliminary geotechnical logs are presented in Appendix 9C (document reference 6.2), accompanied by an interpretation of the deposits. The location of the boreholes is presented in Appendix 9C Figure 1 (document reference 6.2) and the deposit model in Appendix 9C Figure 2 (document reference 6.2).

9.5.29 The stratigraphy of the deposits within the Scheme is summarised in Table 9.9 below.

Table 9.9: Summary of the Stratigraphy of Deposits within the Scheme

Unit Name (age)	Sediment Characteristics	Depositional History	Geoarchaeological Potential
Modern Alluvium and Made Ground (Modern)	Silt and clay or heterogeneous clay, silt, sand and gravel including concrete and brick.	Influenced by human activity post-medieval.	Low – although Made Ground may include near-surface archaeology.
North Denes Formation (Holocene)	Sand with subordinate layers of gravel and thin layers of silty clay.	Coastal barrier/spit that has developed from AD 500 to present day.	Low - but may contain archaeology.
Breydon Formation – peat (Holocene)	Peat comprised of partially decomposed	Deposited in and around the valleys of the River Yare and	High – preservation palaeoenvironmental material likely.

Unit Name (age)	Sediment Characteristics	Depositional History	Geoarchaeological Potential
	organics matter.	associated tributaries during the Holocene under the influence of rising sea level.	
Breydon Formation – alluvium (Holocene)	Silt and clay, occasionally organic rich with shelly marine fauna. Sand is generally subordinate but may be substantial locally.	Deposited in the valleys of the River Yare and associated tributaries during sea-level rise when the area became an estuary with associated saltmarsh and mudflats.	Medium - preservation of palaeoenvironmental material is possible.
Happisburgh Glacigenic Formation – sand and gravel (Anglian)	Sands and gravels.	Glaciofluvial deposits.	Low – landscape not suitable for occupation.
Crag Group - Wroxham Crag Formation (Pleistocene)	Sands interbedded with silt and clay.	Deposited in shallow marine-estuarine setting on the edge of the North Sea Basin.	Low – predates Occupation.
London Clay (Eocene)	Silt and clay.	Marine	Low – predates occupation.

London Clay

9.5.30 Bedrock comprised of London Clay was encountered in seven of the 48 boreholes (BH10, BH10a, BH11, BH12, BH12b, BH13 and BH13a, see

Appendix 9C Figure 1 (document reference 6.2)). The geoarchaeological potential of the solid geology London Clay is low as these deposits pre-date hominin occupation.

Crag Group - Wroxham Crag Formation

9.5.31 Overlying bedrock, deposits associated with Crag Group were recovered, forming the most extensive and thickest sequences (>40 m at BH11, see Appendix 9C Figure 1 (document reference 6.2)) across the site. These most likely belong to the Wroxham Crag Formation, which are the youngest of Crag Group deposits dating to the Middle Pleistocene/Lower Palaeolithic. Within the River Yare channel, Crag is present at, or within 1 m of the river bed. Elsewhere, along the margins of the River Yare, Crag is overlain by up to 15 m of Pleistocene and/or Holocene sediments.

Happisburgh Glacigenic Formation – Sand and Gravel

9.5.32 In seven of the boreholes, Crag Group was overlain by gravelly sand (BH4, BH4a, BH4d and BH6, see Appendix 9C Figure 1 (document reference 6.2)) and sandy gravel (BH8, BH9 and BH15) interpreted to be deposited in a glaciofluvial environment as part of the Happisburgh Glacigenic Formation. They are present on the western side of the River Yare where they appear to thin towards the west from 3.75 m (BH9) to 2.00 m (BH6). Happisburgh Glacigenic Formation sediments were deposited during the Anglian glacial period approximately 450,000 years ago. The geoarchaeological potential of these deposits is low.

Breydon Formation – Alluvium and Peat

9.5.33 Breydon Formation was recovered in 19 boreholes (WS1, WS3, WS4, WS6, WS7, WS9, BH1, BH2, BH4, BH4a, BH5, BH5a, BH6, BH7, BH4BU, BH8, BH9, MB01 and BH4A3, see Appendix 9C Figure 1 (document reference 6.2)), comprising peat (BF-p) and/or alluvium (BF-a). Where both peat and alluvium are present in the same borehole, the peat is overlain by alluvium, but can be intercalated as is the case in BH2. The peat deposits range in thickness from 0.6 m (BH2) to 2.3 m (WS7), whereas the overlying alluvium can reach thicknesses in excess of 6 m (BH1). The alluvium is fine-grained silts and clays that can be organic rich or comprise discrete organic lenses.

9.5.34 Of all the deposits within the Principal Application Site boundary, Breydon Formation peat and alluvial deposits have the greatest geoarchaeological potential. These deposits represent a freshwater-brackish low-lying marshland that formed in and around the River Yare throughout the Holocene.

9.5.35 Within the Principal Application Site boundary, there is at least one, but possibly two distinct peat deposits preserved on the western side of the River Yare. The Breydon Formation is expected to have three distinct peat

bodies separated by estuarine alluvium, with each peat representing a different time periods as follows (Boomer and Godwin 1993):

- Upper peat – post AD 500 (Anglo-Saxon to Early Medieval);
- Middle peat – 2,700 BC to AD 0 (Neolithic to Iron Age); and
- Lower peat – pre- 5,500 BC (Mesolithic).

9.5.36 It is not possible to establish which of these peats are present within the Scheme without further paleoenvironmental works. Based on their depth and thickness, they may be part of the middle peat forming at some point between the Neolithic and Iron Age. It is anticipated the upper peat has been removed due to extensive peat extraction for fuel between 12th and 15th centuries AD (Ref 9.13)

North Denes Formation

9.5.37 In seven of the boreholes, North Denes Formation was recovered (BH13, BH13a, BH14, BH15, BH16, BH17 and BH18, see Appendix 9C Figure 1 (document reference 6.2)). These deposits are present at elevations between -0.10 m OD (BH18, see Appendix 9C Figure 1 (document reference 6.2)) and -12.60 m OD. North Denes Formation is not present to the west of the River Yare. The North Denes Formation deposits are associated with a coastal barrier system that extends from the present-day coast to the River Yare. These deposits are younger than Breydon Formation and documentary evidence supports the existence of the barrier from 500 AD onwards (Ref 9.14). Given its age, there is potential for the deposits to contain archaeological material, although the presence of significant layers or occupation is unlikely. Given the coarse-grained nature of these deposits, their geoarchaeological potential is considered low.

Modern Alluvium and Made Ground

The youngest deposits recovered in all boreholes, with the exception of MB04a, MB07, MB09 and MB10, are characterised by Made Ground and Modern Alluvium. Modern Alluvium deposits appear to thicker on the eastern side of the River Yare where they overlay North Denes Formation. The thickness of Made Ground deposits broadly varies from 0.40 m (WS3, see Appendix 9C Figure 1 (document reference 6.2)) to 3.50 m (BH2). The potential of Modern Alluvium is considered low. Made Ground is also considered to be of low potential, although it is important to note that should any near-surface archaeological remains be present, they would be included within this designation.

Built Heritage

9.5.38 There are two non-designated built heritage assets within the Principal Application Site (Figure 9.2B):

- Late 19th century terraced buildings on Queen Anne's Road (WSP04); and
- Late 19th century terraced buildings on Southtown Road (WSP06).

9.5.39 The non-designated heritage assets correspond to buildings shown on late 19th century Ordnance Survey Maps. The Scheme would require the demolition of these non-designated built heritage assets. The assessment has been limited to a visual inspection of the front elevation of the assets from Southtown Road and Queen Anne's Road. As the properties are in occupation at the time of the assessment, no internal inspection was undertaken at this stage. As the main purpose of the assessment was to determine if the properties did represent those shown on the historic mapping, this level of assessment is deemed suitable.

9.5.40 A programme of historic building recording in advance of the demolition of the buildings is set out in the Written Scheme of Investigation (Document 6.17).

Late 19th Century Terraced Housing on Southtown Road (WSP06)

9.5.41 A date stone on the buildings names the row of properties as "Brighton Terrace" and dates their construction as 1873. This date is supported by the historic mapping consulted. The terrace is made up of nine separate "two up to down"-style properties, set back slightly from Southtown Road (Figure 9.2B). They appear to belong to two phases of construction, as the northern three vary in their design, being having slightly higher front elevations and ornate decoration along the roof line compared to the rest. All nine of the buildings share the same external design, with large bay windows extending from the ground up to the first floor. Two of the properties have had small extensions added to the front by the doorway.

9.5.42 The properties have architectural value as they are an example of late 19th century domestic buildings, likely built to support the rapidly growing population in Great Yarmouth. They also have some historic value as evidence for the expansion of the settlement of Southtown, and the potential multi-phasing of construction may have some historic significance. The value of the assets is judged be low as they are of local interest.

Plate 9.1: WSP06: Late 19th Century Terraced Housing on Southtown Road

Late 19th Century Terraced Housing on Queen Anne's Road (WSP04)

9.5.43 The terrace comprises of ten separate "two up two down" properties, which front onto Queen Anne's Road (Figure 9.2B). They appear to belong to a single phase of development. They are architecturally simpler compared to the ones on Southtown Road and lack the large bay windows.

9.5.44 The properties have some architectural value as they are an example of late 19th-century domestic buildings, likely built to support the rapidly growing population in Great Yarmouth. They also have some historic value as evidence for the expansion of the settlement of Southtown. The value of the assets is judged be low as they are of local interest.

Plate 9.2: WSP04: Late 19th Century Terraced Housing on Queen Anne's Road

Contribution of the Setting to the Value of Heritage Assets

9.5.45 All of the designated assets within the 1km Study Area and non-designated built heritage assets within the 500m Study Area of the Principal Application Site have been assessed to identify those which are potentially sensitive receptors due to a change in their setting from the construction and operation of the Scheme. The assets identified as being at risk due to a change in views, noise levels, lighting, and visual prominence resulting in a change in setting were then fully examined to determine if and to what degree their setting contributes to the value and importance of the asset in order to establish the baseline for the assessment. As a result of this exercise, the following designated and non-designated built heritage assets have been identified as being potentially sensitive receptors through changes in setting and are reported on in the HEDBA (Appendix 9B, Section 7 (document reference 6.2)):

- Grade I listed Nelson's Monument (NHLE 1246057);
- Grade II Listed Gas Holder (NHLE 1096789);
- Grade II Scenic Railway Roller Coaster at Great Yarmouth (NHLE 1436976);
- St Nicholas Hospital Block Asset group (NHLE 1245982, 1245983, 1245984, 1245985 and 1245986);
- Camperdown Conservation Area;
- Hall Quay South Quay Conservation Area;
- Gorleston Conservation Area;
- Potential Fish Wharf 1877 Extension Building (WSP01);
- Late 19th century terraces off Southtown Road (WSP03); and
- Late 19th century terraces off St Anne's Road (WSP05).

9.5.46 The assessment has identified that there would be significant effect on the Grade I Nelson's Monument and the Grade II Listed Gas Holder only and these assets are presented below.

9.5.47 The value of the remaining assets would not be impacted upon to result in significant effects, either due to a limited change in the assets setting or due to the setting contributing minimally to the value of the asset. A full description of these assets, the contribution of the setting, the impacts and resulting effects are presented in the HEDBA (Appendix 9B (document reference 6.2)).

Nelson's Monument (NHLE 1246057)

9.5.48 Nelson's Monument, also known as Nelson's Pillar, was built between 1817-19 and was the first monument built in England to commemorate the achievements of Admiral Lord Nelson. It is located on Monument Road and Fenner Road, approximately 450 m south-west of the Principal Application Site (Figure 9.1B). An information board at the monument states that the monument designed by William Wilkins, who was also responsible for the National Gallery building in London. It comprises of a tall, fluted Greek Doric column placed on a square pedestal, which is located on a raised square plinth. The figure of Britannia is located on the top of the column, facing inwards from the coast. Overall, it measures approximately 40m in height.

Plate 9.3: NHLE 1246057: Nelson's Monument

9.5.49 The monument is designated as a Grade I Listed Building, and therefore is of high, national value. The importance of Nelson's Monument is drawn from its architectural, historical and artistic values. Architecturally, it is intentionally ornate, classically inspired and an imposing structure. It has firm links to the historical maritime activity, and specifically to Admiral Lord Nelson himself. The purpose of the monument is to present a visual representation of the achievements of Nelson and to ensure they are remembered. The monument also has appeared in artistic representations (see Plate 9.4).

Plate 9.4: View of Yarmouth seen from Gorleston, with Nelson's Monument on the Right (Ref 9.5)

9.5.50 The setting of the monument has changed substantially since its construction. In the early 1800s, the South Denes area was part of the Naval base and was predominately open land. This is illustrated in Plate 9.4, and supported by the historic mapping. Following the closure of the Naval base, the South Denes area became available for development and the area around the monument is now densely occupied. The monument itself is bordered on all four sides by a wall and fence, which in turn is boarded by roads and public footpaths. Today, the monument is surrounded by industrial and commercial properties. This allows the monument to stand out in its immediate environment.

Plate 9.5: View South from Nelson's Monument (NHLE 1246057)

Plate 9.6: View of Nelson's Monument (NHLE 1246057), Facing North

9.5.51 The immediate setting of the monument at ground level contributes little to its overall significance due to the modern development undertaken around it. Its wider setting comprises the area of the former Naval base, and also is in the same county that Nelson was born, and therefore in this context the setting provides a contribution due to the historic links. Due to the height of the monument, however, the setting of it extends beyond its immediate location. The monument is visible across a wide area, particularly from the south towards Gorleston (Plate 9.7), although it does have to compete with other high features in its surroundings (e.g. cranes alongside the River

Yare). It is also visible from the west side of the Scheme (Plate 9.8). This ability to see it from a long distance, albeit intermittently, is an important part of the significance of the monument and how the asset is experienced in its wider setting. Overall, the setting provides a moderate contribution to the significance of the asset.

Plate 9.7: Long Distance View of Nelson's Monument (NHLE 1246057) from Corner of Icehouse Hill and Riverside Road, Gorleston (monument location shown by red arrow)

Plate 9.8: Long Distance View of Nelson's Monument (NHLE 1246057) Southtown Road (monument location shown by red arrow)

Gas Holder (NHLE 1096789)

9.5.52 The Gas Holder consists of a steel drum set in a cast-iron and steel frame. The frame is composed of 14 cast columns, with needle finials and volutes providing an aesthetic value. It bears a maker's plate which reads "R.P. Spice/Engineer/London/1884" and "S. Cutler & Sons/Contractors/1884", and based on this the NHLE description states it dates to 1884, however it first appears in this location on the 1926 Ordnance Survey map. A Gas Works is shown here from 1883, with two gas holders shown to the west. None are shown on the 1904 Ordnance Survey Map, and by 1926 there are three, including the Grade II listed one. Gas Holders were once a common feature in urban environments from the 19th century and were used up until the 1960s to store gas produced on land. Following the establishment of a gas supply from the North Sea, gas holders were made redundant and many demolished.

Plate 9.9: Gas Holder (NHLE 1096789)

9.5.53 The Gas Holder was designated as a Grade II Listed Building in 1998 and is of medium value. The importance is drawn largely from its architectural value, which is increased by the use of ornate elements within an otherwise utilitarian structure. Historically, it is representative of 19th century efforts to provide a regular and constant gas supply to businesses and homes which also adds to its value.

9.5.54 The Gas Holder is located on the corner of Barrack Road and Admiralty Road. The areas to the north and west are predominately residential and to the south and west it is industrial. A second smaller gas holder lies immediately to the south. The Gas Holder was previously located within a gas works, which went out of use in the later 20th century and no above

ground remains are visible. The gas works were likely located here as part of the development of the South Denes area following the closure of the Naval base and the availability of a large area of land for expansion.

9.5.55 Due to their function and purpose, gas holders are intentionally large and prominent structures and many have become landmarks. The Gas Holder has little to challenge its visibility in its immediate proximity and it can be viewed from long distances. It is very visible from the west side of the Scheme (Plate 9.10). The asset therefore has a visual prominence in the landscape and acts as a focal point, albeit unintentionally. It is this experience of the asset in its setting that provides a minor contribution to the significance of the asset.

Plate 9.10: View East Towards the Gas Holder (NHLE 1096789) from Southtown Road

9.6 Future Baseline

9.6.1 The assessment has not identified any committed developments which would impact on the historic environment and alter the baseline prior to the construction period. No change is therefore anticipated in the baseline

9.7 Sensitive Receptors

9.7.1 The following are the sensitive receptors which have been assessed:

- Non-designated below ground heritage assets within the Principal Application Site, consisting of:

- Site of late 19th century icehouse and three salt stores (HER 55685);
- Site of Wharf side Buildings (WSP09);
- Site of late 19th century Fish Wharf (WSP10);
- Site of buildings on west side of Southtown Road (WSP11, WSP12 and WSP13);
- Site of 19th century house (WSP08); and
- Site of Marsh House (WSP14).

- Palaeoenvironmental remains in the Principal Application Site in the form of peat and alluvial deposits of the Breydon Formation;
- Non-designated built heritage assets within the Principal Application Site, consisting of:
  - Potential Fish Wharf 1877 Extension Building (WSP01); and
  - Late 19th century terraced housing off Southtown Road (WSP03 to WSP06).
- The setting of designated above ground heritage assets in the 1km study area around the Principal Application Site, consisting of:
  - Grade I listed Nelson's Monument (NHLE 1246057); and
  - Grade II listed Gas Holder (NHLE 1096789).

9.7.2 There is also the potential for currently unidentified below-ground remains to be located within the main Scheme area which could be sensitive receptors.

9.8 Establishing the Scenario for Assessment

Construction Phase

9.8.1 There is a potential for non-designated below ground archaeological and Palaeoarchaeological remains present to be adversely impacted by the construction of the Scheme through development activities such as pilling, stripping of overburden or hardstanding, landscaping, ground compaction access, service installation, stockpiling and storage may all have a negative effect on cultural heritage assets. The extent and location of any substantial ground disturbance would be focused on the footprint of the road and bridge. However, there is a potential for some level of disturbance throughout the entire Principal Application Site in order to facilitate the construction works

(i.e. temporary works areas). For the purposes of this assessment it is assumed that there is potential for disturbance within the Principal Application Site and could result in the damage or complete loss of archaeological assets. The impacts would be permanent and irreversible.

9.8.2 The construction phase would require the demolition of the non-designated late 19th century terraced buildings on Southtown Road (WSP06) and Queen Anne's Road (WSP04) to accommodate the Scheme. The impacts on the non-designated assets would be permanent and irreversible.

9.8.3 There is a potential for temporary impacts and effects on built heritage assets in the immediate vicinity of the Principal Application Site due to a change in the setting as a result of the construction phase. The impacts are predicted to derive from temporary visual intrusions from construction related infrastructure, such as lighting (see Chapter 10 Townscape and Visual) piling rigs, cranes, plant, along with a temporary increase in noise, ground vibration, construction related traffic (see Chapter 7: Noise and Vibration and Figure 7.2) and dust (see Chapter 6: Air Quality).

Operational Phase

9.8.4 There is potential that following the completion of the construction, any below ground archaeological remains present around the Scheme would be adversely impacted through changes in the local hydrology, resulting the compaction, desiccation or waterlogging of below ground remains. The effects on the groundwater levels are assessed in Chapter 11: Road Drainage and the Water Environment. This has determined that there will be no change and neutral effects to the groundwater quality, recharge and flow, and a negligible change and negligible effects to the groundwater flow and quantity in superficial deposits and to the Crag Group aquifer, the main aquifer underlying the Principal Application Site (Section 11.8). The Preliminary Ground Water Control Strategy contains some uncertainties, however, which will be improved and defined through the project lifecycle (Section 11.10).

9.8.5 The assessment of change and effect on groundwater levels indicates no or negligible levels of change to the groundwater level, however it is not known currently what the impact of a negligible change would have on the archaeological value of the superficial geological deposits, in particular the Breydon Peats and Alluvium. There is still some additional information pending about aquifer permeabilities.

9.8.6 There is a potential for permanent impacts and effects on built heritage assets in the Principal Application Site and in the wider landscape due to a change in the setting during operation. The impacts are predicted to derive from the visual intrusion resulting from the introduction of the road, bridge, control tower and plant room in particular. There are potential permanent

impacts in the immediate vicinity of the Principal Application Site associated with the direction of traffic through the Scheme, resulting in an increase in noise levels, vibration (see Chapter 7: Noise and Vibration, Figure 7.2) and pollution (see Chapter: 6 Air Quality). There are anticipated to be limited impacts due to artificial lighting associated with the Scheme, however, as any additional lighting would be consistent with the baseline conditions (see Chapter 10: Townscape and Visual, Section 10.7), although some change to the setting is anticipated associated with the increase in vehicle lights.

9.9 Assessment of Effects, Mitigation and Residual Effects

Construction Phase

Non-Designated Below Ground Archaeological Remains

9.9.1 The assessment has identified the potential for eight non-designated below ground heritage assets within the Principal Application Site (The Icehouse and Three Salt Stores (HER 55685), Wharf side Buildings (WSP09), and Fish Wharf (WSP10), Site of buildings on west side of Southtown Road (WSP11, WSP12 and WSP13), Site of 19th century house (WSP08) and Site of Marsh House (WSP14)). The sensitivity of all the non-designated heritage assets is considered to be low, and the magnitude of change prior to mitigation, is considered to be major. Therefore, there is likely to be a direct permanent, long-term of **moderate (significant)** effect on the non-designated heritage assets prior to the implementation of mitigation measures.

9.9.2 There is a potential for currently unknown below ground archaeological assets, including deeply stratified deposits not disturbed by modern development. Due to the proximity of the Principal Application Site to the River Yare and the medieval shoreline, there is potential for below ground remains associated with maritime activity, and for high level of preservation of remains, such as wooden artefacts, in waterlogged deposits. The presence of, extent, quality, date and sensitivity of such remains is unknown and cannot be quantified prior to excavation. As such, any remains present could range in sensitivity from negligible to high, with any remains of Palaeolithic date being classed as being of international significance and Very High sensitivity.

9.9.3 The HEDBA (Appendix 9B (document reference 6.2)) has assessed the likelihood for the nature of unknown below ground archaeological assets within the Principal Application Site. This has determined that there is greater likelihood for buried assets on the west side of the River Yare of medieval, post-medieval and modern date. The sensitivity of these assets is predicted, based on the current evidence, to be negligible to medium. The magnitude of change prior to mitigation is considered to be moderate to

major. Therefore, there is likely to be a direct permanent, long-term of **slight (not significant) to large (significant)** effect on any below ground heritage assets prior to the implementation of mitigation measures.

9.9.4 The HEDBA has identified that the potential for unknown below ground archaeological remains on the east side of the River Yare varies from that predicted to the west. The land mass here is of a more recent date and historically has been part of the Naval base and then a port. Therefore, there is a higher likelihood for below ground remains of post-medieval and modern date of negligible to low sensitivity. The magnitude of change prior to mitigation is considered to be moderate to major and for this side of the Application Site it is judged to be a direct permanent, long-term of **slight (not significant)** effect, due to the differing nature of the remains predicted.

Mitigation

9.9.5 A programme of archaeological evaluation is required to determine whether potential features identified from the assessment survive as below ground assets within the Principal Application Site to confirm the presence or absence of currently unknown below-ground remains. The Acting Historic Environment Team Leader (Strategy and Advice) at NCC has agreed this could be undertaken post-decision due to the constraints of the Principle Application Site (see Table 9.4 above). The aim of the post-consent archaeological works would be to determine the importance, extent, date, level of survival of the assets, and to inform a mitigation strategy which would be implemented either prior to or during the construction phase. The scope of the evaluation is presented in a WSI (document reference 6.9). This is secured in the draft DCO (document reference 3.1) by Requirement 12 which ensures that construction work must be carried out in accordance with the WSI.

9.9.6 Current legislation draws a distinction between archaeological remains of national or international importance and other remains considered to be of lesser importance. Any below-ground archaeological remains identified which are judged to be of very high or high importance may require preservation in situ, whilst those of lesser importance may undergo archive recording, where they are of medium or low value. This would be in the form an archaeological excavation which would ensure preservation by record.

9.9.7 The design and methodology for any subsequent archaeological mitigation would be presented in further WSIs and detailed method statements. The WSI would also outline the approach to post-excavation assessment, reporting, dissemination of the results of the work and archiving. The WSI would be produced in consultation with the NCC County Archaeologist and GYBC, before being approved by the county planning authority.

Residual Effects

9.9.8 The magnitude of residual effects is dependent upon the mitigation measures applied: preservation in-situ; or preservation by record.

9.9.9 The sensitivity of the eight non-designated below ground heritage assets are considered to be low, and the magnitude of change following mitigation through preservation in-situ is no change. Therefore, there is likely to be a direct permanent, long-term **neutral (not significant)** effect on the non-designated heritage assets following to the implementation of mitigation measures (preservation in-situ). The magnitude of change following mitigation through preservation by record is moderate and there is likely to be a direct permanent, long-term **slight (not significant)** effect on the eight non-designated heritage assets.

9.9.10 The sensitivity of currently unknown below ground heritage assets in the Principal Application Site is unknown, however the HEDBA has established that the likelihood they will be of negligible to medium value, with a higher potential for medium value remains on the west side of the River Yare. Where present, the magnitude of change would be no change following mitigation through preservation in-situ. Where this is secured, there is likely to be a direct permanent, long-term **neutral (not significant)** effect. The magnitude of change following mitigation through preservation by record would be moderate. The residual effect following mitigation through preservation by record is likely to be a direct permanent, long-term effects ranging from **slight (not significant)** to **moderate (significant)**, depending on the sensitivity of the heritage asset.

Palaeoenvironmental

9.9.11 Palaeoenvironmental remains in the form of peat and alluvial deposits of the Breydon Formation are located between depths of -0.23m OD and -10m OD on the west side of the Yare within the Principal Application Site and predicted to be of medium to high sensitivity. The magnitude of change prior to mitigation would be moderate to major and there is likely to be a direct permanent, long-term effects ranging from **moderate** to **large (significant)**.

Mitigation

9.9.12 Further evaluation is required to determine the nature of the deposits identified from the GI borehole logs where they would be disturbed within the Principal Application Site. A dedicated geoarchaeological borehole survey would be undertaken as part of the pre-construction evaluation stage and is set out in the WSI (document 6.9). The aim of the borehole survey is to recover undisturbed core samples from the Breydon Formation deposits. The cores would be split and each cleaned and recorded. Dependent upon the results, sub-sampling and palaeoenvironmental assessment (pollen, diatoms and foraminifera) may be required.

9.9.13 Depending on the nature of deposits recovered, further paleoenvironmental works may be recommended to ensure preservation by record of any important deposits. These would be set in subsequent WSIs and method statements. Where possible, any sensitive deposits would be preserved in situ.

Residual Effects

9.9.14 Mitigation in the form of preservation by record would not remove the effect as the deposit would still be destroyed, but will reduce the impacts as a permanent record of the assets existence would be made. The sensitivity of palaeoenvironmental remains in the form of peat and alluvial deposits of the Breydon Formation is predicted to be medium to high, and the magnitude of change, following mitigation through preservation by record, is moderate. Therefore, there is likely to be a direct, permanent, long-term effect of **moderate (significant)** effect following the implementation of mitigation measures.

9.9.15 Where palaeoenvironmental deposits can be preserved in situ, there would be no change and a direct permanent, long-term **neutral (not significant)** effect.

Built Heritage Assets

9.9.16 The sensitivity of the non-designated built heritage assets late 19th century terraced buildings on Queen Anne's Road (WSP04) and Southtown Road (WSP06) are considered to be low, and the magnitude of change prior to mitigation, is also considered to be major. Therefore, there is likely to be a direct, permanent **moderate adverse (significant)** effect on the non-designated built heritage assets within the Principal Application Site prior to the implementation of mitigation measures.

Mitigation

9.9.17 A level 1 historic building assessment would be undertaken, in accordance with Historic England's 2016 guide, titled 'Understanding Historic Buildings. A Guide to Good Recording Practice', ahead of demolition. The aim of the building assessment would be to determine the condition and value of any historic elements terraced housing, determine if additional, more detailed, building recording or monitoring is required prior to or during demolition; and to produce an archive for deposition with an appropriate museum, and to provide information for accession to the NHER, to ensure the long-term survival of the excavated data. The scope of the historic building assessment is set out in the WSI (document reference 6.9).

Residual Effects

9.9.18 The sensitivity of the non-designated built heritage assets late 19th century terraced buildings on Queen Anne's Road (WSP04) and Southtown Road (WSP06) are considered to be low, and the magnitude of change following mitigation, is moderate.

9.9.19 Therefore, there is likely to be a direct, permanent long-term slight (**not significant**) effect on the non-designated built heritage assets in the Principal Application Site following the implementation of mitigation measures.

Setting of Built Heritage Assets

9.9.20 Nelson's Monument is a Grade I Listed Building and is therefore of high value, based on its architectural, historical and artistic interest. The immediate setting contributes minimally towards the value of this asset, however its height, physical prominence and the broader historic links between the monument and the wider landscape, does contribute to its value. Overall, the setting is judged to have a moderate contribution to the sensitivity.

9.9.21 The visual intrusion resulting from the construction of the Scheme is predicted to present a challenge to the prominence of the asset. The infrastructure required to build the Scheme, particularly the bridge, control tower and plant room, would require the introduction of plant and equipment, such as cranes and piling rigs, which would compete visually with Nelson's Monument. The asset is already competing with other high features and the Scheme would increase this impact. Views to the heritage asset from ground level on Southtown Road would also be impeded during the construction phase.

9.9.22 The sensitivity of the Nelson's Monument is high, and the magnitude of change on its setting is considered to be minor. Therefore, there is likely to be a direct, temporary, short-term **moderate (significant)** effect on the setting of the Grade I Listed Building.

9.9.23 The Grade II Listed Gas Holder is a medium value asset and is located approximately 150m from the east side of the new road and bridge. Due to the proximity of the asset to the Principal Application Site, there would be temporary adverse impacts on the setting during the construction period associated with an increase in noise, vibration, construction related traffic, and plant. The Noise and Vibration assessment (Chapter 7) indicates a moderate increase in noise levels at this location (+5.0 to 9.9 dB; Figure 7.2). There would be visual impacts too, with view from the asset outwards and views towards it being substantially altered.

9.9.24 The setting of the Gas Holder contributes minimally to the value of the asset. The most significant element is its height and prominence in the wider landscape. The visual intrusion from the construction phase would have adverse impact on views towards Gas Holder, potentially either reducing its visibility or competing with it.

9.9.25 The sensitivity of the Gas Holder is medium, and the magnitude of change on the setting is considered to be moderate. Therefore, there is likely to be a direct, temporary, short-term **moderate (significant)** effect on the setting of the Grade II Listed Building.

Mitigation

9.9.26 There are no mitigation measures proposed to reduce or remove the temporary adverse impacts on the setting of the Grade I Listed Building Nelson's Monument and the Grade II Listed Building Gas Holder during the construction phase.

Residual Effects

9.9.27 There are no mitigation measures proposed to reduce the effects. Therefore, the effects remain as direct, temporary, short-term **moderate (significant)** on the Grade I Listed Building Nelson's Monument and the Grade II Listed Building the Gas Holder.

Monitoring

9.9.28 Monitoring arrangements during the evaluation phase for the below ground heritage assets, palaeoenvironmental deposits and non-designated built heritage assets within the Principal Application Site are set out in the WSI (document reference 6.9, notably Section 6.1). This provides for monitoring visits by NCC County Archaeologist during the course of the fieldwork. Any monitoring arrangements required during the mitigation phase would be set out in subsequent WSIs.

Operational Phase

Below-Ground Archaeological Assets and Palaeoenvironmental Deposits

9.9.29 There is a potential for currently unknown below ground archaeological assets, including deeply palaeoenvironmental, stratified deposits not disturbed by modern development. Due to the proximity of the Principal Application Site to the River Yare and the medieval shoreline, there is potential for below ground remains associated with maritime activity, and for high level of preservation of remains, such as wooden artefacts, in waterlogged deposits. The sensitivity of such remains is unknown and may range from negligible to high value. Any remains of Palaeolithic date would

be classed as being of international significance and very high sensitivity, and of low to high value located within the Principal Application Site.

9.9.30 There is potential that following the completion of the construction, any below ground archaeological remains present in the Principal Application Site and its environs would be adversely impacted through changes in the local hydrology, resulting in the compaction, desiccation or waterlogging of below ground remains. The potential for change and effects for groundwater is reported in Chapter 11: Road Drainage and the Water Environment. This has determined that there will be no change and neutral effects to the groundwater quality, recharge and flow and a negligible change and negligible effects to the groundwater flow and quantity in superficial deposits and to the Crag Group aquifer (Section 11.8). The Preliminary Ground Water Control Strategy contains some uncertainties, however, which will be improved and defined through the project lifecycle (Section 11.10).

9.9.31 The assessment of change and effect on groundwater levels indicates no or negligible levels of change to the groundwater level, however it is not known currently what the impact of a negligible change would have on the archaeological value of the superficial deposits until they have been evaluated (in particular the Breydon Formation peats). Based on the information currently available, there is a potential for direct permanent, long-term **negligible (not-significant)** to **large (significant)** effect on any below ground heritage assets and palaeoenvironmental deposits due to changes in local hydrology, prior to the implementation of mitigation measures.

Mitigation

9.9.32 The pre-construction archaeological and palaeoenvironmental evaluation set out in the WSI (document 6.9) would provide more information to assess the presence or absence of below ground assets which could be impacted upon by changes in the local groundwater levels.

9.9.33 Depending on the nature of heritage assets identified in the archaeological and paleoenvironmental evaluation, additional works may be required to ensure preservation by record of any important deposits which cannot be preserved in-situ. These would be set in subsequent WSIs and method statements.

Residual Effects

9.9.34 The sensitivity of currently unknown below ground heritage assets is unknown, however where present the magnitude of change would be no change following mitigation through preservation in-situ. Where this is secured, there is likely to be a direct permanent, long-term **neutral (not significant)** effect. The magnitude of change following mitigation through preservation by record would be moderate. Where no mitigation can be

secured, the effects would remain **negligible (not significant)** to **moderate (significant)**, depending on the sensitivity of the assets changed.

Setting of Built Heritage Assets

9.9.35 Nelson's Monument is a high value heritage asset (Grade I Listed Building) and the immediate setting contributes minimally towards the value of this asset. The introduction of the road, bridge, control tower and plant room would introduce features within the wider setting of Nelson's Monument which have the potential to challenge the visual prominence of the asset. The visual challenge would be higher during the time when the bridge is in the raised position (up to 5.5 minutes per vessel passage). The Scheme would also change the views towards the asset from the north and north-west, and would block some currently existing views at the current street level. The asset is already facing significant challenges to its visual prominence due to the variety of features in the modern landscape, including cranes and large commercial structures, and therefore the Scheme would compete with it in some locations. It is important to note, however, that the introduction of the Scheme would provide a new opportunity to view the asset from an elevated position from the bridge.

9.9.36 The visual prominence in the wider landscape represents an important aspect of the asset's setting and therefore any changes to this would impact on the asset. The impacts on the setting are judged to be minor, as the setting would be noticeably changed, but not significantly modified. The sensitivity of the Nelson's Monument is high, and the magnitude of change is considered to be minor. Therefore, there is likely to be a direct, permanent, long-term **moderate (significant)** effect on the Grade I Listed Building.

9.9.37 The Grade II Listed Gas Holder is a medium value asset and is located approximately 150m from the east side of the Principal Application Site. The introduction of the Scheme would represent a substantial change in the immediate setting of the Grade II Listed Building Gas Holder. The Scheme would challenge and compete with the visual prominence of the asset, due to the scale and proximity of the Scheme to the asset. The dominance of the Scheme would be increased by the movement of traffic and pedestrians across it, and the introduction of a vehicle lighting and a moderate increase in the level of noise (+5.0 to 9.9 dB, Figure 7.2). from vehicles using the Scheme. There are anticipated to be limited impacts due to artificial lighting associated with the Scheme, however, as any additional lighting would be consistent with the baseline conditions (see Chapter 10: Townscape and Visual, Section 10.7). The Scheme would significantly change the views at current street level from the west and the road and bridge new block some existing views. New views would be introduced towards it from the bridge itself, however.

9.9.38 The setting of the Gas Holder has a minor and largely unintentional contribution to the value of the asset. The Scheme would have a moderate impact on the setting as it would be significantly modified. The sensitivity of the Gas Holder is medium, and the magnitude of change is considered to be moderate. Therefore, there is likely to be a direct, temporary, long-term **moderate (significant)** effect on the Grade II Listed Building.

Assessment of Harm on Designated Heritage Assets

9.9.39 The NPS NN (paragraphs 5.128 to 5.138) and NPPF (paragraphs 193 to 202) outlines the requirement to assess the magnitude of harm on the historic environment resulting from a development. Substantial harm to or loss of a Grade II Listed Building or a Grade II Registered Park or Garden should be exceptional. Substantial harm to or loss of designated assets of the highest significance, including World Heritage Sites, Scheduled Monuments, Grade I and II* Listed Buildings, Registered Battlefields, and grade I and II* Registered Parks and Gardens should be wholly exceptional.

9.9.40 The assessment of magnitude of harm is determined by the impact of the development on the value and interest of the heritage asset (architectural, historic, archaeological, and/or artistic). The assessment of harm is expressed on a three-point scale: Minor Harm and Harm (both constitute “Less than Substantial Harm”) and Substantial Harm.

9.9.41 Harm can occur from a change in the setting of the cultural heritage asset. Less than Substantial Harm results from either the slight degradation (Minor Harm) or appreciable degradation (Harm) of the contribution of the setting to the value of the cultural heritage asset. Substantial Harm occurs when the contribution of the setting of the cultural heritage asset to its significance is effectively lost or substantially reduced as a result of the development, the relationship between the asset and its setting is no longer readily appreciable.

9.9.42 Minor Harm corresponds with Slight Adverse effects for EIA and is therefore not significant. Harm is can be considered to correspond with Moderate Adverse effect and therefore in EIA assessment is a significant effect, however in compliance with NPS NN it is judged to be Less Than Substantial Harm.

9.9.43 Nelson’s Monument is a Grade I Listed Building and is therefore of high value, based on its architectural, historical and artistic values. The assessment has established that its immediate setting contributes minimally towards the value of this asset, however the wider setting does contribute to its value. The impacts on the setting are judged to be minor, as the setting would be noticeably changed, but not significantly modified, however as the asset has a high value the effects would be moderate adverse.

9.9.44 The Scheme would not result in a significant change to the architectural, historical and artistic interest of the Nelson's Monument. The Scheme would reduce the contribution the setting makes in a few locations in the wider setting by diminishing its visual prominence, however the introduction of the Scheme would provide new opportunities to view the asset from the bridge itself. The Scheme would therefore have Less than Substantial Harm on Nelson's Monument.

9.9.45 The Gas Holder was built in the 1880s and was designated as a Grade II Listed Building in 1998. As it is a Grade II listed building, it is of medium sensitivity, based largely on its architectural value, which is increased by the use of ornate elements within an otherwise utilitarian structure. Historically, it is representative of 19th century efforts to provide a regular and constant gas supply to businesses and homes which also adds to its value. The setting provides a minor contribution due to the size and prominence of the structure.

9.9.46 The introduction of the Scheme would not impact significantly on the architectural interest of the Gas Holder, as there would be no direct physical impacts, and would not change the historic value in anyway. The asset has unintentionally become a prominent feature in the wider landscape and the Scheme would impact on the asset by reducing and removing some views towards it. The impacts are judged to be minor and would be Less than Substantial Harm.

9.9.47 Where any harm to the significance of a designated heritage asset would be less than substantial, the harm should be weighed against the public benefits of the proposal, in compliance with NPS NN Paragraph 5.134. The relevant policy tests and the balance exercise is outlined in the Case for The Scheme (document 7.1).

Mitigation

9.9.48 There are no mitigation measures proposed to reduce or remove the adverse impacts and effects on the setting of the Grade I Listed Building Nelson's Monument and the Grade II Listed Building Gas Holder during the operation phase.

Residual Effects

9.9.49 There are no mitigation measures proposed to reduce the effects. Therefore, the effects remain as direct, permanent, long-term **moderate (significant)** on the Grade I Listed Building Nelson's Monument and the Grade II Listed Building the Gas Holder.

Monitoring

9.9.50 No monitoring is considered to be required over and above that which is would normally be carried out during the operational phase.

9.10 Limitations and Assumptions

9.10.1 This assessment draws upon the records held on the NHLE and NHER. The data does not represent a full record of all surviving archaeological receptors, but a record of the discovery of a wide range of archaeological and historical components of the historic environment. The information held within it is not complete and does not preclude the subsequent discovery of further elements of the historic environment that are, at present, unknown.

9.11 Summary

9.11.1 The assessment has identified the potential for significant effects on eight non-designated below ground heritage assets within the Principal Application Site of 19th century date during the construction phase (The Icehouse and Three Salt Stores (HER 55685), Wharf side Buildings (WSP09), and Fish Wharf (WSP10) and Site of buildings on west side of Southtown Road (WSP11, WSP12 and WSP13)). The value of these assets is judged to be low based on the currently available evidence. The magnitude of change of the Scheme on below ground remains would be moderate to major adverse, and the effects likely to be direct permanent, long-term of **moderate (significant)**, depending on their value, reducing to **neutral to slight adverse (not significant)** with mitigation. Mitigation would be in the form of preservation in-situ or through preservation by record and would be informed by a programme of evaluation set out in a WSI (document 6.9).

9.11.2 There is a potential for currently unknown below ground archaeological assets of unknown sensitivity, but which could vary from negligible to very high level. The assessment has established there is greater likelihood for remains of negligible to medium value within the Principal Application Site. The magnitude of change prior to mitigation is considered to be moderate to major. Therefore, there is likely to be a direct permanent, long-term of **slight (not significant)** to **large (significant)** effect on any below ground heritage assets prior to the implementation of mitigation measures. These would be reduced to **slight adverse** (**not significant**) to **moderate (significant)** effect with mitigation. Mitigation would be in the form of preservation in-situ or through preservation by record and would be informed by a programme of evaluation set out in a WSI (document 6.9).

9.11.3 There is potential that during the operation phase, below ground archaeological remains present in the Principal Application Site and its environs would be adversely impacted through changes in the local

hydrology, resulting in the compaction, desiccation or waterlogging of below ground remains. The magnitude of change prior to mitigation is currently unknown, and the effects predicted to range from direct permanent, long-term **slight (not significant)** to **large (significant)** prior to the implementation of mitigation measures. The evaluation measures set out in the WSI (document 6.9) would inform any future programme of mitigation, where necessary, and the residual effects would range from **neutral (not significant)** to **moderate (significant)** with mitigation, depending on the sensitivity of the assets changed.

9.11.4 The paleoenvironmental assessment has identified peat and alluvial layers on the west side of the Scheme which could date from the early prehistoric through the Anglo-Saxon period, of medium to high sensitivity based on the currently available evidence. The magnitude of change prior to mitigation would be moderate to major and there is likely to be a direct permanent, long-term effects ranging from **moderate** to **large (significant)**. Further evaluation is required to determine the nature and sensitivity of the deposits identified from the GI borehole logs where they would be disturbed within the Principal Application Site (see WSI, document 6.9). The residual effects would **neutral** to **slight adverse (not significant)** where deposits are preserved in-situ, and direct, permanent, long-term effect of **moderate (significant)** where any change would occur.

9.11.5 There are two non-designated built heritage assets within the Principal Application Site which would be demolished during the construction phase. They are of low sensitivity and would be subject to major change. There is likely to be a direct, permanent **moderate adverse (significant)** effect prior to the implementation of mitigation measures, reducing to direct, permanent long-term slight (**not significant**). Mitigation would be in the form of a Level 1 Historic Building assessment initially (prior to demolition), with additional recording being undertaken where required.

9.11.6 Significant effects are anticipated on the settings of the Grade I Nelson's Monument (NHLE 1246057) and Grade II Listed Gas Holder (NHLE 1096789) during both construction and operation as a result of the visual intrusion of the road, bridge, control tower and plant room. The value of both assets is linked to their height and visual dominance. The sensitivity of the Nelson's Monument is high, and the magnitude of change is considered to be minor. Therefore, there is likely to be a direct, temporary, short-term **moderate (significant)** effect on the Grade I Listed Building. The sensitivity of the Gas Holder is medium, and the magnitude of change is considered to be moderate. Therefore, there is likely to be a direct, temporary, short-term **moderate (significant)** effect on the Grade II Listed Building. There are no mitigation measures proposed to reduce or remove the temporary adverse impacts on the setting of the Grade I Listed Building Nelson's Monument and the Grade II Listed Building Gas Holder during the construction or operation phase.

9.11.7 The Scheme would not result in a significant change to the architectural, historical and artistic interest of the Nelson's Monument. The Scheme would slightly reduce the contribution the setting makes in a few locations in the wider setting by diminishing its visual prominence, however the introduction of the Scheme would provide new opportunities to view the asset from the bridge itself. The Scheme would therefore have Less than Substantial Harm on Nelson's Monument.

9.11.8 The introduction of the Scheme would not impact significantly on the architectural interest of the Gas Holder, as there would be no direct physical impacts, and would not change the historic value in anyway. The asset has unintentionally become a prominent feature in the wider landscape and the Scheme would impact on the asset by reducing and removing some views towards it. The impacts are judged to be minor and would be Less than Substantial Harm.

9.11.9 A summary of the significant effects is presented in Table 9.10 below.

Table 9.10: Summary of Effects Table for Cultural Heritage

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Permanent destruction of all or part of below ground heritage asset.	Eight non-designated below ground heritage assets of low value (The Icehouse and Three Salt Stores (HER 55685), Wharf side Buildings (WSP09), and Fish Wharf (WSP10) and Site of buildings on west side of Southtown Road (WSP11, WSP12 and WSP13) Site of 19th century house (WSP08) and Site of Marsh House (WSP14)).	Moderate Significance -/ P/ D/ L	Preservation in-situ or by record.	Neutral for preservation in situ and Slight Significance for preservation by record -/ P/ D/ L
Permanent destruction of all or part of below ground heritage assets.	Currently unknown below ground assets of unknown value.	Based on available evidence, predicted to be Slight to Large significance, depending on value of receptor.	Preservation in-situ or by record.	Neutral for preservation in situ and Slight to Moderate significance for preservation by record.

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
		-/ P/ D/ L		-/ P/ D/ L
Permanent destruction of all or part of palaeoenvironmental remains.	Peat and alluvial deposits of the Breydon Formation of medium to high value.	Large to Moderate significance, depending on value. -/ P/ D/ L	Preservation in-situ or by record.	Neutral where preservation in situ and Moderate Significance for preservation by record. -/ P/ D/ L
Demolition of built heritage assets.	19th century terraced housing of low value.	Moderate Significance -/ P/ D/ L	Preservation by record.	Slight Significance -/ P/ D/ L
Impacts on heritage assets through changes in setting.	The Grade I listed Nelson's Monument (NHLE 1246057) of high value; and Grade II Listed Gas Holder (NHLE 1096789) of medium value.	Moderate Significance -/ T/ I/ ST	None appropriate	Moderate Significance -/ T/ I/ ST
Operational Phase				
Loss or reduction of	Currently unknown below ground	Slight to Large	Preservation in-	Neutral for

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
below ground heritage assets around the Scheme through changes in hydrology.	assets and palaeoenvironmental remains of unknown value.	significance, depending on value. -/ P/ D/ L	situ or by record.	preservation in situ and Slight to Moderate significance for preservation by record. -/ P/ D/ L
Impacts on heritage assets through changes in setting.	The Grade I listed Nelson's Monument (NHLE 1246057) o high value; and Grade II Listed Gas Holder (NHLE 1096789) of medium value.	Moderate Significance -/ T/ I/ ST	None appropriate.	Moderate Significance -/ T/ I/ ST

Key to table:

+ / - = Positive or Negative P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short-Term, Medium-Term or Long-Term N/A = Not Applicable

9.12 References

Ref. 9.1: DMRB, Volume 11, Section 3, Part 2; Appendix 8 (DMRB: HA208/07).

Ref. 9.2: National Policy Statement for National Networks (NPS NN) (January 2015).

Ref. 9.3: National Planning Policy Framework (NPPF) (February 2019).

Ref. 9.4: Historic Environment Good Practice Advice in Planning Policy Notes 2-3 managing significance and setting (2017).

Ref. 9.5: Meeres, F. A (2007), History of Great Yarmouth, Phillimore.

10 Townscape and Visual Impacts

10.1 Introduction

10.1.1 This chapter describes the assessment of the likely significant effects of the Scheme on the townscape character and on the visual amenity experienced by people (referred to as visual receptors) during the construction and operational phases of the Scheme. The assessment considers potential impacts of the primary elements of the Scheme (the Crossing with its control tower, associated approach and link roads, including tie-ins within the existing road network, and the public realm and landscape elements) on the receiving environment and on people. Chapter 2: Description of the Scheme provides details of the Scheme which has informed this assessment.

10.1.2 For the purposes of the assessment, as the predominant landscape character in Great Yarmouth is one of townscape, references in this chapter to townscape should be taken as also covering landscape. Townscape relates to the landscape of an urbanised area and the relationship between built form and open spaces, including green space.

10.1.3 The assessment in this chapter should also be read in conjunction with Chapter 9: Cultural Heritage, which reports on the effects of the Scheme on heritage assets.

10.2 Competent Expert

10.2.1 The Landscape and Visual lead, Peter Metcalfe, is a Chartered Landscape Architect who holds a Master's degree in Landscape Architecture from The University of Sheffield (2014). He is suitably experienced in the preparation of Landscape and Visual Impact Assessment as part of Environmental Assessment, and is knowledgeable about the DCO process and sector-specific environmental mitigation.

10.2.2 The Landscape and Visual reviewer, Christopher Rance, is a Chartered Landscape Architect who holds a Master's degree in Landscape Management from The University of Manchester. He is suitably experienced in technical review of Landscape and Visual Impact Assessment as part of Environmental Assessment, and is knowledgeable about the DCO process and sector-specific environmental mitigation.

10.3 Legislative and Policy Framework and Guidance

10.3.1 Table 10.1 provides a summary of the relevant key policy and guidance for this assessment. A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 10A (document reference 6.2).

Table 10.1: Applicable Policy Relevant to the Assessment

Policy/ Guidance	Summary	Conformance
National Policy Statement for National Networks (NPS NN) (Ref 10.2)	The following paragraphs are applicable to this assessment and are detailed below. Paragraph 5.144 states *"where the development is subject to EIA the applicant should undertake an assessment of any likely significant landscape and visual impacts"* Paragraph 5.146 states *"The assessment should include the visibility and conspicuousness of the project during construction and of the presence and operation of the project and potential impacts on views and visual amenity. And "including on local amenity, tranquillity"* Paragraph 5.149 *"Having regard to siting, operational and other relevant constraints, the aim should be to avoid or minimise harm to the landscape, providing reasonable mitigation*	The chapter conforms with paragraph 5.144, as it presents an assessment of any likely significant landscape and visual impacts during construction and operation (see Section 10.9). The chapter has considered impacts on views and visual amenity, including local amenity and tranquillity (see Sections 10.4,10.5 and 10.9). The chapter conforms with paragraph 5.149. It considers the existing baseline conditions and nature of the likely effect of the Scheme. It has embedded mitigation within the Scheme to minimise the landscape and visual amenity effects. See Section 10.9 for a description of embedded mitigation. The assessment conforms with paragraph 5.154 as the assessment

Policy/ Guidance	Summary	Conformance
	where possible and appropriate." Also, with regards to developments that lie outside of national designation paragraph 5.154 states *"The duty to have regard to the purposes of nationally designated areas also applies when considering applications for projects outside the boundaries of these areas which may have impacts within them."* Local designations outside national designations that indicate value as stated in paragraph 5.156 states *"Outside nationally designated areas, there are local landscapes that may be highly valued locally and protected by local designation."*	has considered the potential impacts on The Broads. Direct Landscape effects have been determined as insignificant (see insignificant effects) and effects on users enjoying The Broads have been included with the inclusion of two viewpoints within The Broads (see section 10.9). The assessment conforms with paragraph 5.156 by the inclusion of local Conservation Areas and their contribution to overall value of a Townscape Character Area (see Figure 10.3 and Section 10.5).
National Policy Statement for Ports (NPS for Ports) (Ref 10.3)	Whilst the Scheme does not constitute Port development, the NPS for Ports does provide useful context for coastal projects in so far that in paragraph 5.11.1 it clarifies that references to landscape should be taken as *"covering seascape and townscape, where appropriate."*	The chapter conforms with this policy by assessing the impacts of the Scheme on townscape. Seascape has been scoped out (see Section 10.4).

Policy/ Guidance	Summary	Conformance
National Planning Policy Framework (NPPF) (Ref 10.4)	The NPPF was published in March 2012 and updated in February 2019. Paragraph 124 of the NPPF states that: *"The creation of high-quality buildings and places is fundamental to what the planning and development process should achieve. Good design is a key aspect of sustainable development, creates better places in which to live and work and helps make development acceptable to communities."* Paragraph 127 of the NPPF specifies design objectives that development should achieve, and paragraph 170 of the same document states that the planning system *"should contribute to and enhance the natural and local environment by protecting and enhancing valued landscapes."*	These principles have been considered in the design of the Scheme. See Chapter 4: Approach to EIA. The assessment considers local designations such as Conservation Areas which indicate value, and which informs the baseline. See Figure 10.3 and Section 10.5.
Guidelines for Landscape and Visual Impact Assessment (Ref 10.5)	This sets out the assessment methodology for undertaking landscape and visual impact assessments. The GLVIA (Ref 10.5) acknowledges the relationship between the perception of landscape and townscape and the similarities in the approach to be undertaken in the	The assessment methodology is based on GLIVA (Ref 10.5), see Section 10.4. This chapter assesses effects on townscape and visual receptors (See Section 10.9).

Policy/ Guidance	Summary	Conformance
	assessment process. It also identifies the perception of townscape, and the experience of viewers (referred to as receptors – defined as residents, people in their workplace, attending school, using recreational facilities and using the countryside, shoppers etc.) and development proposals.	
East Inshore and East Offshore Marine Plans (EIEOMP) (Ref 10.1)	Marine Plans are implemented as a requirement of the Marine and Coastal Access Act 2009. The plans provide for the application or clarification of national planning policy in relation to coastal areas. Policy SOC3 sets out, in order of preference, how proposals that may affect terrestrial or marine character should avoid, reduce, mitigate or provide justification for potential impacts.	The chapter has assessed the impacts on the River Yare, as a tidal estuary river, however an assessment of effects on the seascape has been scoped out (see Section 10.4).
Townscape Character Assessment (Technical Information Note 05/2017) (TIN-05-2017) (Ref 10.15)	Provides guidance on undertaking townscape assessment in line with the GLVIA (Ref 10.5).	The methodology has considered the technical note and is presented within Section 10.4.

10.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

10.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the Scoping

Report (document reference 6.6), Scoping Opinion and PEIR (appended to Consultation Report (document 5.2)).

10.4.2 Seascape has been scoped out of the assessment for the following reason. Seascape is defined in the Marine Policy Statement (Ref 10.17) as "landscape with views of the coast or seas, and coasts and the adjacent marine environment with cultural, historical and archaeological links with each other". The Crossing, in its raised position has limited or no visibility from the sea and from the coastline (see Figure 10.2). Therefore, the Scheme is considered to have no effects on seascape including on the Norfolk Coastal Waters Character Area (Ref 10.16).

10.4.3 It is noted that the East Inshore Marine Plan area includes the waters of any estuary, river or channel, so far as the tide flows at mean high water spring tide. However, as the tidal Yare in this location is a river with extensively urbanised banks, it is not considered to contribute to the local marine character and the presence of the Scheme would not change this.

Consultation

10.4.4 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

10.4.5 Table 10.2 and 10.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 10.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
ID2 – Study Area: *"The Scoping Report states that the study area would be identified through a combination of 3D modelling and site work, to be agreed with GYBC. The ES should explain how the consultation with GYBC and the studies have informed the decisions taken with regards to the assessment. It should be clear how the study area has been defined with reference to the desk studies and site visits, and how the visual envelope has been*	PINS	A Zone of Theoretical Visibility (ZTV), modelled on the Scheme has been used to determine the 3km study areas, with an adjustment to the east to follow the high-water line (see Figure 10.2). There would be limited visibility of the Scheme with the Crossing in the raised position beyond the 3km study area, however if visible due to the distance and existing context of the backdrop of the town of Great Yarmouth it would not result in significant effects.

Scoping Opinion Item	Consultee	Response
used to identify sensitive receptors for inclusion in the assessment."		A site walk over was undertaken to confirm the ZTV and study areas.
ID3 – Baseline: *"The Inspectorate notes that the character areas of North East Norfolk and Flegg, Suffolk Coast and Heaths, and The Broads have been identified on the Environmental Constraints Plan (Figure 3, Appendix B) of the Scoping Report. However, in the townscape section there is no mention of these character areas in the description of baseline conditions within the Scoping Report (paragraphs 6.6.1 to 6.1.10). The ES should make clear whether National Character Areas have been considered in the ES baseline and assessment of impacts, where they are deemed relevant to the Proposed Development."*	PINS	The National Character Areas (NCA), NCA 79: North East Norfolk and Flegg, NCA 80: The Broads and NCA 82: Suffolk Coast and Heaths have been considered within the baseline conditions, but as they primarily relate to the rural characteristics and are of such a large geographical extent that the Scheme and 3km study area is too fine a scale that there would be no discernible effects on the key characteristics of the NCAs (see Section 10.5).
ID4 – Potential Effects: *"The Scoping Report refers to 'a new prominent feature'. It is not clear whether this statement is referring to the proposed bridge structure or the entirety of the Proposed Development. The ES should assess all impacts of the Proposed Development that are likely to give rise to significant effects. Effects should be assessed during both the operational and construction phases of the development. Consideration should also be given to likely significant effects at the point of opening and effects in the longer term. Where*	PINS	The chapter reports on the assessment of any likely significant landscape and visual effects of the Scheme (which includes all elements of the Scheme) during construction and operation (at opening Year 1 and at Year 15) (see Section 10.9).

Scoping Opinion Item	Consultee	Response
relevant, the ES should include both positive and negative effects."		
ID5 – Methodology: *"The Inspectorate notes from Paragraph 6.6.15 of the Scoping Report that a methodology for townscape character and visual amenity is to be prepared and agreed with GYBC and that the Scoping Report only identifies key components of the methodology likely to be adopted. The ES and/or accompanying appendices must include a detailed description of the methodology applied to the assessment. The Applicant is reminded to ensure that the Townscape and Visual Impact aspect chapter makes clear in each case whether any residual effect is deemed to be 'significant' or 'not significant'. Where professional judgement has been used to determine significance, this should be stated. The ES should also document agreements reached with GYBC with regards to the assessment methodology and justify the approach taken, should the chosen approach differ."*	PINS	The methodology has been agreed with GYBC. See Table 10.4. The threshold of significance has been determined as those of moderate and above. See Chapter 4: Approach to EIA. The methodology for determining significant effects is presented in Section 10.4. Residual effects are presented in Section 10.11.
ID6 – Baseline (identification of heritage-specific viewpoints): *"Receptors - With reference to comments made by the Inspectorate in Table 4.4 Cultural Heritage above, the chosen viewpoints for the Proposed Development should include heritage-specific viewpoints/receptors to inform the Cultural Heritage impact*	PINS	A comparison with the Cultural Heritage chapter has been undertaken and there is no duplication. Viewpoint locations are presented in Figure 10.1. Conservation areas have been considered within the assessment in how they contribute to an understanding of the townscape baseline but have been assessed where

Scoping Opinion Item	Consultee	Response
assessment. The ES should not duplicate assessments in aspect chapters and the assessment of visual effects on heritage assets should be presented in the Cultural Heritage aspect chapter; however, the ES should ensure appropriate cross-referencing is provided between the two aspect chapters."		appropriate within the Chapter 9: Cultural Heritage.
ID7 – Visual receptors (land): *"The Inspectorate notes the intention to include footpaths and other rights of way as viewpoints in the assessment of visual impact. The ES should include an assessment of visual effects on users of the Sustrans National Route 517 and the English Coast Path National Trail."*	PINS	The assessment has included two representative viewpoints which include the NCN517 and ECP (see Sections 10.5 and 10.7 and Figure 10.1).
ID8 – Visualisations: *"The Scoping Report does not specifically describe what visualisations would be produced in the ES. To support a robust assessment of likely significant effects, the ES should include appropriate visualisations of the Proposed Development, which highlight the specific elements that would impact on townscape character and be visually prominent to visual receptors. Cross sections and photomontages should be included in the ES for this purpose."*	PINS	Photomontages have been produced where there are significant visual effects in accordance with Landscape Institute TGN 02/17 (Ref 10.6) and are presented in document reference 6.12. It was agreed with NCC to produce photomontages for two viewpoint locations. Photomontages have been produced for four locations (see Figure 10.1). The approach taken is presented in Appendix 10B (document reference 6.2). Photomontages have been referred to and used in the assessment but have not been relied upon to inform the outcomes of the assessment due to their indicative nature (see Section 10.4).

Scoping Opinion Item	Consultee	Response
ID9 – Design: *"The ES should provide details of the design and materials of the new structures. It should be explained how the design and materials have been selected with the aim of minimising the potential adverse and maximising the potential beneficial townscape and visual impacts."*	PINS	These principles have been considered in the design of the Scheme (see landscaping references in Chapter 2: Description of Scheme). The parameters of assessment of relevance to this assessment are presented in Section 10.8.
ID10 – Artificial Lighting: *"The Inspectorate welcomes the intention to assess the effects of artificial lighting as stated at paragraph 6.6.27. The ES should describe the lighting scheme for the Proposed Development and assess effects of the proposed lighting on both terrestrial and marine receptors. The proposed isolux contour plans should be appended to the ES.* *The inter-relationship between the proposed lighting impacts identified in the Townscape and Visual Impact aspect chapter and receptors for other aspects (e.g. nature conservation receptors) should be assessed in the ES, where significant effects are likely to occur."*	PINS	An assessment of artificial lighting has been undertaken for both construction and operation (see Sections 10.4 and 10.9). Reference has been made to the ISOLUX contour plan (see Figure 10.5). Marine receptors have not been considered further due to limited potential for overspill of light resulting from the Scheme design and incorporation of suitable lighting cowls, which are considered unlikely to significantly alter the baseline conditions. The lighting assessment has been referred to in Chapter 9: Cultural Heritage, however there are no predicted significant effects.

Table 10.3: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
Agreement on the 3km study area, agreement of chosen viewpoints, agreement on verifiable photomontages for two sensitive viewpoints. Proposed mitigation will be through the design of the scheme and the bridge will be a prominent new feature and landscaping is unlikely to reduce effects but could soften the public realm.	NCC	Study area has been agreed with NCC at 3km. Further details are provided in Section 10.4. Viewpoint locations were agreed with NCC, and additional ones have been added (See Figures 10.1 and 10.4). The Scheme incorporates embedded mitigation and there would be planting included within public realm (See Chapter 2: Description of Scheme and Section 10.9). Verifiable photomontages have been produced for four viewpoint locations (See Figure 10.1 and Photomontages (document reference 6.12)).
A TVIA should be provided and include two viewpoints from within The Broads area.	The Broads	In addition to the undertaking of the TVIA, two viewpoints have been included from within The Broads area (See Figures 10.1 and 10.4).

10.4.6 Table 10.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

10.4.7 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 10.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
GYBC (to seek agreement on assessment methodology).	Principal Strategic Planner	Email dated 05/06/2018	GYBC does not have a landscape officer and asked to refer landscape matters to NCC's Green Infrastructure and Landscape Officer.
NCC (to seek agreement on assessment	Green Infrastructure	Email dated 27/06/2018	NCC was consulted and agreed the proposed

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
methodology, study area and viewpoint locations)	and Landscape Officer		townscape and visual methodology (Section 10.4), along with the study area and representative viewpoint locations and visual receptors (see Figure 10.1).
NCC	Green Infrastructure and Landscape Officer	Email dated 05/11/2018	NCC was consulted and agreed the proposed additional representative viewpoints, the Zone of Theoretical Visibility Methodology and figure (see Section 10.2) along with the two photomontage representative viewpoints. They agreed that should any further significant effects be identified for representative viewpoints through the assessment then in accordance with TGN 02/17 (Ref 10.6) additional photomontages would be produced to support the assessment.
The Broads Authority (to seek agreement on locations of two viewpoints within The Broads)	Landscape Officer	Email dated 21/02/2019	The Broads were consulted to agree two representative viewpoints from within the Broads and the location of

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			the representative viewpoints.

Insignificant Effects

10.4.8 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would be insignificant and have therefore not been considered further in the assessment:

- Effects on townscape and visual receptors beyond the study area have not been assessed. As demonstrated by the Zone of Theoretical Visibility (see Figure 10.2), visibility beyond the study area would be limited to few locations when the Crossing is in the raised position (worst case) and at an intervening distance of over 3km, which in the context of the view is considered unlikely to give rise to a significant effect;

- Effects on townscape and visual receptors in relation to works within the Satellite Application Sites. This is due to works predominately involving the addition to, replacement or upgrade of existing signage to include variable message signage, that along with other associated roadside infrastructure which, due to the location and scale, will not result in significant effects so have not been assessed further;

- Landscape effects on The Broads, (designated under The Norfolk and Suffolk Broads Act (Ref 10.13)) which is located within the study area to the north west are not directly affected by the Principal Application Site resulting in no modification to the baseline conditions. Visual effects on users of The Broads are included within this assessment (See Section 10.9);

- Effects on Norfolk Coastal Waters Character Area (Ref 10.16) would not be directly impacted by the Scheme which lies to the west of the character area boundary and limited visibility of the Scheme (See Figure 10.2). This character area covers a large geographic area and the scale of the Scheme would be too small to have any direct and indirect effects on its key characteristics;

- Effects on National Character Areas (NCA), NCA 79: North East Norfolk and Flegg, NCA 80: The Broads and NCA 82: Suffolk Coast and Heaths as they cover a large area. The scale of the Scheme would be too small to have any direct and indirect effects on the key characteristics of these character areas;

- Effects on LCA C1: Yare Valley (this has been incorporated into and assessed under TCA 9 – Great Yarmouth Edge);
- Effects on LCA G4: Hobland Settled Farmland as there would be no predicted visibility of the Scheme therefore there are no anticipated effects;
- Effects on LCA 20: Yare – Breydon Water as there would be no predicted visibility of the Scheme therefore there are no anticipated effects;
- Effects on LCA 21: Yare – Burgh Castle Marshes as visibility of the Scheme would be limited to the Scheme in its raised position and only from a small proportion of the overall LCA. Following a site visit it has been determined that visibility of the Scheme would have no impact on the key characteristics of this character area due to the existing urban backdrop of Great Yarmouth;
- Effects on TCA 8 – Northgate as there would be no or limited impact on the visibility of the Scheme and there are no anticipated effects; and
- Effects on The Venetian Waterways Grade II Registered Park and Garden due there being no predicted visibility of the Scheme from this location, as shown in Figure 10.2.

Likely Significant Effects

Construction Phase

10.4.9 The following likely significant effects have been assessed in this chapter:

- Effects on users of the England Coast Path and NCN517;
- Effects on residential receptors close to the Scheme; and
- Effects on users of the Kingsgate Community Centre.

Operation Phase

10.4.10 The following likely significant effects that have been assessed in this chapter:

- Effects on users of the England Coast Path and NCN517;
- Effects on residential receptors close to the Scheme; and
- Effects on users of the Kingsgate Community Centre.

Extent of the Study Area

10.4.11 In line with guidance provided in GLVIA (Ref 10.5), the extent of the study area has been defined as the area in which existing townscape character may change or be influenced, or views available to people and their visual amenity modified as a direct result of construction and operation of the Scheme.

10.4.12 The study area (Figure 10.1), a 3km radius from the Principal Application Site with an adjustment to the east to follow the high-water line, was validated through the modelling of the ZTV of the main works of the Scheme (Figure 10.2). This has been agreed with the NCC as recorded in Table 10.4.

Method of Baseline Data Collation

Desk Study

10.4.13 The identification and evaluation of the existing townscape and visual context of the study area and wider area involved the following tasks:

- Desk-based analysis of OS mapping relating to landform, built form, vegetation, settlement patterns and the drainage regime in the wider area;
- Desk based analysis of aerial photography for the area;
- Review of published townscape characterisation, types and relevant landscape or landscape related designations including Conservation Areas and Registered Parks and Gardens;
- Site surveys and identification of project specific townscape units/types. Site recording involving annotation of 1:1,250 and 1:25,000 scale OS plans defining the units and the key elements determining character;
- Identification and agreement with the local authority specialist of representative viewpoints to be assessed for potential visual effects;
- Site photography to illustrate character units, views from identified viewpoints and key townscape elements; and
- Determining the local townscape character units appropriate to this project including an evaluation of their quality, value and sensitivity to change in the context of the proposed form of the Scheme.

Site Visits

10.4.14 As part of the assessment the following site visits were undertaken:

- 14th to 16th August 2018 – The purpose of this visit was to survey and photograph from viewpoint locations, to confirm townscape character area boundaries, to check the ZTV and study area where appropriate and to identify any additional receptors that may have been missed during the desk-based study;

- 10th to 11th September 2018 – The purpose of this visit was to survey and photograph from agreed additional viewpoint locations and to confirm townscape character area boundaries;

- November 21st, 2018 – The purpose of this visit was to survey and photograph all viewpoints to include winter views and have a consistent set of photographs to be presented with the chapter; and

- January 22nd, 2019 – The purpose of this visit was to capture additional photographs from alongside Breydon Water at Weavers' Way / Wherryman's Way and Angles Way walking trails within the Broads.

Assessment Methodology

10.4.15 The methodology for assessment follows topic specific guidance as set out in Table 10.1 and was agreed with the Green Infrastructure and Landscape Officer at NCC in their capacity as landscape consultee on behalf of GYBC.

Stages in the Assessment Process

10.4.16 There are four key stages in the assessment:

- Recording and analysis of the existing townscape and visual context of the receiving environment (the baseline environment);

- Identification of changes and associated impacts that would be associated with the design of the Scheme including embedded mitigation (see Section 10.8) and the significance of these impacts in the context of the baseline townscape and visual context of the study area;

- Identification of further mitigation which could reduce potentially significant effects and would be appropriate to the Scheme and the townscape character and visual context of the receiving local area; and

- Description of the residual effects and their significance associated with the Scheme following the application of further mitigation.

Approach of the Assessment

10.4.17 As the predominant landscape character in Great Yarmouth is one of townscape, references in this chapter to townscape should be taken as covering landscape more generally. Townscape relates to the landscape of

an urbanised area and the relationship between built form and open spaces, including green space.

10.4.18 GLVIA (Ref 10.5) requires that a clear distinction is drawn between landscape (referred to as townscape in this chapter) and visual effects as follows:

- Townscape effects relate to the degree of change to characteristics or physical components of an urban area, which together form the character of that townscape, including the buildings, the relationships between them, the different types of open spaces, and the relationships between buildings and open spaces; and
- Visual effects relate to the degree of change to the views of the surrounding environment and visual amenity experienced by a person or group of people (e.g. residents, users of public footpaths or motorists passing through the area).

10.4.19 The TVIA considers the potential effects of the Scheme during:

- The construction phase, which is anticipated take approximately two years to complete, during which time cranes, lifting equipment, excavation machines and piling equipment are anticipated to be present within the Principal Application Site. This would also include construction compounds, local traffic management and delivery vehicle movements, (refer to Chapter 2: Description of the Scheme for information relating to the construction phase);
- Operation, at Year 1 (the opening of the Scheme). The assessment scenario assumes that the visual context applicable would be experienced during winter months with the Crossing in its raised position, when its visibility is potentially greatest (when leaves are not present on deciduous trees reducing their screening effect). However, the Crossing would be predominantly in the lowered position and therefore commentary is provided on this as appropriate. The assessment also includes commentary on the potential effects of lighting; and
- Operation at Year 15 (the end of the assessment period). The assessment scenario assumes that the visual context applicable would be during the winter months with the Crossing in its raised position (greatest visibility). The analysis at 15 years into operation demonstrates the effectiveness of any townscape and visual related embedded mitigation (see section 10.8) proposals associated with the Scheme, allowing for maturation of any planting.

Baseline Environment Identification

Townscape Character

10.4.20 The Great Yarmouth Borough Landscape Character Assessment (2008) (Ref 10.7) identifies the town of Great Yarmouth as 'urban' with no local townscape characterisation. Therefore, it has been necessary for WSP to devise local townscape character areas for the purposes of this assessment (Refer to Figure 10.3 and Section 10.5) In addition, the study area extends to cover the eastern fringes of the area included within The Broads Landscape Character Assessment (Ref 10.8).

10.4.21 The assessment of townscape effects has been structured around the identified Townscape Character Areas (TCAs). TCAs are areas of relatively homogenous townscape character. They are defined by the combination of elements that contribute to townscape context, character and value. Typical townscape elements include landform, street pattern and buildings, vegetation and open space. More subjective criteria have also informed the establishment of the baseline, such as scale, tranquillity, amenity, unity and enclosure.

10.4.22 The sensitivity of the receiving townscape, established through a combination of value, tranquillity and susceptibility to change, combined with the magnitude of impact has been assessed to determine a significance of effect rating resulting from the construction and operation of the Scheme.

Townscape Value

10.4.23 Page 11, paragraph 3.12 of the TIN-05-17 (Ref 10.15) states:

"Value relates to the relative importance of the townscape to different stakeholders and can apply to areas of the townscape, or to individual elements, features and aesthetic or perceptual dimensions which contribute to the value of the place".

10.4.24 High townscape value correlates to areas of architectural or aesthetic merit or those displaying important historic and cultural associations or highly valued locally for other reasons. Townscape value is frequently addressed by reference to international, national, regional and local designations. An absence of a formal designation does not, however, determine that a townscape is necessarily of low value. Typical indicators of townscape value include: inclusion in a Conservation Area; presence of locally or nationally listed buildings or spaces; buildings or spaces which have received an award or have otherwise received recognition; key or locally well-known views, locations or landmarks including those represented on art works or described in literature.

Tranquillity

10.4.25 As stated within Landscape Technical Information Note 01/2017 (Ref 10.14) "how it is actually considered in practice is not at all clear and there is limited document evident to demonstrate how tranquillity assessment is carried out." And also stated within TIN-05-2017 (Ref 10.15) that tranquillity is "the quality or state of being tranquil, calm" and that "small spaces can provide a degree of tranquillity in comparison to busy streets" and "extent to which a townscape is lit at night may also affect tranquillity".

10.4.26 Tranquillity has been considered as part of this chapter due to the requirement within NPS NN (Ref 10.2) and has been used to inform judgement of townscape sensitivity.

10.4.27 For the purposes of this assessment the level of existing tranquillity is established over the geographical area of each TCA. Within these TCAs, there may be localised areas of higher tranquillity. Higher levels of tranquillity typically contribute to higher sensitivity of the associated townscape.

Susceptibility to Change

10.4.28 Susceptibility to change is the ability of the TCA to accommodate the Scheme without undue consequences for the maintenance of the baseline situation.

10.4.29 A high quality or high value townscape should not, by definition, infer that it has a high susceptibility to future change. Similarly, an area expressing low quality or value does not automatically have a lower susceptibility to change. Susceptibility has been defined in GLVIA3 on page 88 paragraph 5.40 (Ref 10.5) as:

"The ability of the landscape receptor to accommodate the proposed development without undue consequences for the maintenance of the baseline situation and / or the achievement of landscape policies and strategies".

10.4.30 Susceptibility to change is therefore likely to reflect the type and nature of the proposed changes.

Townscape Sensitivity

10.4.31 The sensitivity of a TCA has been judged based on a combination of its susceptibility to the type of change or development proposed and the value attached to the townscape, as set out in Table 10.5 below.

Table 10.5: Townscape Criteria

Townscape Sensitivity	Criteria
High	• Townscape characteristics or features with little or no capacity to absorb the type of change proposed without fundamentally altering current character. • Townscape designated for its international or national townscape value or with highly valued features and or quality and amenity provision. • Moderate or higher levels of tranquillity • Outstanding example in an area of well cared for townscape or set of features that combine to give a very strong sense of place. • Few detracting or incongruous elements.
Medium	• Townscape characteristics or features with moderate capacity to absorb change without fundamentally altering their present character. • Townscape designated for its local townscape value or a regionally designated townscape where the characteristics and qualities that led to the designation of the area are less apparent or are partially eroded or an undesignated townscape which may be valued locally – for example an important open space. • Typically, low to moderate levels of tranquillity • An example of a townscape or a set of features which is relatively coherent, with a good but not exceptional sense of place - occasional buildings and spaces may lack quality and cohesion.
Low	• Townscape characteristics or features which are tolerant of change without determent to their present character. • An area with a weak sense of place and/or poorly defined character / identity. • Typically, low levels of perceived tranquillity

Townscape Sensitivity	Criteria
	• No designation present or of low local value or in poor condition. • An example of monotonous unattractive visually conflicting or degraded townscape or set of features.

Magnitude of Impact

10.4.32 The magnitude of impact has been determined through a description of changes and on the extent and manner in which the Scheme would form a new component in the townscape and alter the balance between existing components.

10.4.33 Magnitude of impact is an expression of the size or scale of change in the townscape, the geographical extent of the area influenced and its duration and reversibility. The variables that have been used are described below:

- The extent and proportion of existing townscape elements that would be lost and the contribution of those elements to the character of the immediate townscape and wider setting;
- The extent to which aesthetic or perceptual aspects of the townscape are altered either by the removal of existing townscape elements or by the addition of new ones;
- Whether the impact changes key characteristics of the townscape, which are integral to its distinctive character;
- The geographic extent of the Scheme; and area over which the townscape effects would be experienced (within the Application Site itself; the immediate setting of the Application Site; the scale of the townscape type or character area; on a larger scale influencing several townscape types or character areas); and
- The duration of the effects (short term, medium term or long term) and whether it is permanent, temporary or reversible.

10.4.34 In this assessment, the magnitude of impact is assessed as high, medium or low considering the types of typical criteria that indicate the magnitude of impact and are set out in Table 10.6 below.

Table 10.6: Townscape Magnitude of Impact Criteria

Magnitude of Impact	Typical Descriptions that Inform Magnitude of Impact
High	▪ Highly noticeable change, affecting most key characteristics and dominating the experience of the townscape ▪ Introduction of highly conspicuous new development. ▪ May be extensive, affecting the entire TCA.
Medium	▪ Noticeable change, affecting some key characteristics and the experience of the townscape ▪ Introduction of some new elements. ▪ Affecting the immediate area site and a proportion of the TCA greater than the immediate setting, ▪ Usually medium term 5 – 10 years, ▪ May be Partially Reversible/ Temporary
Low	▪ Localised change, affecting some characteristics and the experience of the townscape ▪ Introduction of small or relatively inconspicuous new elements. ▪ Might be limited to within the site and immediate setting ▪ Usually short-term (0-5 years) ▪ Considered reversible

Significance of Effect Assessment

10.4.35 The evaluation of effects for townscape character has involved consideration of the sensitivity to change, derived during the baseline assessment and the predicted magnitude of impact that would occur because of the construction and subsequent operation of the Scheme. Effects are significant in EIA terms where they are identified as being moderate or greater as shown within Chapter 4: Approach to EIA.

10.4.36 The findings of the assessment have been represented using a descriptive, descending scale ranging from large - moderate – slight - beneficial through Neutral to an ascending scale of slight - moderate – large – very large adverse. Explanation of the significance of effect ratings is provided below in a descending scale of significance shown in Table 10.7 below.

Table 10.7: Townscape Character Significance of Effect Criteria

Degree of Significance	Townscape Significance of Effect Criteria
Large Beneficial Effect	The proposals: ▪ Constitute a major restructuring of a degraded townscape or form an essential part of a townscape strategy to redevelop a major

Degree of Significance	Townscape Significance of Effect Criteria
	area of dereliction, leading to establishment of a new, attractive environment.
Moderate Beneficial Effect	The proposals provide an opportunity to enhance the townscape because: ▪ They fit very well with the scale, built form and pattern of the townscape; ▪ There is potential, through mitigation, to enable the restoration of characteristic features, partially lost or diminished as the result of changes to the baseline context, e.g. from previous inappropriate development; ▪ They would enable a sense of place and scale to be restored through careful design and appropriate mitigation measures, that is, characteristic features are perhaps enhanced through the use of local materials and appropriate scale of the development that fits well into the surrounding townscape; ▪ They enable some sense of quality to be restored or enhanced through design features; and ▪ They further government objectives to regenerate degraded urban areas.
Slight Beneficial Effect	The proposals: ▪ Fit well with the scale, built form and pattern of the townscape; ▪ Incorporate measures for mitigation to ensure they would complement the surrounding townscape structure; ▪ Would enable some sense of place and scale to be restored through careful design and appropriate use of materials as mitigation measures; and ▪ Maintain or enhance existing townscape quality and character.
Neutral Effect	The proposals: ▪ Complement the scale, built form and pattern of the townscape; ▪ Incorporate measures for mitigation to ensure that the Scheme would blend in well with surrounding features and elements; and ▪ Maintain existing townscape quality and character.
Slight Adverse Effect	The proposals: ▪ Do not quite fit the built form and scale of the townscape; ▪ Cannot be completely mitigated for because of the nature of the proposal itself or the character of the townscape in which the development would sit; and

Degree of Significance	Townscape Significance of Effect Criteria
	▪ May affect an area of recognised townscape quality.
Moderate Adverse Effect	The proposals: ▪ Are out of scale with, or at odds with, the local townscape pattern and built form; ▪ Are not possible to fully mitigate for, that is, mitigation would not prevent the Scheme from scarring or detrimentally affecting the townscape in the longer term as some features of interest would be partly destroyed or their setting reduced or removed; and ▪ Would have an adverse effect on a townscape of recognised quality or on vulnerable and important characteristic features or elements.
Large Adverse Effect	The proposals are very damaging to the townscape in that they: ▪ Are at considerable variance with the built form, scale and pattern; ▪ Are likely to degrade, diminish or even destroy the integrity of a range of characteristic features and elements of their setting; ▪ Would be substantially damaging to a high value or highly vulnerable townscape, resulting in fundamental change and be considerably diminished in quality; and ▪ Cannot be adequately mitigated for.
Very Large Adverse Effect	The proposals would result in exceptionally severe adverse effects on the townscape because they: ▪ Are at complete variance with the built form, scale and pattern; ▪ Would irrevocably damage or degrade, badly diminish or even destroy the integrity of characteristic features and elements and their setting; ▪ Would cause a very high quality or highly vulnerable townscape to be irrevocably changed and its quality very considerably diminished; and ▪ Cannot be mitigated for, that is, there are no measures that would protect or replace the loss of a nationally important townscape.

Assessment of Visual Effects

10.4.37 Visual effects result from changes in the composition of views or the overall visual amenity experienced by people as a result of the Scheme. The degree

to which people would be affected by changes depends on a range of factors, such as:

- The activity of the receptor, such as taking part in leisure, recreational and sporting activities (whether terrestrial or marine), travelling through the area or working;
- The value of the viewing place or viewpoint, as reflected by designations, inclusion in guidebooks or the facilities provided for visitors, for example;
- Whether receptors are likely to be stationary or moving and how long they would be exposed to views of the Scheme;
- The extent of the route or area over which the changes would be visible;
- Whether receptors would be exposed to the change daily, frequently, occasionally or rarely; and
- Whether views are oblique or direct.

Zone of Theoretical Visibility

10.4.38 It is widely accepted that the magnitude of visible impact declines with distance. A desktop study together with a Zone of Theoretical Visibility (ZTV) has been used to determine the likely areas where there could be views of the Scheme. The ZTV models the extent of the area where there would be potential for views of the Scheme. The analysis considers three scenarios with a receptor height of 1.6m above AOD to reflect eye level. The following points are based on General Arrangement Plans (document reference 2.2).

- Crossing lowered – 4 points at 25m intervals along the Crossing deck (including parameters of the environmental assessment (See Table 2.1 in Chapter 2: Description of the Scheme)) of +1.0metres (worst-case)) and 4 points at 25m intervals along the Crossing deck to simulate HGV traffic (4.5m above road level);
- Crossing Raised - 4 points to represent the high point of the deck of the Crossing (including parameters of the environmental assessment (See Table 2.1 in Chapter 2: Description of the Scheme)) when raised; and
- Control tower – 4 points to represent the high point of the top of the control tower (including a maximum height of 20m (worst-case) above AOD).

10.4.39 The visual analysis has been carried out using the viewshed analysis tool in ArcMap 10.5 using:

- Lidar 0.25m DSM Information; and

- Observer points using XYZ co-ordinates for the Scheme for the three scenarios.

10.4.40 The 2008-2009 LiDAR Digital Surface Modelling (DSM) at 0.25m resolution (which includes surface features such as buildings and vegetation) and is accurate to +/-10cm for XY and +/- 5cm for Z has been used to develop the ZTV, it includes all landform, vegetation and built form.

10.4.41 The results of the analysis are shown on Figure 10.2. Areas have been shaded to indicate locations that are predicted to have direct views of all or part of the Crossing structure and represent the worst-case scenario. In areas where the shading is less dense and more sporadically distributed, this would indicate that these views may be highly constrained and/or comprise only the very highest sections of the Crossing structure, factors which are likely to limit the degree to which a significant effect is anticipated to arise.

10.4.42 As a result, the top of the structure may not be visible from all locations suggested by the software or these locations may not be representative of views experienced by the public, such as on rooftops. The following reasons may include intervening buildings and/or vegetation which were not recorded within the baseline data used (e.g. built form and vegetation is not recorded within the mapping data) or glimpses between buildings would be included which in reality may be heavily constrained.

10.4.43 Therefore, interpretation of the results is required. A site visit was conducted, and it has been determined that while there is potential visibility in the north within The Broads, the actual view of the Crossing would be obscured or where visible would be backgrounded and lost within the backdrop of built form around Great Yarmouth, particularly in views from The Broads.

Representative Viewpoints

10.4.44 The assessment of visual effects is based on a series of representative viewpoints, selected to represent a range of receptors within the study area that are likely to experience views of the Scheme. A total of eighteen viewpoints (see Figure 10.1 for the locations) have been agreed including sixteen with the landscape officer at NCC, who was requested to act as consultee on behalf of GYBC, and a further two requested by the Broads Authority. Site surveys were undertaken to establish the nature, exact location and actual availability of the anticipated view.

Photomontages

10.4.45 Where significant effects on visual receptors have been predicted, in accordance with LI TGN 02/17 (Ref 10.6) photomontages have been produced (refer to Appendix 10B (document reference 6.2) for the approach taken) to illustrate the Scheme in the view. Winter photomontages for

viewpoints 1, 6, 15 and 16 have been prepared (refer to Figure 10.1 for their locations), showing four different scenarios for each based on the Crossing being raised or lowered for each of Years 1 and 15. Therefore a total of sixteen photomontages have been prepared and these are presented in document reference 6.12: Photomontages.

10.4.46 The photomontages were referred to in preparing this chapter but have not been relied upon to inform outcomes of the assessment due to their indicative nature. They are intended to help illustrate the appearance of the Scheme when in operation and should be read alongside the General Arrangement Plans (document reference 2.2), Landscaping Plans (document reference 2.9) and Appendix A of the Design Report (document reference 7.4a).

10.4.47 Summer photomontages have not been provided as part of this assessment.

Identification of Representative Viewpoints

10.4.48 The 18no. viewpoint locations were selected by reviewing the settlement pattern, land use, topography, vegetation, and access and transportation patterns contained within the boundaries of the ZTV. Viewpoints plotted via the desk-based review and validated through site survey include the following:

- Residential clusters and individual properties;
- Heritage or cultural locations;
- Main and local roads; and
- Recreational and public access areas including footpaths, cycle routes and other public rights of way.

Field Assessment of Viewpoints

10.4.49 All viewpoints were visited for the purposes of assessment. Factors considered during the visual assessment included:

- Associated receptor types and numbers where appropriate (e.g. dwelling or footpath);
- Existing view;
- Distance of view;
- Percentage and elements of the Scheme likely to be visible;
- Angle of view (acute, perpendicular or oblique);

- Type of view (foreground, middle ground or background) and position of the Scheme in the view; and
- Analysis of potential impact.

Analysis of Visual Effects

10.4.50 Analysis of the likely visual impacts and evaluation of their associated effects involved consideration of the sensitivity to change and magnitude of impact based upon information gathered through site surveys and analysis of the aesthetics of the Scheme.

10.4.51 Evaluation of visual effects relates to the potential impacts during:

- The construction phase, which is anticipated to take approximately two years to complete during which time cranes and lifting equipment are anticipated to be present within the Principal Application Site, and would include the presence of associated plant, construction compounds and local traffic management (refer to Chapter 2: Description of the Scheme for information relating to the construction period);
- Operation, at the opening of the Scheme (referred to as Year 1), the assessment assumes that the visual context applicable would be experienced during winter months and with the Crossing in its raised position, when the its visibility is potentially greatest. However, the Crossing would be predominantly in the lowered position and therefore commentary is provided on this as appropriate. The assessment also comments on the potential effects of lighting; and
- Operation at Year 15 (the end of the assessment period), for both summer and winter periods and with the Crossing its raised position. The analysis at 15 years into operation demonstrates the effectiveness of any townscape and visual related embedded mitigation (see section 10.8) proposals associated with the Scheme, allowing for maturation of any planting.

Visual Sensitivity

10.4.52 Sensitivity to change considered the nature, location and context of the receptor and was derived from the susceptibility to change of the receptor and the value of the view. Less sensitive receptors were considered, for example, to be people engaged in work whose primary focus would not necessarily be on the surrounding townscape views. Conversely, more emphasis has been placed upon receptors whose change in view or visual amenity is either the prime focus, greater in scale, a valued view such as a lookout or potentially covers a wider area.

10.4.53 The degree and importance of the view gained from a receptor also contributed to an understanding of how sensitive a given receptor is towards change. Therefore, value of the view, scenic quality and visual amenity of the receptor were also considered. In this assessment, sensitivity to change is ranked as described in Table 10.8.

Table 10.8: Sensitivity of Viewpoints

Viewpoint Sensitivity	Criteria
High	• Visitors to internationally and nationally important public open space, routes or historical cultural site or space. • High quality designed public open space, recreational historical or cultural site where the landscape or townscape is a significant factor in its enjoyment. • Residents that enjoy a high level of visual amenity and enjoyment of the view is the primary focus • High number of users and therefore many viewers.
Medium	• People enjoying locally important public open space, routes or historical cultural site or space. • Residents views where the views are orientated towards poor quality landscape or townscape or viewed obliquely. • People enjoying recreational space or routes where the landscape or townscape is an important factor in its enjoyment.
Low	• No designations or little local importance associated with the view or is of poor visual amenity. • Transient views typically along busy roads or routes where the view is not upon the landscape or townscape but focussed upon an activity such as people driving. • Views from people in places of work where the view is not upon landscape or townscape but focussed upon an activity.

Viewpoint Sensitivity	Criteria
	• Views from people in retail areas or sports facilities where the townscape is secondary to the enjoyment of the activity such as playing sports. • Low number of users and therefore few viewers.

Magnitude of Impact

10.4.54 The magnitude of visual impact resulting from the Scheme has been based on the size or scale of change in the view, the geographical extent of the area influenced and its duration and reversibility. The variables involved are described below:

- The scale of the change in the view with respect to the loss or addition of features in the view and changes in its composition, including the proportion of the view occupied by the Scheme;
- The degree of contrast or integration of any new features or changes to the form, scale, mass, building line, height, sky-line, background, visual clues, focal points, colour and texture;
- The time over which the Scheme would be visible and whether views would be full, partial or glimpsed;
- The angle of view in relation to the main activity of the receptor, distance of the viewpoint from the Scheme and the extent of the area over which the changes would be visible; and
- The duration of the effects (short term, medium term or long term) and the reversibility of the effect (whether it is permanent, temporary or partially reversible).

10.4.55 In this assessment, the magnitude of impact is assessed as high, medium or low. The types of typical criteria that indicate magnitude of impact are set out below in Table 10.9.

Table 10.9: Magnitude of Visual Impact Criteria

Magnitude of Impact	Size or Scale of Change
High	• Scheme typically occupies the majority of the view • Intensive/dominant within the view

Magnitude of Impact	Size or Scale of Change
	• Major alteration to key elements of the baseline view • Extensive, affecting the entire view or series of views and/or within close proximity, and/or open views. • Typically, Long-term (10+ years) • May be Permanent /Irreversible
Medium	• Scheme occupies a noticeable portion of the view • Partial/noticeable alternation to key elements of the baseline view • Affecting approximately half of the view • Framed, or contained, or medium distance, or partially screened views • Typically, Medium-term (5-10 years) • May be Partially Reversible/ Temporary
Low	• Scheme occupies a small proportion of the view • Minor alteration to few elements of the baseline view • Limited to a small proportion of the view • Narrow, or fragmented, or long distance, or heavily screened views. • Typically, Short-term (0-5 years) • Typically, Reversible

Degree of Significance of Visual Effect Criteria

10.4.56 The main criteria used to evaluate visual effects relate to the extent to which existing views associated with viewpoints (such as experienced by residents, users of public facilities and visitors to open space and public areas) would change, taking account of embedded mitigation measures. Effects determined as significant where they are identified as being moderate or greater as identified in Chapter 4: Approach to EIA.

10.4.57 Other criteria used to ascertain visual effect include the size, elevation and proportion of the Scheme in respect of the receiving environment and the degree to which visible activity within the receiving environment would alter, both during and post construction.

10.4.58 Effects on people can be detrimental where features or key characteristics such as established planting, old buildings or structures are removed from view. Conversely, effects can prove beneficial where derelict buildings or poorly maintained features are restored, replaced or maintained, or where there is new tree planting or attractive townscape elements are added where few currently exist.

10.4.59 The identification of the resulting effects has been established through an evaluation of the sensitivity of the baseline and the magnitude of the impact likely to occur because of the Scheme.

10.4.60 The findings are represented using a descriptive scale ranging in a descending scale from large - moderate – slight - beneficial and through Neutral to an ascending scale of slight – moderate – large – very large adverse.

10.4.61 Whilst there is a large degree of professional judgement involved in determining the significance of visual effects, based on knowledge and experience of similar schemes, they can broadly be determined by the interaction of the sensitivity of the receptor and magnitude of impact, which has been informed by pre-defined criteria as outlined Table 10.10.

Table 10.10: Visual Significance of Effect Criteria

Degree of Significance	Description of Visual Effect
Large Beneficial Effect	Lead to the removal of a derelict site or buildings and incorporates landscape or public realm measures which substantially remodel and enhance the outlook for many people, or where the proposal would cause a substantial improvement in the existing view.
Moderate Beneficial Effect	Visual intrusion associated with the existing view is noticeably relieved, or where the Scheme would result in a marked improvement. It would also apply where the Scheme includes embedded provision for landscape or public realm proposals which would largely reduce the visual intrusion of the existing outlook.
Slight Beneficial Effect	Existing visual intrusion associated with the current outlook is slightly relieved, or where the Scheme would cause a barely perceptible improvement in existing receptor view.

Degree of Significance	Description of Visual Effect
Neutral Effect	Implementation of the Scheme not leading to a discernible improvement or deterioration in existing receptor view or outlook.
Slight Adverse Effect	The Scheme is at some distance from the viewpoint, or where the Scheme would not constitute a new point of principal focus. It would also occur where the Scheme is closely located to the viewpoint but is seen at an acute angle and at the extremity of the overall available view, or by less sensitive receptor types.
Moderate Adverse Effect	The Scheme resulting in a noticeable deterioration to the current outlook, involving removal of existing, visually screening elements in the view, exposing the Scheme. It would also occur where large new structures are introduced as part of the Scheme which may appear at distance but be positioned as a focal point the field of view, or where the Scheme can only be partially mitigated.
Large Adverse Effect	The Scheme would cause a marked deterioration in the current receptor view or outlook, be positioned prominently within an existing view of local interest in a valued townscape, or where only selected elements of the Scheme can be effectively mitigated.
Very Large Adverse Effect	The Scheme would cause a high level of deterioration to the current view, and/or be positioned prominently within an existing view of regional or national importance.

Artificial Lighting

10.4.62 The baseline lighting situation is of a largely artificially lit environment. Typically, significant artificial lighting effects are considered to be relevant where there is an ostensibly dark baseline night-time landscape and not an extensively lit urban environment. A formal assessment has therefore not been undertaken as it is considered there would be no significant effects due to artificial lighting. Instead, and where relevant, existing baseline lighting conditions have been briefly described in association with the relevant TCA or viewpoint (see Section 10.5). Where a perceptible change is anticipated to arise due to lighting, commentary has been provided in the assessment of effects. A summary is also provided for both construction and operation stages (See Section 10.8).

10.4.63 To inform this process reference has been made to Chapter 2, Section 2.5 Other Design Elements, Lighting. In addition, the Isolux Contour Plan (Figure 10.5) has been referenced to help understand the degree to which lighting might influence existing local light levels or to illuminate additional areas. Due to the indicative layout of the lighting shown on the ISOLUX contour

plan, this has informed the assessment but not been relied upon to draw conclusions on effects.

10.4.64 Due to the absence of formal guidance or thresholds on lighting in relation to landscape/townscape or visual receptors a quantitative comparison could not be undertaken. Therefore, a qualitative judgement has been made on the perception of artificial lighting at the construction and operation stages.

10.5 Baseline Conditions

Published National Character Areas

10.5.1 The Scheme lies within NCA 79: North East Norfolk and Flegg (Ref 10.9) and NCA 80: The Broads. Due (Ref 10.10) to its proximity, 500m south-west of the Scheme, NCA 82: Suffolk Coast and Heaths (Ref 10.11), to the south west has also been included. They provide high level broad key characteristics of the landscape. It should be noted that the published descriptions of these character areas primarily relate to their rural characteristics, and not urban areas lying within or adjoining them. They cover a large geographical extent; therefore it is considered that the Scheme will have no impact on their key characteristics.

Designations

10.5.2 The Broads are designated under The Norfolk and Suffolk Broads Act (Ref 10.13) and is located within the study area to the north west but is not directly affected by the Principal Application Site, refer to Section 10.4 – Insignificant Effects.

10.5.3 Conservation Areas within the study area are as listed within the GYBC Local Plan – Core Strategy 2013-2030 (Ref 10.12) which include the following:

- No 1. Camperdown;
- No 2. Marketplace, Rows & North Quay;
- No 3. Hall Quay/ South Quay;
- No 4. King Street;
- No 5. St Nicholas/ Northgate Street;
- No 6. Gorleston Town Centre;
- No 10. Princes Road;

- No 12. Gorleston Cliff;
- No 15. St Georges;
- No 16. Great Yarmouth Seafront; and
- No 17. Gorleston.

10.5.4 The presence of a Conservation Area indicates an area of high value by its designation. The contribution to the perception of overall value of the TCA is described within the baseline description for each TCA.

10.5.5 There is no assessment of impacts on individual Conservation Areas within this chapter. This is presented in Chapter 9: Cultural Heritage and Appendix 9B – Historic Desk-based Assessment (document reference 6.2).

Townscape

10.5.6 This section describes the baseline for the local identified TCA within the townscape in Great Yarmouth (shown on Figure 10.3).

10.5.7 The townscape of Great Yarmouth is classified within the Great Yarmouth Borough Landscape Character Assessment (2008) (Ref 10.7) as 'urban', and no further explanation or descriptions of the townscape is provided. The following landscape character areas within the study area (shown on Figure 10.3) are:

- C1: Yare Valley (this has been incorporated into TCA 9 – Great Yarmouth Edge); and
- G4: Hobland Settled Farmland.

10.5.8 In addition, on the study area's north-western fringes (located within The Broads) the following LCA are identified within The Broads District Council Landscape Character Assessment Landscape Character Areas (Ref 10.8) (Areas 16-23) (shown on Figure 10.3). These are:

- 20: Yare – Breydon Water; and
- 21: Yare – Burgh Castle Marshes.

10.5.9 The TCA's within the identified urban area have therefore been established by WSP through desk-based studies, supported by site surveys undertaken in 2018, as part of the baseline studies. For each TCA a judgement has been made as to its sensitivity based on its value and susceptibility to change, informed by professional judgement and experience of similar schemes. The TCA's descriptions and sensitivity have not been agreed in advance of the assessment with GYBC.

TCA 1 – River Yare and Port

10.5.10 This area encompasses a large proportion of the Principal Application Site. It extends to the north and south along the River Yare, widening to the south to cover South Denes and the harbour.

10.5.11 This TCA encompasses two Conservation Areas, (No 3. Hall Quay/ South Quay in the north and No 17. Gorleston in the south). These areas are of high value based on their designation but are present in a small proportion of the overall TCA.

10.5.12 One of the key characteristics of this townscape is a tidal length of the River Yare with its strong associations to Yarmouth's past as a port, and still active today with large vessels manoeuvring or moored. The River Yare is a natural body of tidal water, the appearance of which is continually changing through the day with the ebb and flow of the tide. Although a natural feature, its banks are heavily urbanised, being contained by artificial revetments and port facilities.

10.5.13 The riverside, particularly to the south, is generally inaccessible to the public, and characterised by large metal sheds with extensive concrete aprons and security fencing (see Plate 10-1). There are old red brick warehouses interspersed with more recent development which demonstrates its heritage as a working port and docks. The mooring points and existing navigation lights along the river are indicative of port activity.

10.5.14 This character area lacks significant vegetation. At South Quay there are remnant planting pits of trees which have been removed or died. External spaces are predominately paved with impermeable surfacing, with large storage yards in constant change except on vacant plots where buildings have been demolished or land that is awaiting development, particularly in the south-east.

10.5.15 The only bridge Crossing within this TCA is Haven Bridge over the River Yare in the north. Opened in 1930, it is clad in natural stone and has ornate blue railings and decals reminiscent of a Victorian style. Haven Bridge complements the assemblage of historic buildings in the adjacent TCA 2 to the east.

10.5.16 Nelson's Monument is a Grade I listed structure which is a local landmark (see Plate 10.1). It contrasts strongly with the surrounding assemblage of industrial buildings, chimney stacks, cranes and masts (see Plate 10.1).

10.5.17 In the south there is the outer harbour with a large breakwater again reinforcing the port and marine character of this TCA.

10.5.18 As a working port, with movement of plant within commercial areas, along with vessels along the River Yare, the levels of tranquillity are considered to

be low due to the presence of a working port, busy roads and industrial context.

10.5.19 There is existing artificial lighting throughout this TCA, predominately street lighting and security lighting around commercial buildings. The River Yare is not directly lit, but there is overspill from adjacent light sources and from docked vessels.

10.5.20 The value of this TCA is medium, due to elements of higher value such as Nelson's Column and the two Conservation Areas (including Conservation Area No. 3 at South Quay) set within a largely industrial nature. The higher value of these locations is diluted by the largely industrial context of much of the remainder of the character area including vacant land and derelict buildings. As a working port, with warehousing and the movement of plant and vehicles the levels of tranquillity are considered to be relatively low.

10.5.21 The susceptibility to change for this area is considered to be low, due to the presence of large-scale port infrastructure and roads close to where the Scheme would be located.

10.5.22 The combination of a medium value and low susceptibility results in this TCA having a low sensitivity.

Plate 10.1: Nelson's Column to Mid Right within the Industrial Setting

TCA 2 – Great Yarmouth Historic Core

10.5.23 This TCA covers the town centre of Great Yarmouth, located adjacent and east of the Principal Application Site extending to the north-east.

10.5.24 This TCA encompasses seven Conservation Areas which cover a large proportion of this TCA (No 1. Camperdown, No 4. King Street, No 3. Hall Quay. South Quay, No 15. St Georges, No 2. Marketplace, Rows & North Quay, No 10. Princes Road and No 5. St Nicholas/ Northgate Street). These areas are of high value based on their designation.

10.5.25 The key characteristics of this townscape include the medieval streets of Great Yarmouth. There are lengths of the medieval town walls which have survived and can be seen adjacent to Blackfriars Road. Later expansion in the 18th and 19th centuries included construction of the former naval hospital. Residential properties are predominately Victorian terraces. A large proportion of the densely packed narrow streets of houses known as 'the rows' were lost to bombing in World War 2, but a few remain within the north of the character area. There are a great number of older (pre-Victorian) buildings that are also listed. Great Yarmouth Minister Church of St Nicholas (founded in 1100) in the north, with its distinctive flint and stone appearance, is a notable landmark in the town. However, there is a large proportion of post-war development in this area, much of which is insensitive in its appearance and positioning relative to the older buildings (see Plate 10-2).

10.5.26 There are four notable green spaces within this character area: the cemeteries and grounds of St Nicholas Church in the north; the 19th century St George's Park within the centre; the grounds of the Naval Hospital; and St Nicholas Recreation Ground in the south. Haven Bridge is the key connection between the Spit of Great Yarmouth and the mainland.

10.5.27 Great Yarmouth Town Centre is characterised by shops and restaurants, particularly along the pedestrianised Regent Road and around the Bus Station and Market Gates Shopping Centre.

10.5.28 This TCA is considered to have low to moderate levels of tranquillity, however within greenspaces the levels of tranquillity may be perceived as higher.

10.5.29 Artificial lighting is present within this TCA, this is in the form of existing street lighting, architectural lighting and security lighting around commercial buildings.

10.5.30 This character area, which encompasses seven separate conservation areas suggests and townscape of high value, and is considered to be of medium value, this is due to its historic layout and attractive historic elements, but this is countered by more modern development that is unsympathetic and often contrasting with the older buildings as illustrated in Plate 10-2.

10.5.31 The susceptibility to change is medium due to existing modern large structures such as the Market Gates Shopping Centre with significantly older architectural periods. An example of this is the Great Yarmouth Minister Church of St Nicholas along with the presence of major road junctions and Haven Bridge.

10.5.32 The combination of a medium value and a medium susceptibility to change results in this TCA having a medium sensitivity.

Plate 10.2: View towards Medieval Walls Abutting Modern Development

TCA 3 – Southtown and Gorleston-on-Sea

10.5.33 This is the residential TCA of Southtown and Gorleston-on-Sea, it encompasses the western extent of the Scheme extending to north and south of the Principal Application Site, along the west bank of the River Yare.

10.5.34 This TCA encompasses three Conservation Areas which cover a small proportion of the south half of the eastern boundary (No 6. Gorleston Town Centre, No 12. Gorleston Cliff and No 17. Gorleston). These areas are of high value based on their designation.

10.5.35 This character area predominately consists of Victorian terraces (see Plate 10-3), laid out on a grid. This pattern is strong in the north and south, becoming fragmented and less ordered in the middle where post-war

development occurred in response to wartime bomb damage. The Beccles Road dual carriageway and 5-arm roundabout in the centre adds to this fragmentation. The Southtown neighbourhood to the north is much more modern with large outlet stores, compared with its southern neighbour, Gorleston-on-Sea with its smaller high street shops, many of which are converted houses and some modern purpose-built buildings.

10.5.36 Greenspace is focused within the centre of this character area, the two largest being Gorleston and Southtown recreation grounds, along with smaller parks and grounds of churches and schools such as St Andrew's Church, a local landmark.

10.5.37 Southtown has a greater sense of movement and disturbance than Gorleston due to its proximity to Haven Bridge and Pasteur Road. Levels of tranquillity are considered relativity low, however they may be perceived as higher within greenspaces, such as Southtown recreational ground.

10.5.38 Overall tranquillity levels are perceived to be relatively low to moderate, due in part to the areas of greenspace such as Southtown recreational ground which may have higher perceived levels of tranquillity, however in association with busy roads such as Pasteur Road and commercial outlets, tranquillity is considered to be ow.

10.5.39 Artificial lighting is present within this TCA, including existing street lighting and security floodlighting around commercial buildings.

10.5.40 This character area is of medium value. This is because although there is a strong pattern, in much of this character area it is fragmented by more recent development. This is particularly the case in the north in Southtown where the outlet stores are at variance with the surrounding scale and character of built form.

10.5.41 The susceptibility to change is considered to be medium due to the presence of major roads and their junctions within the character area; and larger scale buildings in the north.

10.5.42 The combination of medium value and medium susceptibility results in this character area having a medium sensitivity.

Plate 10.3: View of Victorian Terraces

TCA 4 – Harfrey's

10.5.43 This TCA covers the Harfrey's Industrial Estate, located adjacent and west of the Principal Application Site. The northern and western boundary are distinct edges where it abruptly changes from industrial land into agricultural fields.

10.5.44 This TCA is characterised by double storey warehouse buildings, typically with brick ground floors and metal clad second storeys and roofs. The road layout is broadly in a geometric grid in the east, becoming more organic to the west where there are newer additions to the estate. This character area is lacking in vegetation and there is predominately hard surfacing throughout this TCA. However, there is an area of scrubby vegetation surrounding the quarry workings in the south east.

10.5.45 This TCA is considered to have low levels of tranquillity, associated with the industrial and commercial character, and movement of vehicles and plant.

10.5.46 Artificial lighting is common throughout this TCA, predominately street lighting and security lighting around commercial buildings.

10.5.47 This TCA is considered to be of low value due to it being an industrial estate and lacking a strong character with large buildings and security fencing. The

susceptibility to change is judged as low, due to the existing major roads and large scale of many of the buildings within this character area.

10.5.48 The combination of low value and low susceptibility results in this character area having a low sensitivity.

Plate 10.4: View within Harfrey's Industrial Estate

TCA 5 – Bradwell and Gorleston-on-Sea

10.5.49 This is the 20th century residential TCA of Bradwell and Gorleston-on-Sea, approximately 500m to the south-west of the Principal Application Site. The area is dominated by post war 20th century housing of varying styles but mainly semi-detached with gardens (see plate 10-5). In addition, there are schools and leisure centres within this character area. The presence of a number of parks and occasional street trees gives the area a green appearance and raises levels of tranquillity within this TCA, there are detracting features such as major roads. Overall the levels of tranquillity are considered to be moderate.

10.5.50 Artificial lighting is present within this TCA, predominately in the form of existing streetlighting.

10.5.51 The value of this area is medium, due to the green spaces, street trees and open layout of housing.

10.5.52 The susceptibility to the Scheme would be high, due to the lack of features of a similar nature and small scale of the existing buildings.

10.5.53 The combination of medium value and high susceptibility results in this character area having a high sensitivity.

Plate 10.5: View within Bradwell

TCA 6 – Gorleston-on-Sea Seafront

10.5.54 This area covers the seafront of Gorleston-on-Sea, located approximately 1800m south of the Principal Application Site. This TCA encompasses No 17. Gorleston Conservation Area. This area is of high value based on its designation and importance as a recreational area to the local community and as a tourist attraction.

10.5.55 The key features of this TCA are its traditional seaside resort buildings along with formal Victorian style gardens in the south on the Gorleston cliffs. Features include a bandstand, boating pond and the Pavilion Theatre. Most of the buildings are of Victorian origin and many features ornate detailing. There are however more recent developments such as the Ocean Room and the amusement arcade and cafes along Lower Esplanade which contrast with the Victorian character.

10.5.56 Residential properties are predominately terraced with many painted in bright colours. There are a number of cafés, either modern purpose built or

in converted Victorian houses. The most notable of the numerous hotels here are the Pier Hotel and the Cliff Hotel which are both grand Victorian buildings.

10.5.57 The value of this townscape is medium, due to its strong Victorian character being diluted by a series of more modern unsympathetic and larger scale development.

10.5.58 The relationship with the sea and pleasant outlook, greenspace and public realm, indicating higher levels of tranquillity within this TCA. However, there are detractors in the form of unsympathetic buildings and car parks and periods of high visitor numbers, therefore it is considered to have moderate levels of tranquillity associated with it.

10.5.59 Artificial lighting is present within this TCA, predominately in the form of existing street lighting, architectural lighting on commercial buildings and security lighting.

10.5.60 The susceptibility to change is medium, due to a pattern of small scale of buildings and roads, although the Ocean Room and more recent developments reduce the susceptibility to the Scheme.

10.5.61 The combination of medium value and medium susceptibility results in this character area having a medium sensitivity.

Plate 10.6: View of Victorian Bandstand

TCA 7 – Great Yarmouth Seafront

10.5.62 This area covers the seafront of Great Yarmouth, approximately 400m east of the Principal Application Site. This TCA encompasses No 16. Great Yarmouth Seafront Conservation Area. This area is of high value based on its designation and importance as a recreational area to the local community and as a tourist attraction.

10.5.63 The characteristic features of this area are typical of the beach front of a traditional British seaside resort. The sandy beach is lined with numerous amusement attractions, including The Grade II listed Scenic Railway Roller Coaster at Great Yarmouth Pleasure Beach. Hotels, bars and restaurants line the front. In the north are the formal gardens and Grade II listed Venetian Waterways. Towards the centre of this TCA are the more modern amusement rides and attractions which contrast with older elements, such as Wellington Pier (see Plate 10-7).

10.5.64 The South Beach Parade, with its model train, horse rides and wide promenade has a traditional seaside resort character. Hotels, bars and restaurants line the seafront, typically within Victorian buildings to the north and more modern buildings to the south. The presence of occasional Victorian former grand houses illustrates the evolution of the town in this locality.

10.5.65 The relationship with the sea is predominately through urban influences and intrusion of urban features and the busy promenade within this TCA, aside from the beach which may have higher levels of tranquillity, the levels of tranquillity are considered to be low to moderate within this TCA.

10.5.66 Artificial lighting is present within this TCA, predominately in the form of existing street lighting, architectural lighting on commercial buildings and security lighting.

10.5.67 The value of this TCA is medium to high, due to the erosion of its Victorian character by more recent and differently scaled development, such as the Marina Leisure and fitness centre.

10.5.68 The susceptibility to change is medium, due to the presence of large scale buildings and the mix of styles in the area. The combination of medium to high value and medium susceptibility results in this character areas having a medium sensitivity.

Plate 10.7: View of Wellington Pier

TCA 8 - Northgate

10.5.69 This area covers the residential areas of Newtown, located approximately 1500m north of the Principal Application Site.

10.5.70 From the ZTV modelling, as illustrated in Figure 10.2 there is predicted to be little to no visibility of the Scheme from within this TCA, refer to Section 10.4- Insignificant Effects.

TCA 9 – Great Yarmouth Edge

10.5.71 The northern part of this TCA is located within The Broads designation. This TCA is based upon the published character area C1: Yare Valley – (Ref 10.7) and is located approximately 400m to the north west of the Principal Application Site. It covers the urban fringes of Great Yarmouth.

10.5.72 The key characteristics of this area are its low-lying landform where the Yare flows through Breydon Water. It has regular shaped wet grassland fields, defined by drainage ditches. There are holiday parks and an urban influence including some industrial development along the edge of Great Yarmouth. There are occasional farms and panoramic views to the north across Breydon Water, with occasional vertical features such as windmills and pumps.

10.5.73 The north part of this character area has a strong urban influence, of note is a supermarket and Vauxhall Holiday Park, along with Breydon Bridge (see Plate 10-8).

10.5.74 This TCA is considered to have moderate levels of tranquillity due to its semi-rural context and lack of urban influence, but its strong relationship to Great Yarmouth to the east as a transitional landscape and presence of Holiday parks and other urban influences reduce the levels of tranquillity. Therefore, levels of tranquillity are considered to be low to moderate within this TCA. There are urban detractors such as retail parks and other active uses which reduce tranquillity within this TCA. This TCA acts as a buffer between Great Yarmouth and The Broads, which would typically suggest a high value. However, as a transitional landscape with existing detractors and no formal designations the value is reduced to medium.

10.5.75 Artificial light is present within this TCA, predominately in the north in the form of existing street lighting and security lighting around commercial buildings. There is a lack of artificial lighting in the south of this TCA.

10.5.76 This TCA is of medium value and has a medium susceptibility to the Scheme due to the existing Breydon Bridge and proximity to Great Yarmouth town centre. The combination of medium value and medium susceptibility results in this TCA being of medium sensitivity.

Plate 10.8: View of Breydon Bridge from Path adjacent to Asda Supermarket

Visual

10.5.77 The visibility of the Scheme would be restricted in several directions. Long views are possible to the north and south along the River Yare, but these are channelled by the large buildings lining the River. To the east and west, views are mainly contained by the large warehouses and other buildings fronting the river bank, with gaps between these allowing narrow views along side streets. There are more distant views from high points such as on Breydon Bridge from road users which look out over the town and similarly pedestrian views from elevated footbridges.

Representative Viewpoint 1

10.5.78 This viewpoint is located on Southtown Road, with the view north along Southtown Road itself. It is representative for users of the England Coast Path (ECP, incorporating Norfolk Coast, England Coast Path and National Cycling Network Route 517 (NCN517)) and road users. It is also representative for oblique views from approximately 8no. residential properties, including apartments on Southtown Road and direct views from two residential properties on Southtown Road.

10.5.79 The view has some detracting features, including the cluttered appearance of Southtown Road, including commercial buildings and port facilities to the north and west along the River Yare. Other noteworthy features include the Gas Holder and the former Dolphin Inn, set within a context which also includes the large forms of metal fabricated buildings and ships moored along the river. It is therefore considered that this view has a low value and is consistent with poor visual amenity. The susceptibility of these residential and leisure receptors to change is high due to the enjoyment of the view being a primary focus for these receptors.

10.5.80 Artificial lighting is present within this view in the form of existing street lighting along Southtown Road and on the raised embankments along the River Yare.

10.5.81 The combination of a low value view and high susceptibility results in the viewpoint having a medium sensitivity.

Representative Viewpoint 2

10.5.82 This viewpoint is located on Queen Anne's Road, west of Southtown Road, with a view south-west towards the MIND Centre. It is representative for users of the neighbourhood cycle route along Queen Anne's Road and users of the MIND Centre and its grounds. It is also representative of direct and

oblique views from approximately 12no. residential properties along Queen Anne's Way.

10.5.83 The view comprises Queen Anne's Road lined by residential properties with front gardens, and footpaths on both sides. A wire mesh fence, partly covered with vegetation, defines the boundary between Queen Anne's Road and the MIND Centre, and the wooden huts of the centre can be seen above the fence. In the distance trees can be seen marking William Adams Way. Views are generally contained to Queen Anne's Road, whilst traffic along William Adams Way is perceptible between gaps in trees. In the distance the Kingsgate Community Centre is visible.

10.5.84 The view is a pleasant green outlook and consistent with good visual amenity, it is assumed to be of high value to residents. There are some detracting features such as the wire mesh security fence and views of traffic along William Adams Way that are heavily filtered by vegetation. The susceptibility of these receptors to change is high due to the enjoyment of the view being their primary focus.

10.5.85 Artificial lighting is present within this view, predominately street lighting along Queen Anne's Road.

10.5.86 The combination of a high value view and high susceptibility results in the viewpoint having a high sensitivity.

Representative Viewpoint 3

10.5.87 This viewpoint is located within Southtown Recreation Ground, looking north-east towards William Adams Way. It is representative for users of the recreation ground and for workers and users of the buildings off Suffolk Road who have a similar view towards William Adams Way, heavily screened by mature vegetation.

10.5.88 The view comprises a grass field in the foreground, with an artificial football pitch, skate park, and play equipment. The footbridge over William Adams Way is visible through the trees. To the north the field is bounded by a belt of mature shrubs and trees, containing views to the recreation ground. The footbridge over William Adams Way is perceptible through gaps in the trees.

10.5.89 The view is contained and has a pleasant outlook and is considered to have good visual amenity. The value of the view is high as users may visit to experience the view for relaxation and enjoyment. The susceptibility of recreational receptors to change is high, albeit much of the use of this location is for those engaged in formal sports and, nearby, people at their place of work; the latter two categories are less susceptible to changes in the view.

10.5.90 Artificial lighting is not located close to this viewpoint, but existing street lighting is perceptible along William Adams Way and Suffolk Road.

10.5.91 The combination of a high value view and high susceptibility results in this viewpoint having a high sensitivity (although some associated receptors in this location would be lower sensitivity).

Representative Viewpoint 4

10.5.92 This representative viewpoint is located on William Adams Way, looking east towards the A47. It is representative for road users of William Adams Way and workers within Harfrey's Industrial Estate.

10.5.93 In the foreground is William Adams Way with the A47 roundabout beyond and lighting columns surrounding the roundabout. To the north mature vegetation helps to screen distant views, and to the south security fencing and scrub vegetation filters views. In the distance the roofline of the Kingsgate Community Centre is visible above a belt of mature vegetation. Planting within the roundabout limit's views to the east. The view is considered to have poor visual amenity.

10.5.94 The view is channelled along William Adams Way. Long distance views are limited due to existing vegetation present on the roundabout. The view is of low value due it primarily being of a major road with associated traffic. The susceptibility of these receptors to change is low due to the view not being the primary focus of drivers and workers.

10.5.95 Artificial lighting is present within this view, predominately street lighting around the A47 and William Adams Way roundabout.

10.5.96 The combination of a low value view and low susceptibility results in this viewpoint being of low sensitivity.

Representative Viewpoint 5

10.5.97 This viewpoint is located on the eastern end of the footbridge over the A47, looking east towards the River Yare. It is representative for users of the footbridge (neighbourhood cycle route).

10.5.98 This is a panoramic elevated view over Southtown to the east. In the foreground is a carpark with a metal fabricated building, the two-storey brick faced Haven Veterinary Centre and another metal fabricated building, the Kingsgate Community Centre, lying beyond. The view is urban with an amalgam of residential properties with the roofs of metal fabricated buildings. The only indicators of the sea or the river are The Scenic Railway Roller Coaster at Great Yarmouth Pleasure Beach and upper deck of a vessel temporarily docked on the River Yare. Further south, the industrial port infrastructure, associated cranes and the stack of the power station are visible on the skyline, although partially screened by trees along William Adams Way. The Grade II Gas Holder is a prominent landmark. The trees along William Adams Way give the appearance of a 'green wedge' through the built environment.

10.5.99 The value of the view is low, due to its predominately industrial outlook and is consistent with poor visual amenity. The susceptibility to change of the

receptors is medium due to their focus likely to be the road, rather than enjoying views and scenery along the route.

10.5.100 Artificial lighting is in this view, predominately security lighting around commercial buildings in the foreground.

10.5.101 The combination of a low value of view and medium susceptibility results in this viewpoint having medium sensitivity.

Representative Viewpoint 6

10.5.102 This viewpoint is located on Southtown Road, looking south-west towards the River Yare. It is representative for users of the England Coast Path and National Cycling Network Route 517 and for road users. It is also representative of oblique and direct views from approximately 21no. residential properties on Southtown Road.

10.5.103 The view comprises Southtown Road, with residential properties in the foreground. Southtown Road is bordered by a wide shared footpath on the west side (ECP and NCN517) and an on-road cycle lane on the east side (NCN517), which is bordered by a large concrete retaining wall, approximately 2m in height. Beyond this is a raised narrow walkway, with the port land beyond fenced off by a 1m high wire mesh fence. Beyond this, temporarily moored ships indicate the location of the river. Further in the distance the former Dolphin Inn at Fish Wharf is lost amongst the prominent rooflines of large metal fabricated buildings and cranes. There are numerous roadside light columns on both sides of Southtown Road. In the distance, along the River Yare, cranes and blue storage silos are visible. It is therefore considered that this view has a low value and poor visual amenity. The susceptibility of these residential and leisure receptors to change is high due to the enjoyment of the view being a primary focus for these receptors.

10.5.104 Artificial lighting is present within this view in the form of existing street lighting along Southtown Road and on the raised embankments along the River Yare.

10.5.105 The combination of a low value view and high susceptibility results in the viewpoint having a medium sensitivity.

Representative Viewpoint 7

10.5.106 This viewpoint is located at the junction of South Denes Road and Barrack Road, looking south-west towards the River Yare. It is representative of views experienced by road users along South Denes Road. It is also representative of oblique residential views of approximately 3no. properties on South Denes Road.

10.5.107 The view comprises South Denes Road at its junction with Fish Wharf. The metal fabricated building and service yard with security fencing is a dominant feature visible to the west. To the south is South Denes Car Centre, with the former Dolphin Inn visible beyond. The River Yare is not in view, however cranes and lighting columns are frequent on the skyline.

10.5.108 The view is of low value, and consistent with poor visual amenity due to its industrial outlook associated with the Port. The susceptibility to change of these receptors in this scenario is high due to views from residential properties, within which the enjoyment of the view is their primary focus, it is noted that users of South Denes Road would be less susceptible.

10.5.109 Artificial lighting is present within this view, predominately existing street lighting along Southgates Road and security lighting around commercial buildings.

10.5.110 The combination of a low value view and high susceptibility receptors (but taking into account that not all receptors would be of high susceptibility) results in this viewpoint having a medium sensitivity.

Representative Viewpoint 8

10.5.111 This viewpoint is located on Barrack Road, looking south-west towards the River Yare. It is representative of oblique views from approximately 9no. properties along Barrack Road, including an apartment block and seven properties along The Steeps.

10.5.112 The existing outlook is of a concrete sealed area of land used for temporary storage beyond Barrack Road, surrounded by security mesh fencing. There is a strip of scrubby vegetation between the road and the vacant land beyond. To the west the roofline of the former Dolphin Inn can be seen, with trees perceptible beyond. Further to the west a large metal shed screens views, but properties along Southtown Road can be seen through the service yard. The River Yare is not perceptible in this view.

10.5.113 The view has detracting features and is of low value and consistent with poor visual amenity. The susceptibility to change of these receptors in this scenario is high due to views from residential properties, the enjoyment of the view being their primary focus.

10.5.114 Artificial lighting is present in this view, predominately existing street lighting along Barrack Road, and security lighting around commercial buildings in the distance.

10.5.115 The combination of a low value view and high susceptibility receptors results in this viewpoint having a medium sensitivity.

Representative Viewpoint 9

10.5.116 This viewpoint is located at the junction of Sutton Road and Admiralty Road, looking west along Sutton Road towards the River Yare. It is representative for users of the Route 1 cycleway and for workers within commercial buildings with an outlook towards the Scheme. It is also representative of direct and partially filtered views of approximately 26no. residential properties along Admiralty Way and two properties on South Denes Road who would have a direct outlook.

10.5.117 The existing outlook is of a residential road with commercial three-storey buildings. To the north is a gas substation, surrounded by a red brick wall with security wire on top with a metal clad building within. Tall lighting columns, a communication mast and cranes are strong vertical elements in the view. There is a narrow-channelled view along Sutton Road, which is often lined with parked cars, towards the river. The River Yare is not perceptible but properties along Southtown Road can be seen in the distance.

10.5.118 The view contains detracting industrial features and is of low value and poor visual amenity. The susceptibility to change of these receptors in this scenario is high due to views from residential properties that enjoyment of the view is their primary focus.

10.5.119 Artificial lighting is present within this view, predominately street lighting along Sutton Road and security lighting around commercial buildings in the distance.

10.5.120 The combination of a low value view and high susceptibility receptors results in this viewpoint having a medium sensitivity.

Representative Viewpoint 10

10.5.121 This viewpoint is located at the junction of Ferryboat Lane, Malthouse Lane and Ferry Hill looking north towards the River Yare. It is representative for users of NCN517 and the town centre cycle route and in views from the Nelson Monument and Gorleston Extension Conservation Area. It is also representative of oblique views from two residential properties on Ferryboat Lane.

10.5.122 The outlook is of a residential road, bordered by security fencing and a flint wall. The view is channelled along Ferry Hill. A property is visible down the embankment with a glimpsed view of the River Yare. Scrubby trees filter views to the north and break up the rooflines of the metal sheds in the view. There are several tall elements in the view, including a telegraph pole, television antenna and lighting columns. The view is of low value and consistent with poor visual amenity. The susceptibility to change of these receptors is high due to the enjoyment of the residential view as the primary focus.

10.5.123 Artificial lighting is present in this view, predominately street lighting along Malthouse Lane.

10.5.124 The combination of low value and high susceptibility results in a medium sensitivity.

Representative Viewpoint 11

10.5.125 This viewpoint is located on South Quay at the South Quay Viewing Point looking towards the Crossing. It is representative for recreational users and users of the neighbourhood cycle route. It is also representative of oblique residential views along South Quay, including those associated with the South Quay Conservation Area.

10.5.126 The existing outlook is of a car park with metal rail fencing and South Quay Road to the east with varied two and three-storey buildings. To the west is a paved dock with concrete retaining wall incorporating mooring points and the River Yare beyond. Ships are temporarily moored along the banks of the River Yare, with industrial buildings visible beyond on the western bank. The view is cluttered with street furniture and lighting columns. The Grade II listed Gas Holder is noticeable in the distance. The view has a strongly maritime character with a high scenic value and is consistent with a high level of visual amenity due to the views along the River Yare. This high value is demonstrated by the presence of the lookout point. The susceptibility to change of these receptors is high.

10.5.127 Artificial lighting is present in this view, predominately existing street lighting along South Quay, with security lighting around commercial buildings in the distance and on docked vessels.

10.5.128 The combination of a high value view and high susceptibility receptors results in this viewpoint having a high sensitivity.

Representative Viewpoint 12

10.5.129 This viewpoint is located on Haven Bridge on the parapet looking south south-east along the River Yare. It is representative for users of the ECP, NCN517 and local cycle routes. It is also representative for associated road users.

10.5.130 The existing outlook is along the River Yare, with concrete embankments and differing styles of two and three-storey buildings on the east bank, which contrast with the industrial metal fabricated buildings on the west bank. In the distance the Great Yarmouth Power Station is a notable landmark. The industrial contrast between the western bank and residential/ commercial buildings on the east bank is very noticeable.

10.5.131 The view is expansive but focussed along the River Yare, which curves south-west into the distance. The view is of high value consistent with a high level of visual amenity particularly the assemblage of buildings fronting South Quay along the east bank of the river; less so where there are detracting features to the west. The susceptibility of these receptors to change in this scenario is high, due to their primary focus being on the enjoyment of the view (it is noted that road users would be less susceptible).

10.5.132 Artificial lighting is present within this view, predominately street lighting and security lighting around commercial buildings. There is also visibility of lighting on docked vessels.

10.5.133 The combination of a high value view and high susceptibility receptors (but taking into account that road users would be less susceptible) results in this viewpoint being of high sensitivity.

Representative Viewpoint 13

10.5.134 This viewpoint is located on South Pier looking north along the River Yare. It is representative for recreational users of South Pier and of NCN517. It is also representative of oblique views from residential properties along Quay Road and direct views for people staying at the Pier Hotel.

10.5.135 The existing outlook is of the River Yare. To the west the Gorleston Lighthouse, a prominent feature, along with the brightly painted houses give a maritime feel. The east side of the River Yare contrasts with the residential appearance in the west with large metal sheds, storage silos and cranes in the view.

10.5.136 The view is of medium to high value. Whilst not a promoted view or formal lookout point, it is located at the war memorial so is a place for gathering and reflection; however, there are detracting features such as the industrial warehouses at South Denes. Overall this is consistent with good visual amenity. The susceptibility of these receptors to change is high due to their primary focus being enjoyment of the view.

10.5.137 Artificial lighting is present in this view, predominately street lighting and security lighting around commercial buildings.

10.5.138 The combination of a medium to high value view and high susceptibility results in this viewpoint being of high sensitivity.

Representative Viewpoint 14

10.5.139 This viewpoint is located on Suffolk Road, looking south to the roundabout and tie in of the Scheme. It is representative for cyclists using the neighbourhood route, road users, and workers in the surrounding commercial buildings who would have a view towards the Scheme.

10.5.140 The existing outlook is of Suffolk Road with a cycleway and footpath on the east side and grass verge on the west. The road is bordered by mesh fences on both sides with vegetation on the east side and a caravan park to the west. William Adams Way is perceptible in the distance and trees fringing Southtown Recreation Ground provide a backdrop. Tall vertical elements such as lighting columns and flagpoles give height and further channel the view.

10.5.141 This view of a road and commercial property is of a low value and of poor visual amenity. The susceptibility of these receptors to change is medium, as they are likely to be preoccupied with getting to their destination than enjoying views.

10.5.142 Artificial lighting is present in this view, predominately street lighting along Suffolk Road and security lighting around commercial buildings.

10.5.143 The combination of a low value view and medium susceptibility results in this viewpoint being of low sensitivity.

Representative Viewpoint 15

10.5.144 This viewpoint is located on the eastern side of the Kingsgate Community Centre looking east towards the River Yare. It is representative of direct views of users of the Kingsgate Community Centre.

10.5.145 The existing view is of a grassed recreation space, bordered by a metal fence with semi mature vegetation beyond which heavily filters views beyond, the blue storage silos are perceptible in the distance and the footbridge over William Adam's Way. To the north the metal clad buildings on Suffolk Road and the caravan sales park in the foreground. Properties along Queen's Anne's Road can be seen, with mature conifer trees beyond.

10.5.146 The view is of medium to high value due to the existing outlook of a recreational field with semi-mature vegetation beyond. This provides good visual amenity to those using the Kingsgate Community Centre. Although there are detracting features within the view, particularly to the north east which reducing the overall quality of the view. The susceptibility of change of these receptors is high, due to the primary focus of people within the café and annex, their primary focus is the enjoyment of the view as well with people using the recreation space.

10.5.147 Artificial lighting is present in this view, predominately street lighting and commercial lighting around the caravan sales park.

10.5.148 The combination of a medium value view and high susceptibility results in this viewpoint being of medium sensitivity.

Representative Viewpoint 16

10.5.149 This viewpoint is located on Cromwell Road looking south-east towards the River Yare along Cromwell Road. It is representative of direct views from approximately ten residential properties along Cromwell Road and five properties within Cromwell Court.

10.5.150 The existing view is of a narrow street, with terraced houses (and their small front gardens) to one side and dense vegetation creating a visual screen to the other. The rooflines of metal clad buildings beyond are visible above the vegetation. The view has limited attributes of scenic merit, however the intimate scale of the road with its vegetated screening to part of one side is judged to be of high value to the residents and in this context, provides a high level of visual amenity. The susceptibility of these receptors to change is high due to their primary focus being enjoyment of the view.

10.5.151 Artificial lighting is present in this view, predominately street lighting along Cromwell Road.

10.5.152 The combination of a high value view and high susceptibility results in this viewpoint having a high sensitivity.

Representative Viewpoint 17

10.5.153 This viewpoint is located on Angles Way looking south towards Great Yarmouth. It is representative of oblique views from users of Angles Way and those enjoying The Broads.

10.5.154 The existing view is of scrub land in the foreground with a gappy hedgerow and recreational ground beyond. Urban development on the northern edge of Great Yarmouth can be seen along with the Grade II Gas Holder visible in the distance in a gap between buildings. There is vegetation within the foreground and tall urban elements visible beyond in Great Yarmouth. The susceptibility of these receptors to change is high due their primary focus being enjoyment of the view, however it is noted the primary focus of the view would be to the west over Breydon water. The outlook of the view is pleasant and as a promoted recreational route the view is considered to be of high value and of high visual amenity.

10.5.155 Artificial lighting is not present in the foreground; however, it is clearly visible associated with Great Yarmouth in the distance.

10.5.156 The combination of high value view and high susceptibility results in this viewpoint having a high sensitivity.

Representative Viewpoint 18

10.5.157 This viewpoint is located on Weavers' Way and Wherryman's Way looking south across Breydon Water towards Great Yarmouth. It is

representative of oblique views from users of Weavers' Way and Wherryman's Way and those enjoying The Broads.

10.5.158 The existing view is of Breydon Water with the urban backdrop of Great Yarmouth in the distance. The foreground is of marshy land around the edge of Breydon Water, with vegetation visible on the far side. Breydon Bridge is a prominent feature in the view, along with a derrick crane and other tall buildings in the distance, particularly the power station at South Denes. The outlook of the view is pleasant with the view across the water. The susceptibility of these receptors to change is high due their primary focus being enjoyment of the view. The outlook is pleasant and as it is from a promoted recreational route the view is considered to be of high value and of high visual amenity.

10.5.159 Artificial lighting is not present in the foreground; however, it is clearly visible associated with Great Yarmouth in the distance.

10.5.160 The combination of high value view and high susceptibility results in this viewpoint having a high sensitivity.

10.6 Future Baseline

10.6.1 The understanding of the future townscape of Great Yarmouth has been informed by Chapter 19: Cumulative Assessment. The relevant developments within the study area which have the potential to create a substantial change to existing townscape character of Great Yarmouth are outlined below with the relevant TCA:

- Leisure developments south of the Pleasure Beach (ID11);
- Former Claydon High School Residential Development (ID14);
- Southern Terminal Expansion (ID43) – TCA 1;
- O&M Facility (ID53) – TCA 1; and
- Manufacturing Facility (ID54) – TCA 1.

10.6.2 There are varying degrees of certainty around the future townscape of Great Yarmouth because the potential developments within the study area are at different stages in the planning process. This assessment has reviewed these developments in order to understand the likely changes within the identified TCA that may influence the future setting of the Scheme. Where this is likely to occur, it is outlined below.

10.6.3 Leisure developments south of the Pleasure Beach. This would extend TCA 7 further south along South Beach Parade, reducing TCA 1 and the extent of Port character within Great Yarmouth.

10.6.4 Former Claydon High School Residential Development and Bradwell South. These would further increase the residential character and reduce open green space within TCA 5.

10.6.5 Southern Terminal Expansion, O&M Facility and Manufacturing Facility would see the redevelopment of derelict land, loss of red brick buildings and replacement with metal clad buildings further increasing the industrial and Port character within TCA 1, it would also define a distinct contrast between TCA 1 and TCA 7 and 2.

10.7 Sensitive Receptors

10.7.1 This section identifies key receptors for the assessment and their sensitivity.

10.7.2 Tables 10.11 and 10.12 summarise the sensitive receptors which have been assessed.

Table 10.11: Summary of Sensitive Townscape Receptors

TCA	Sensitivity
TCA 1	Low
TCA 2	Medium
TCA 3	Medium
TCA 4	Low
TCA 5	High
TCA 6	Medium
TCA 7	Medium
TCA 9	Medium

Table 10.12: Summary of Sensitive Visual Receptors

Visual Receptor	Viewpoint	Sensitivity
Users of ECP, NCN517 and residential properties	1	Medium
Users of Neighbourhood Cycle Route, MIND Centre and Grounds and residential properties	2	High
Users of Southtown Recreation Ground and workers off Suffolk Road	3	High

Visual Receptor	Viewpoint	Sensitivity
Road Users and Workers within Harfrey's Industrial Estate	4	Low
Users of the footbridge and neighbourhood cycle route	5	Medium
Users of ECP, NCN517, road users and residential properties	6	Medium
Road users and residential properties	7	Medium
Residential properties	8	Medium
Route 1 Cycleway, workers within South Denes and residential properties	9	Medium
Users of NCN517, town centre cycle route and residential properties	10	Medium
Recreational users and neighbourhood cycle route and residential properties	11	High
Users of ECP, NCN517, local cycle routes and road users.	12	High
Recreational users, NCN517 and residential and commercial properties	13	High
Users of neighbourhood cycle route, road users and workers	14	Low
Users of the Kingsgate Community Centre	15	Medium
Residential properties	16	High
Users of Angles Way	17	High
Users of Weavers' Way and Wherryman's Way	18	High

10.8 Establishing the Scenario for Assessment

10.8.1 The following information that is relevant to this assessment is outlined below for the construction and operation phase of the Scheme.

Construction Phase

10.8.2 The construction information is as defined within Chapter 2: Description of the Scheme and is anticipated to take approximately two years to complete. It is anticipated there would be tall plant such as cranes and excavators present throughout the construction period. The following key aspects have been considered in the assessment:

- Creation of temporary construction compounds and accesses from the public highway;
- Demolition of a number of existing residential and commercial/ business properties; and
- Demolition of an existing footbridge on William Adams Way.

Operational Phase

10.8.3 The operational design is as set out in Chapter 2: Description of the Scheme and includes the parameters of the environmental assessment (See Table 2.1 in Chapter 2: Description of the Scheme). The following key aspects have been considered in the assessment:

- A new double-leaf bascule bridge providing an opening span to facilitate vessel movement within the river.
- The new five-arm roundabout connecting the new dual carriageway road with Suffolk Road, William Adams Way and the western end of Queen Anne's Road.;
- A single-span bridge over Southtown Road, with reinforced earth embankments joining that bridge to the new roundabout at William Adams Way, along with pedestrian guardrails at the back of the footway/ cycle track on the new embankments;
- A single-span bridge to provide an underpass on the eastern side of the river, with reinforced earth embankments joining that single span bridge to South Denes Road, along with pedestrian guardrails at the back of the footway/ cycle track on the new embankments;
- A control tower with a maximum height of 20m AOD, located immediately south of the Crossing on the western side of the river;
- A plant room located on the eastern side of the river for the operation of the opening span of the new double-leaf bascule bridge;
- New public realm, landscape, ecology and sustainable drainage measures;
- Provision of lighting and landscaping; and
- The MIND Centre and Grounds would be reinstated within a smaller footprint adjacent to the base of the embankment of the widened and elevated William Adams Way. The relocated allotments, and the MIND Centre and Grounds, would be accessible from the walking and cycling

route to the south of the Crossing, and also from Queen Anne's Road for vehicles.

Embedded Mitigation

10.8.4 Given the location, scale and prominence of the Scheme, specific or targeted visual mitigation is generally not possible. The Scheme is of a larger scale than could be readily screened by any further measures than those incorporated as embedded mitigation. Alternatives to the Scheme design were considered early on in the design phase (See Chapter 3: Consideration of Alternatives). However, the mitigation and reduction of potentially adverse effects to townscape character and visual amenity, particularly in the immediate environment, has been embedded within the Scheme, which seeks to respond to, and integrate with the surrounding townscape.

10.8.5 Embedded mitigation is included within the Scheme, and there is no proposed additional mitigation for the Scheme. The Scheme is described in Chapter 2: Description of the Scheme and the key elements of embedded mitigation relevant to the assessment described in the below bullet points.

- Construction: Hard and soft landscaping works in general accordance with the landscaping plans (document reference 2.9). This is secured by the landscaping requirement in Schedule 2 of the DCO;
- Operation: Public realm including landscape planting incorporated within the Scheme would be implemented and maintained, by the Applicant, commencing with that date of completion of the landscaping works, as per Requirement 6 of the draft DCO.

10.9 Assessment of Effects, Mitigation and Residual Effects

Construction Phase

10.9.1 This section details the assessment of potential construction phase effects on townscape and visual receptors, including a description of potential impact and evaluation of the magnitude with reference to the proposed method of construction and whether the effect is considered to be significant or not.

10.9.2 Changes to the artificial lighting baseline and effects resulting from construction lighting are considered to be not significant. However, there may be a temporary increase in levels of lighting for short periods such as for specific task working. Commentary and a qualitative assessment has been provided where appropriate.

Construction Effects - Townscape

TCA 1 – River Yare and Port

10.9.3 Construction compounds on the eastern bank would alter the composition of the townscape locally, however are reflective of the existing land use which would be for temporary storage of parts and goods for loading onto vessels, where movement and use of cranes and plant would be commonplace.

10.9.4 The construction of cofferdams into the River Yare would further intrude urban influence into this piece of tidal water altering its characteristics. The impact of this change is considered to be negligible.

10.9.5 Floating cranes and barges would be used during construction within the River Yare, however these are characteristic of vessels temporarily docking within the River Yare. The Crossing deck would enclose the river and change its open aspect locally but is not uncharacteristic due to Haven Bridge in the north of TCA 1.

10.9.6 During construction there would be awareness of additional artificial lighting within this TCA, particularly during construction within the River Yare where there would be additional lighting within the river on barges, but this is within context of vessels that currently navigate the river. Lighting on the banks would be of similar levels to existing lighting associated with the warehousing and external storage.

10.9.7 There would be a slight reduction in the levels of tranquillity locally during construction around the Principal Application Site, but this would not affect the TCA as a whole.

10.9.8 The Scheme would be visible in the majority of this TCA, particularly along the River Yare, visibility reduces to the east where it would be limited to when the Crossing is in the raised position. The change would be for the short term and is reversible, except for the cofferdams and Crossing deck, the magnitude of impact would be low.

10.9.9 The sensitivity of TCA 1 is low, and the magnitude of impact is low. Therefore, there would be a direct **slight adverse (not significant)** effect on TCA 1.

TCA 2 – Great Yarmouth Historic Core

10.9.10 During construction there would be minor changes to the road layout and possible signage and traffic management. There would be no anticipated loss of key characteristic features and no change to townscape character. Visibility of the construction would be limited to the south of this TCA.

10.9.11 There would be some awareness of artificial lighting associated with construction of the Scheme, but the change is not considered to be

significant and reflective of existing artificial conditions associated with the port. The magnitude of impact would be low for the short term.

10.9.12 There would be no perceived effect on tranquillity locally during construction.

10.9.13 The sensitivity of TCA 2 is medium, and the magnitude of impact is low. Therefore, there would be a direct **neutral (not significant)** effect on TCA 2.

TCA 3 – Southtown and Gorleston-on-Sea

10.9.14 During construction there would be the loss of 19no. dwellings, 9no. along Southtown Road and 10no. along Queen Anne's Road, along with loss of commercial buildings off Suffolk Road.

10.9.15 There would be the loss of the footbridge over William Adams Way, along with mature roadside vegetation.

10.9.16 There would be a construction compound to the east of the Kingsgate Community Centre, with associated hoardings, along with construction activity and plant along the Scheme alignment.

10.9.17 There would be losses of local features and these would not be easily reversible but would be limited to the Principal Application Site. Visibility of construction activity would be limited to the central part of this TCA.

10.9.18 There would be a slight reduction in the levels of tranquillity locally during construction around the Principal Application Site, but this would not materially impact the TCA as a whole.

10.9.19 There would be an increased level of artificial lighting during construction that would be noticeable but localised to the Principal Application Site and would be for the short term. The magnitude of impact would be low.

10.9.20 The sensitivity of TCA 3 is medium, and the magnitude of impact is medium. Therefore, there would be a direct **slight adverse (not significant)** effect on TCA 3.

TCA 4 – Harfrey's

10.9.21 During construction there would be minor changes to the road layout and possible signage and traffic management. There would be removal of mature vegetation east of the Kingsgate Community Centre.

10.9.22 There is no anticipated loss of key characteristic features and slight change to townscape character. The Scheme would be visible along the eastern edge of this TCA.

10.9.23 There would be an awareness of additional artificial lighting during construction, but this would be consistent with the existing lighting baseline.

There would be a slight reduction in levels of tranquillity locally within the Principal Application Site, but this would not materially impact the wider TCA.

10.9.24 The sensitivity of TCA 4 is low, and the magnitude of impact is low for the short term. Therefore, there would be a direct **slight adverse (not significant)** effect on TCA 4.

TCA 5 – Bradwell and Gorleston-on-Sea

10.9.25 There would be no modification of features within this TCA during construction. Therefore, the magnitude of impact would be low.

10.9.26 There would be no effect on levels of tranquillity during construction and no perceived change in artificial lighting during construction within this TCA.

10.9.27 The sensitivity of TCA 5 is high, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 5.

TCA 6 – Gorleston-on-Sea Seafront

10.9.28 There would be no modification of features within this TCA during construction.

10.9.29 There would be no effect on levels of tranquillity during construction and no perceived change in artificial lighting during construction within this TCA, therefore, the magnitude of impact would be low.

10.9.30 The sensitivity of TCA 6 is medium, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 6.

TCA 7 – Great Yarmouth Seafront

10.9.31 There would be no modification of features within this TCA during construction.

10.9.32 There would be no effect on levels of tranquillity during construction and no perceived change in artificial lighting during construction within this TCA, therefore, the magnitude of impact would be low.

10.9.33 The sensitivity of TCA 7 is medium, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 7.

TCA 9 – Great Yarmouth Edge

10.9.34 There would be no modification of features within this TCA during construction. Therefore, the magnitude of impact would be low.

10.9.35 There would be no effect on levels of tranquillity during construction and no perceived change in artificial lighting during construction within this TCA.

10.9.36 The sensitivity of TCA 9 is medium, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 9.

Residual Effects

No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Construction Effects - Visual

Representative Viewpoint 1

10.9.37 The view would change with the demolition of a row of terraces and removal of the concrete embankment on the eastern side of Southtown Road. This would give increased openness to the view to the north. However, this would be for a limited period as construction of the Scheme commences and cranes and plant would filter views to the north and east.

10.9.38 Southtown Road would have temporary closures during the construction of the Crossing span over Southtown Road and approach embankment, limiting views to the north along Southtown Road. This would be a noticeable change to users of ECP and NCN517 and oblique residential views.

10.9.39 During construction there would be a temporary reduction in visual amenity within this view as a result of temporary hoardings, cranes and movement of plant.

10.9.40 Construction would introduce additional artificial lighting into the view than the baseline condition, with short durations of notable increase, particularly during works within the River Yare. The magnitude of impact would be high.

10.9.41 The sensitivity of Viewpoint 1 is medium, and the magnitude of impact would be high. Therefore, there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 1.

Representative Viewpoint 2

10.9.42 The view would become more open to the west in oblique views from the front of properties along Queen Anne's Road and direct views of users of the cycle route and MIND Centre and grounds, there would be a noticeable loss of vegetation in this view.

10.9.43 The construction compound would be a noticeable change in the view, with hoarding and plant, this, combined with more open views would increase awareness of the Kingsgate Community Centre and traffic along the A47 in the distance. There would be similar perception of construction activity in rear views which would result in a temporary reduction in visual amenity in this view.

10.9.44 Queen Anne's Road would be closed off at the western extent, during which time there would be noticeable change while these works are completed.

10.9.45 During construction there would be a temporary increase in artificial lighting in this view. The magnitude of impact would be medium.

10.9.46 The sensitivity of Viewpoint 2 is high, and the magnitude of impact would be medium. Therefore, there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 2.

Representative Viewpoint 3

10.9.47 The removal of the footbridge over Williams Adam's Way would be a perceptible change in the view, however wouldn't be a negative impact but potential benefit to the existing view. There would be an increased awareness of movement through the vegetation associated with construction activity, particularly if vegetation is removed or thinned along the northern boundary of Southtown Recreation Ground. Cranes would be visible above the tree line during the construction of the Scheme, which would represent detractors in this view. The view would be similar for workers in buildings off Suffolk Road.

10.9.48 There is no anticipated reduction in visual amenity during construction and no notable increase in artificial lighting due to the existing context of lighting along William Adams Way. The magnitude of impact would be low.

10.9.49 The sensitivity of Viewpoint 3 is high, and the magnitude of impact would be low. Therefore, there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 3.

Representative Viewpoint 4

10.9.50 There would be a subtle change in the view with the removal of vegetation to the west, partly increasing distant views to the west. The demolition of the footbridge over William Adams Way would be a perceptible change. Cranes would be perceptible above the trees within Harfrey's Roundabout.

10.9.51 There is no anticipated reduction in visual amenity during construction. There would be a negligible increase in artificial light levels during construction. The magnitude of impact would be low.

10.9.52 The sensitivity of Viewpoint 4 is low, and the magnitude of impact would be low. Therefore, there is likely to be a direct **neutral (not significant)** effect on Viewpoint 4.

Representative Viewpoint 5

10.9.53 The removal of trees within this panoramic view would be noticeable, along with demolition of commercial buildings and row of terraces along Queen Anne's Road. The demolition of the footbridge over William Adams Way and terraces along Southtown Road would be a subtle change. Construction activity would be noticeable and form a focal point within this view but would occupy a small proportion of the wider view and would be within the context of existing cranes on the horizon.

10.9.54 There is no anticipated reduction in visual amenity during construction given the low visual amenity within the baseline. There would be a slight increase in artificial lighting during construction. The magnitude of impact would be low.

10.9.55 The sensitivity of Viewpoint 5 is medium, and the magnitude of impact would be low. Therefore, there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 5.

Representative Viewpoint 6

10.9.56 The view would change with the demolition of a row of terraces and removal of the concrete embankment on the eastern side of Southtown Road. This would give increased openness to the view to the south and east. However, for a limited period as construction of the Scheme progresses, cranes and plant would filter views to the south east.

10.9.57 Southtown Road would have temporary closures during the construction of the Crossing span over Southtown Road and approach embankment, limiting views to the south along Southtown Road. This would be a noticeable change to users of ECP and NCN517 and in oblique views from properties along Southtown Road.

10.9.58 During construction there would be a temporary reduction in visual amenity within this view as a result of temporary hoarding, cranes and movement of plant.

10.9.59 Construction would introduce additional artificial lighting into the view, with a notable increase of short durations, particularly during works within the River Yare. The magnitude of impact would be high.

10.9.60 The sensitivity of Viewpoint 6 is medium, and the magnitude of impact would be high. Therefore, there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 6.

Representative Viewpoint 7

10.9.61 In the foreground of the view there would be a change in the view with the closure of Fish Wharf to accommodate the construction compound. The change would be perceptible, however of similar context to the existing baseline of the view. The demolition of part of the South Denes Car Centre and alteration of the forecourt would be a perceptible change in the view.

10.9.62 The realignment of South Denes Road and new junction and tie in would be a noticeable change but wouldn't detract from the existing outlook. During construction, cranes would be visible above South Denes Car Centre and The Dolphin Inn but are characteristic of the baseline view, along with storage of materials within the Atlas Terminal in the foreground of the view.

10.9.63 There would be a slight temporary reduction in visual amenity during construction. There would be short durations where artificial lighting would be notably increased, particularly during works within the River Yare. The magnitude of impact would be low.

10.9.64 The sensitivity of Viewpoint 7 is medium, and the magnitude of impact would be low. Therefore, there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 7.

Representative Viewpoint 8

10.9.65 There would be a perception of construction activity within this view, however partially screened by the fencing in the foreground and also by vehicles stored within the storage compound. Cranes would be visible above but would be characteristic of the baseline view. There would be a subtle change in the oblique views from properties along Barrack Way. There is no

anticipated change in visual amenity in this view. There would be short durations where artificial lighting would be notably increased, particularly during works within the River Yare. The magnitude of impact would be low.

10.9.66 The sensitivity of Viewpoint 6 is medium, and the magnitude of impact would be low. Therefore, there is likely to be a direct **neutral (not significant)** effect on Viewpoint 6.

Representative Viewpoint 9

10.9.67 During construction there would be a noticeable change in the view, limited to along Admiralty Way with the presence of the construction compound with hoarding and demolition of the South Denes Car Centre building. However, this would be similar to the baseline situation of security fencing. Cranes would be noticeable along with plant during construction, which would be similar to the baseline but would be more prominent and create a focal point in the view. There would be minor changes in the foreground of the view during the realignment of Admiralty Way, however for a short duration.

10.9.68 There would be a temporary decrease in visual amenity during construction. There would be a notable increase in artificial lighting during construction for a short duration, particularly for works within the River Yare. The magnitude of impact would be low.

10.9.69 The sensitivity of Viewpoint 9 is medium, and the magnitude of impact would be low. Therefore, there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 9.

Representative Viewpoint 10

10.9.70 There is no anticipated change to this view during construction, there may be an awareness of cranes above the building rooflines in the foreground of the view but would be seen within the existing context of the view and be a barely perceptible change in the view. There is no anticipated change in visual amenity during construction and there would be no increase in artificial lighting. The magnitude of impact would be low.

10.9.71 The sensitivity of Viewpoint 10 is medium, and the magnitude of impact would be low. Therefore, there is likely to be a direct **neutral (not significant)** effect on Viewpoint 10.

Representative Viewpoint 11

10.9.72 There would be perceptible change to this view during construction, limited to awareness of barges and cranes within the River Yare for a short duration, along with cranes on the horizon and construction of the cofferdams. Due to the distance it would change a small proportion of this view. There is no anticipated change in visual amenity during construction

and would be no increase in artificial lighting. The magnitude of impact would be low.

10.9.73 The sensitivity of Viewpoint 11 is high, and the magnitude of impact would be low. Therefore, there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 11.

Representative Viewpoint 12

10.9.74 There would be no anticipated perceptible change in the view during construction from this Viewpoint, due to screening by buildings along the eastern embankment. Cranes may be visible above the rooflines but would be consistent with the baseline view of cranes in the view. There is no anticipated change in visual amenity during construction and would be no increase in artificial lighting. The magnitude of impact would be low.

10.9.75 The sensitivity of Viewpoint 12 is high, and the magnitude of impact would be low. Therefore, there is likely to be a direct **neutral (not significant)** effect on Viewpoint 12.

Representative Viewpoint 13

10.9.76 Construction activity would be perceptible over the River Yare, but due to the distance would affect a small proportion of this view. It is not anticipated there would be perceptible change to the view. Where barges and cranes are visible, they would be seen within the existing context of the view, albeit more prominent. The enclosure of the river would be perceptible but lost within the context of the foreground of the view. There is no anticipated change in visual amenity during construction and would be no increase in artificial lighting. The magnitude of impact would be low.

10.9.77 The sensitivity of Viewpoint 13 is high, and the magnitude of impact would be low. Therefore, there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 13.

Representative Viewpoint 14

10.9.78 The removal of vegetation in the foreground and adjacent to Suffolk Road, demolition of terraces along Queen Anne's Road and the footbridge would be a very noticeable change in the view. The view would become more panoramic and open to the south, however construction activity and hoarding would enclosure the across the majority of the view. There would be a temporary reduction in visual amenity during construction and a notable temporary increase in artificial lighting for short durations. The magnitude of impact would be high.

10.9.79 The sensitivity of Viewpoint 14 is low, and the magnitude of impact would be high. Therefore, there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 14.

Representative Viewpoint 15

10.9.80 The removal of the fence in the foreground and vegetation along William Adams Way and off Suffolk Road would be a noticeable change, along with the demolition of terraces along Queen Anne's Road and the footbridge over

William Adams Way. This would open up views to the west and increased awareness of the Port which would detract from this view.

10.9.81 In the foreground the grass field would be reduced, and hoarding would occupy the majority of the view. Plant would be visible above the hoarding, increasing movement within the view. The change in the view would be very noticeable and within the majority of the view. There would be a notable decrease in visual amenity during construction due to the loss of vegetation and construction compound in the foreground. There would be a notable increase in artificial lighting during construction. Therefore, the magnitude of impact would be high.

10.9.82 The sensitivity of Viewpoint 15 is medium, and the magnitude of impact would be high. Therefore, there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 15.

Representative Viewpoint 16

10.9.83 The demolition of industrial buildings, terraces along Southtown Road and a single property off Cromwell Road, and clearance of vegetation in the foreground, would be a very noticeable change in the foreground of the view. Construction hoarding would partially enclose the foreground which would be similar to the baseline, however cranes and plant would create more movement within the view. There would be more open views to the west and increased awareness of the port. As construction progresses the views would become enclosed to the west which would be similar to the baseline conditions. There would be a notable reduction in visual amenity during construction following the removal of vegetation. There would be a notable increase in artificial lighting during construction to the baseline condition of street lighting. The magnitude of impact would be high.

10.9.84 The sensitivity of Viewpoint 16 is high, and the magnitude of impact would be high. Therefore, there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 16.

Representative Viewpoint 17

10.9.85 There would be no anticipated change in the view that would be perceptible given the distance from the Scheme. Where perceptible, it would be limited to cranes during construction, and it would be seen within the baseline context of the backdrop of Great Yarmouth and built form in the foreground. Views are heavily filtered by vegetation in the foreground of the view. There is no anticipated change in visual amenity during construction and would be no increase in artificial lighting. The magnitude of impact would be low.

10.9.86 The sensitivity of Viewpoint 17 is high, and the magnitude of impact would be low. Therefore, there is likely to be a direct **neutral (not significant)** effect on Viewpoint 17.

Representative Viewpoint 18

10.9.87 There would be no anticipated change in the view that would be perceptible given the distance from the Scheme. Where perceptible, it would be limited to cranes during construction and it would be seen within the baseline context of the backdrop of Great Yarmouth. There is no anticipated change in visual amenity during construction and would be no increase in artificial lighting. The magnitude of impact would be low.

10.9.88 The sensitivity of Viewpoint 18 is high, and the magnitude of impact would be low. Therefore, there is likely to be a direct **neutral (not significant)** effect on Viewpoint 18.

Residual Effects

10.9.89 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Artificial Lighting at Construction - Summary

10.9.90 During construction there would be a temporary increase in artificial lighting, localised to the Principal Application Site. This would result from construction task and security lighting. There is not anticipated to be a notable increase in artificial lighting and it would be seen within the context of that existing along William Adams Way, Southtown Road, minor roads and around the commercial properties. There would be notable increases in artificial lighting for short durations associated with specific tasks. Illumination of works at the River Yare where there are no existing lighting sources could be a notable short-term change. Whilst there would be an increase, the perception of this would be minimal and for a short duration so that significant effects would not arise.

Operational Phase: Townscape (Year 1)

10.9.91 This section details the assessment of potential operation phase effects on townscape and visual receptors, including a description of potential impact and evaluation of the magnitude with reference to the Scheme design and any mitigation if applicable.

10.9.92 Changes to the artificial lighting baseline and effects resulting from the Scheme are considered to be not significant. There may be slightly increased levels of artificial lighting resulting from the Scheme in some areas. A qualitative assessment has been provided for each TCA and a summary has been provided to illustrate the likely perceived changes due to artificial lighting as a result of the Scheme.

TCA 1 – River Yare and Port

10.9.93 The Scheme would introduce an additional Crossing into this TCA, which would be similar to Haven Bridge but of a modern style and appropriate to the surrounding industrial context.

10.9.94 The Crossing span over Southtown Road and on the eastern side of the River Yare would introduce additional bridge structures and embankment into this TCA, which are slightly uncharacteristic. The control tower and plant room on the eastern side would be new features but are of appropriate scale to buildings in the surrounding area.

10.9.95 The introduction of these features would be a noticeable change within a small part of this TCA, particularly as the River Yare is a tidal river, and would lead to further urbanisation of this stretch of water. However, the public realm on the western embankment would help to integrate the Scheme into the townscape. It would also increase vegetation cover within this TCA, reinvigorate derelict land and allow more public access to the river.

10.9.96 Lighting on the approach roads of the Scheme, would replace existing lighting adjacent to the River Yare but would be a slight increase and higher given a broader awareness. There is no proposed functional highway lighting on the lifting parts of the Crossing over the River Yare, and this would limit new artificial illumination over the river.

10.9.97 The Crossing would introduce traffic crossing the River Yare and raising and lowering of the Crossing would introduce movement across the river and reduce the levels of tranquillity within this TCA, although only slightly.

10.9.98 The Scheme would be visible as a townscape feature in the majority of this TCA, particularly along the River Yare. Visibility of the Scheme would be less in the east of the TCA where it would be limited to the Crossing in its raised position.

10.9.99 The sensitivity of TCA 1 is low, and the magnitude of impact is medium. Therefore, there would be a direct **slight beneficial (not significant)** effect on TCA 1.

TCA 2 – Great Yarmouth Historic Core

10.9.100 The Scheme would introduce some minor road improvements into a small proportion of this TCA. There would be some visibility of the Scheme from within the TCA. However, given the existing industrial backdrop of Great Yarmouth to the south, the Scheme would be seen within this context and not be out of place. The magnitude of impact would be low.

10.9.101 There are no anticipated increases in artificial lighting within this TCA resulting from the Scheme.

10.9.102 There are no anticipated effects on tranquillity resulting from the Scheme.

10.9.103 The sensitivity of TCA 2 is medium, and the magnitude of impact is medium. Therefore, there would be a direct **neutral (not significant)** effect on TCA 2. Therefore, no assessment at Year 15 is required.

TCA 3 – Southtown and Gorleston-on-Sea

10.9.104 The Scheme would introduce some new elements of which the western embankment would be the most noticeable and uncharacteristic, however it would be a local change and affect a small proportion of this TCA. The new roundabout and road tie-in are not uncharacteristic additions to this TCA.

10.9.105 There would be visibility of the Crossing structure from within this TCA but would not be a prominent feature against the backdrop of industrial buildings in South Denes. Therefore, the magnitude of impact would be medium.

10.9.106 There would be a small increase in artificial lighting within the central part of this TCA resulting from the introduction of the new 5-arm roundabout and the western approach road, which would be elevated compared with existing lighting giving a broader awareness of artificial lighting.

10.9.107 The introduction of the Crossing approach would reduce tranquillity locally due to the increased movement of traffic and around the 5-arm roundabout, however there would be increased levels of tranquillity within the new allotment site and the cycling route along Cromwell Avenue. On balance the level of tranquillity would remain, and the Scheme would not affect overall levels of tranquillity within this TCA.

10.9.108 The sensitivity of TCA 3 is medium, and the magnitude of impact is medium. Therefore, there would be a direct **slight adverse (not significant)** effect on TCA 3. Therefore, no assessment at Year 15 is required.

TCA 4 – Harfrey's

10.9.109 The introduction of the new roundabout and road are characteristic of this TCA, but not common features. However, these elements would affect a small proportion of this TCA and not impact on the wider TCA, as visibility of the Scheme is limited to the eastern fringes of this TCA, with increased visibility with the Crossing in the raised position.

10.9.110 There are no anticipated increases in artificial lighting within this TCA resulting from the Scheme. There are no anticipated effects on tranquillity resulting from the Scheme. The magnitude of impact would be low.

10.9.111 The sensitivity of TCA 4 is low, and the magnitude of impact is low. Therefore, there would be a direct **neutral (not significant)** effect on TCA 4. Therefore, no assessment at Year 15 is required.

TCA 5 – Bradwell and Gorleston-on-Sea

10.9.112 There would be no modification of features within this TCA as part of the Scheme. There could be awareness of the Scheme in distant views to the east, but it would be seen within the existing industrial context of South Denes.

10.9.113 There are no anticipated increases in artificial lighting within this TCA resulting from the Scheme. There are no anticipated effects on tranquillity resulting from the Scheme. Therefore, the magnitude of impact would be low.

10.9.114 The sensitivity of TCA 5 is high, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 5. Therefore, no assessment at Year 15 is required.

TCA 6 – Gorleston-on-Sea Seafront

10.9.115 There would be no modification of features within this TCA as part of the Scheme. Visibility of the Scheme would be limited to the northern fringe of this TCA, predominately when the Crossing would be in the raised position.

10.9.116 There are no anticipated increases in artificial lighting within this TCA resulting from the Scheme. There are no anticipated effects on tranquillity resulting from the Scheme. Therefore, the magnitude of impact would be low.

10.9.117 The sensitivity of TCA 6 is medium, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 6. Therefore, no assessment at Year 15 is required.

TCA 7 – Great Yarmouth Seafront

10.9.118 There would be no modification of features within this TCA as part of the Scheme. Visibility of the Scheme would be limited to the Crossing in the raised position.

10.9.119 There are no anticipated increases in artificial lighting within this TCA resulting from the Scheme. There are no anticipated effects on tranquillity resulting from the Scheme. Therefore, the magnitude of impact would be low.

10.9.120 The sensitivity of TCA 7 is medium, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 7. Therefore, no assessment at Year 15 is required.

TCA 9 – Great Yarmouth Edge

10.9.121 There would be no modification of features within this TCA as part of the Scheme. Visibility would be limited to the eastern edge of this TCA, predominately with the Crossing in the raised position.

10.9.122 There are no anticipated increases in artificial lighting within this TCA resulting from the Scheme. There are no anticipated effects on tranquillity resulting from the Scheme. Therefore, the magnitude of impact would be low.

10.9.123 The sensitivity of TCA 9 is medium, and the magnitude of impact is low. Therefore, there would be a **neutral (not significant)** effect on TCA 9. Therefore, no assessment at Year 15 is required.

Residual Effects

10.9.124 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Operational Phase: Visual (Year 1)

Representative Viewpoint 1

10.9.125 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.126 The introduction of the Scheme Crossing would result in a noticeable change to this view. The Scheme Crossing would be a dominant feature in the view along Southtown Road, particularly where it would pass over Southtown Road, with associated concrete retaining walls. It would enclose and channel the view along Southtown Road which was previously open.

10.9.127 The scale of the Crossing would not be wholly out of proportion with the surrounding built form, such as lighting columns and the existing raised embankment, particularly industrial buildings to the east and the Grade II Gas Holder. However, the control tower and corresponding tower on the eastern side would be notable taller elements in this view and would be disproportionate to the scale of residential properties.

10.9.128 The Crossing would frame views across the River Yare when in the raised position. When lowered the Crossing would obscure views across the river, replacing the chaotic views to the north east with a clean façade. The proposed public realm and tree planting, adjacent to the east of Southtown

Road would be noticeable but would not have matured therefore only a minor improvement to visual amenity in the foreground of the view.

10.9.129 Artificial lighting associated with the Scheme would be present in the view and would be a slight increase due to lighting on the approach roads being elevated compared with existing lighting. The change in the view would be large, resulting in a high magnitude of impact.

10.9.130 The sensitivity of Viewpoint 1 is medium, and the magnitude of impact would be high. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 1. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 2

10.9.131 There would be open views to the west towards the Scheme roundabout, and associated traffic would be perceptible along William Adams Way. Views would be more open, with a greater perception of traffic than at present. However, direct views to the south would have minimal change. The Kingsgate Community Centre would be more noticeable in the view. The 5-arm roundabout would be a noticeable feature in a small part of oblique views to the west, however there is no anticipated reduction in visual amenity.

10.9.132 There would be increased lighting in the view due to the introduction of lighting around the roundabout compared with the baseline condition. Therefore, the magnitude of impact would be low.

10.9.133 The sensitivity of Viewpoint 2 is high, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 2, Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 3

10.9.134 There is unlikely to be any perceptible change in the view from this location. There is likely to be glimpsed views above trees of the Scheme Crossing structure when in the raised position. The absence of the existing footbridge would be a perceptible change but there is no anticipated effect on visual amenity. There is no anticipated change in artificial lighting within this view. There is unlikely to be a noticeable change in the view and therefore the magnitude of impact would be low or none.

10.9.135 The sensitivity of Viewpoint 3 is high, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 3. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 4

10.9.136 There would be a perceptible change in the view, which would be less enclosed towards the east from the loss of trees along William Adams Way. The Crossing would be visible above the existing tree line. Where visible the Scheme would be of a similar scale to the Kingsgate Community Centre and lighting columns in the view. The Scheme would not alter the visual amenity of this view. There would be no anticipated increase in artificial lighting in this view. The change would be barely noticeable in a small proportion of this

view and due to the distance of the viewpoint from the Scheme. Therefore, the magnitude of impact would be low.

10.9.137 The sensitivity of Viewpoint 4 is low, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 4. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 5

10.9.138 The Scheme Crossing structure would be noticeable in the view. In the distance it would be visible above the skyline as a feature in the view, particularly when in the raised position. The control tower would be perceptible but not prominent due to the surrounding height of existing buildings and the backdrop of industrial buildings in South Denes. This view is expansive, and the Scheme Crossing would not be the main focal point.

10.9.139 The scale of the Scheme Crossing would be consistent with the existing elements in the view. The industrial backdrop means the Scheme Crossing structure would tend to blend into the scene, although when in the raised position it would be a noticeable feature, but within this expansive view it would not be a focal point. There is no anticipated reduction to visual amenity given the poor visual amenity in the baseline. Therefore, the magnitude of impact would be low.

10.9.140 There would be increased artificial lighting present in the view in the form of street lighting along the Scheme and elevated on the approach roads compared with baseline lighting.

10.9.141 The sensitivity of Viewpoint 5 is medium, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 5. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 6

10.9.142 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.143 The introduction of the Scheme Crossing would result in a large change to this view. The Scheme Crossing would be a dominant feature in the view along Southtown Road, particularly where it would pass over Southtown Road, with concrete retaining walls. The control tower and corresponding tower on the eastern side would be notable elements on the

skyline. Despite this being a large change, the scale of the Crossing would not be wholly out of proportion with the surrounding built form, such as lighting columns and the existing raised embankment, particularly industrial buildings to the east and the blue silos in the south. However, it would be disproportionate to the scale of residential properties.

10.9.144 The Crossing would frame views along the River Yare when in the raised position. When lowered the Crossing would obscure views along the river, replacing the chaotic views to the south east with a clean façade, apart from the access stairs.

10.9.145 The landscaping adjacent to the east of Southtown Road in the foreground of the view would be noticeable but would not have matured, resulting in a minor improvement in visual amenity in the foreground of the view.

10.9.146 Artificial lighting associated with the Scheme would be present in the view and would be a slight increase due to lighting on the approach roads being elevated compared with existing lighting. The change in the view would be large, resulting in high magnitude of impact. The change in the view is large, resulting in high magnitude of impact.

10.9.147 The sensitivity of Viewpoint 6 is medium, and the magnitude of impact would be high. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 6. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 7

10.9.148 The Scheme Crossing would be a noticeable addition to this view, and the new junction a noticeable change. However, the Scheme junction would be consistent with the existing context of the view. The Scheme Crossing would be perceptible in the view and the control tower would be visible on the skyline. When raised the Crossing would be larger than the existing buildings. However, it would only occupy a small part of this view. There would be no decrease in visual amenity which is low in baseline conditions. There would be a slight increase in artificial lighting due to it being elevated on the approach road compared with existing lighting. The magnitude of impact would be low.

10.9.149 Artificial lighting associated with the Scheme would be present in the view but would be consistent with the baseline conditions and not represent a noticeable increase.

10.9.150 The sensitivity of Viewpoint 7 is medium, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **slight adverse (not significant)** effect on

Viewpoint 7. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 8

10.9.151 The Scheme Crossing would be a noticeable addition to the skyline, particularly when raised, however this would only be the case in oblique views and it would occupy a small proportion of the view. The embankment and road junction are unlikely to be perceptible in the view. The Crossing when raised would be noticeable but would not form a focal point in the view. There is no anticipated reduction in visual amenity due to it being poor in baseline conditions. There would be a slight increase in artificial lighting in the view due to it being elevated on the approach road compared with existing lighting. The magnitude of impact would be low.

10.9.152 Artificial lighting associated with the Scheme would be present in the view but would be consistent with the baseline conditions and not a noticeable increase.

10.9.153 The sensitivity of Viewpoint 8 is medium, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 8, therefore no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 9

10.9.154 The Scheme Crossing would be a noticeable addition to this view, framed by the existing buildings along Sutton Road. When in its raised position the Scheme would be a prominent feature but would only affect a small proportion of the view temporarily blocking the view across the river. The Crossing would appear to be larger than the existing scale of buildings in this view but would not be noticeably larger. Due to the existing context of poor visual amenity there is no anticipated reduction in visual amenity as a result of the Scheme. There would be a slight increase in artificial lighting on the approach road being elevated compared to baseline lighting. The magnitude of impact would be low.

10.9.155 Artificial lighting associated with the Scheme would be present in the view but would be consistent with the baseline conditions and not a noticeable increase.

10.9.156 The sensitivity of Viewpoint 9 is medium, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **slight adverse (not significant)** effect on

Viewpoint 9. Therefore, no assessment at Year 15 is required. The effect is anticipated to be lower when the Crossing is in the lowered position.

Representative Viewpoint 10

10.9.157 It is unlikely that the Scheme Crossing would be visible above the tree line, and it is not likely to be a focal point of the view. It would be a barely perceptible change in the view due to the existing tall elements in the foreground of the view. There is no anticipated change in visual amenity and no change in artificial lighting within the view. Therefore, the magnitude of impact would be low.

10.9.158 The sensitivity of Viewpoint 10 is medium, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 10. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 11

10.9.159 The Scheme Crossing would be perceptible in the view and noticeable particularly when in the raised position, but due to the distance from this viewpoint and the surrounding scale of existing elements, such as industrial buildings and cranes in the view, it would not be a noticeable addition to the view. It is anticipated to have no effect on visual amenity and there would be no increase in artificial lighting within the view. Therefore, the magnitude of impact would be low.

10.9.160 The sensitivity of Viewpoint 11 is high, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 11. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 12

10.9.161 The Scheme Crossing is unlikely to be readily visible from this viewpoint. Given the industrial buildings and cranes along the River Yare, if apparent it would be seen within the existing context and not become a focal feature in the view. There is no anticipated change in visual amenity or increase in artificial lighting. The magnitude of impact would be low.

10.9.162 The sensitivity of Viewpoint 12 is high, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 12. Therefore, no assessment at Year 15 is required. There is no anticipated

difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 13

10.9.163 The Scheme Crossing would be perceptible in the distance along the river. However, due to the bend in the river the built form on either bank appears sinuous. The built form would be of large scale and the Crossing would appear similar in scale and mass. Given the distance of the Crossing from the viewpoint and the wide aspect of this panoramic view there would be no effect on visual amenity experienced from this viewpoint, therefore the magnitude of impact is low.

10.9.164 There is no anticipated increase artificial lighting associated with the Scheme due to the distance and existing lighting in the view.

10.9.165 The sensitivity of Viewpoint 13 is high, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 13. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 14

10.9.166 The Scheme would open up views to the south-east, previously contained by vegetation. There would also be more open views to the south, where the new 5-arm roundabout within the Scheme would be a noticeable and prominent feature in the view. The Crossing could be visible above the industrial buildings when in its raised position but would not form a focal feature. There would be a noticeable change in the view, but the quality of the visual amenity is anticipated to remain similar to the baseline conditions as a result of the Scheme.

10.9.167 There would be an increased level of artificial lighting in the view associated with the new five-arm roundabout and along the approach to the Crossing. This change would not be significant.

10.9.168 The sensitivity of Viewpoint 14 is low, and the magnitude of impact would be medium. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **slight adverse (not significant)** effect on Viewpoint 14. Therefore, no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 15

10.9.169 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.170 With the Crossing in the raised position the Scheme would be a noticeable focal point in this view. There would be open views to the east along the Crossing. The control tower would be a prominent new addition to the skyline, however it would be consistent with the height of surrounding buildings and the Gas Holder. The approach road into the new 5-arm roundabout would be visible, with the roundabout screened by a fence along the eastern boundary of the Kingsgate Community Centre; however, traffic would still be perceptible above the fence. There would be a reduction in visual amenity due to the loss of screening vegetation opening up views of the industrial port in the distance; in combination with the introduction of the built elements of the Scheme. The magnitude of impact would be high.

10.9.171 There would be increased artificial lighting in the view associated with the new 5-arm roundabout and along the approach to the Crossing as lighting would be elevated in the view compared with the baseline condition.

10.9.172 The sensitivity of Viewpoint 15 is medium, and the magnitude of impact would be high. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 15. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 16

10.9.173 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.174 The changes brought about by the Scheme would be very noticeable at this location, due to its proximity and the removal of enclosing vegetation and buildings. The view would have similar enclosure due to the height the embankment but set back than the previous vegetation and factory buildings beyond. In the foreground the view would be open with parking provision with open space beyond with trees and the vegetated Crossing embankment.

10.9.175 The Crossing in the raised position would screen views to the east and would be a prominent focal point in oblique views, however enclosure would be similar to the baseline views, expect for the access stairs which would break up previously open view.

10.9.176 The change in view would be a large, however the outlook in the foreground is considered to have minor improvement in visual amenity, through the provision of open space, trees and vegetated embankment. Proposed planting would not have matured, therefore the magnitude of impact would be high.

10.9.177 Artificial lighting associated with the Scheme would be present in the view, along the top of the embankment as well as at street level. There would be a notable increase in perceived artificial lighting compared to the baseline conditions due to the lighting being elevated in the view.

10.9.178 The sensitivity of Viewpoint 16 is medium, and the magnitude of impact would be medium. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **moderate adverse (significant)** effect on Viewpoint 16. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing

Representative Viewpoint 17

10.9.179 The Scheme Crossing would be barely perceptible in the distance along the river. However, due to the built form of Great Yarmouth in the foreground the Crossing would be barely perceptible in the distance. Where visible the Crossing would appear similar in scale and mass. Given the distance of the Crossing from the viewpoint and the wide aspect of this panoramic view there would be no effect on visual amenity experienced from this viewpoint or increase in artificial lighting, therefore the magnitude of impact is low.

10.9.180 The sensitivity of Viewpoint 17 is high, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 17, therefore no assessment at Year 15 is required. There is no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Representative Viewpoint 18

10.9.181 The Scheme Crossing would be barely perceptible in the distance along the river. However, due to the built form of Great Yarmouth in the foreground the Crossing would be barely perceptible in the distance. Where visible the Crossing would appear similar in scale and mass. Given the distance of the Crossing from the viewpoint and the wide aspect of this panoramic view there would be no effect on visual amenity experienced from this viewpoint and no increase in artificial lighting, therefore the magnitude of impact is low.

10.9.182 The sensitivity of Viewpoint 18 is high, and the magnitude of impact would be low. Therefore (for the Scheme Crossing in its raised position), there is likely to be a direct **neutral (not significant)** effect on Viewpoint 18. Therefore, no assessment at Year 15 is required. There no anticipated difference in overall effect between the raised and lowered position of the Crossing.

Residual Effects

10.9.183 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Additional Mitigation

10.9.184 There is no proposed additional mitigation.

Year 15

10.9.185 There are no significant effects predicted for townscape at Year 1 so therefore no assessment at Year 15 for townscape has been necessary.

Viewpoint 1

10.9.186 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.187 By Year 15 the trees along Bollard Quay would have matured and they would partially filter views of the Scheme and across the River Yare. The shrub planting in the public realm would also have matured, which would create a sense of place and partial improvement to visual amenity. The planting would complement the backdrop of the control tower thus helping to instil a distinct sense of place. The Crossing would still be visible above the planting, particularly in the raised position, however lower parts of the Scheme would be partially filtered by vegetation in winter, therefore the magnitude of impact would be high.

10.9.188 During the summer the trees would screen the lower parts of the Crossing. The trees would help to create a sense of place and would lead to an increase the visual amenity in the outlook of the view, however the change in the view from long open views to enclosed and framed by the Crossing would still result in a high magnitude of impact.

10.9.189 The change in the view would still be large, however the screening of detracting features such as industrial buildings and replacement with a clean façade, along with the creation of the public realm, softened by trees would lead to an increase in the visual amenity within the view compared to baseline conditions.

10.9.190 The sensitivity of Viewpoint 1 is medium, and the magnitude of change is high. Therefore, there is likely to be a long-term effect of **slight beneficial (not significant)** effect on people at this viewpoint following the maturation of planting. There is no anticipated significant difference in overall effect when the Crossing is in the lowered position.

Viewpoint 6

10.9.191 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.192 By year 15 the trees would have matured within the foreground, partially filtering views of the Scheme and over the River Yare. The shrub planting would have matured and complement the paved public realm, which would help to soften the appearance of the Crossing. The combination of these features would also help to contribute to create a sense of place. There would be a marginal improvement in the visual amenity experienced at this location. The Crossing would be visible above the planting when in the raised position. The magnitude of impact would be high.

10.9.193 During Summer the trees would screen lower parts of the Crossing, softening the appearance of the Crossing and improving the visual amenity of the baseline view. However, the majority of the Crossing would still be in view and the improvement would be minimal from Year 1 and would still result in a high magnitude of impact.

10.9.194 The sensitivity of Viewpoint 6 is medium, and the magnitude of change is high. Therefore, there is likely to be a long-term effect of **slight adverse (not significant)** effect on following the maturation of planting. There is no anticipated significant difference in the overall effect when the Crossing is in the lowered position.

Viewpoint 15

10.9.195 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.196 By Year 15 the proposed shrub planting would have matured and part screen views of traffic on the 5-arm roundabout, along with trees within the roundabout which would help restore screening similar to baseline conditions in part of the view. The Crossing would still be a prominent feature in the view when in the raised position. The magnitude of impact would be medium. The tree planting will have matured resulting in restoration of visual amenity and soften views of the Crossing but through views of the industrial port beyond would be greater than compared to baseline views which detract from the view.

10.9.197 During the summer the trees would largely screen views of the Port beyond, although there would be glimpses through gaps in the planting. The Crossing would still be a prominent feature in the raised position in the view. The magnitude of impact would remain as medium.

10.9.198 The sensitivity of Viewpoint 15 is medium, and the magnitude of change is high. Therefore, there is likely to be a long-term effect of **slight adverse (not significant)** effect on people at this viewpoint following the maturation of planting. The effect would be less with the Crossing in the lowered position as the Crossing would be a less prominent feature in the view.

Viewpoint 16

10.9.199 To assist with the assessment of this viewpoint refer to the photomontages (document reference 6.12).

10.9.200 By Year 15 the tree planting would have matured along with the vegetated embankment, filtering views of the scheme and traffic moving along the approach road. The landscaping would soften views and improve the visual amenity of the view, restoring enclosure similar to baseline

conditions and improving visual amenity compared with baseline conditions. The Crossing would still be a prominent feature in the raised position. The magnitude of impact would be high.

10.9.201 During the summer the trees would screen parts of the Crossing, however the Crossing would be visible above the trees in the raised position. The trees would create a sense of place and would improve the visual amenity in the outlook of the view and soften the Crossing and filter views of traffic on the Crossing. The magnitude of impact would remain high.

10.9.202 The sensitivity of Viewpoint 16 is medium, and the magnitude of change is high. Therefore, there is likely to be a long-term effect of **slight beneficial (not significant)** effect on people at this viewpoint following the maturation of planting. There is no anticipated significant difference in effect when the Crossing is in the lowered position.

Artificial Lighting at Operation - Summary

10.9.203 The approaches to the Crossing (but not the raised and lowered leaves of the Crossing deck), would be lit with roadside lighting (in line with current highway standards) using columns and light overspill limited to the carriageway (See Figure 10.5). The lighting, particularly on the approach roads would represent a new lighting source within the context of Great Yarmouth. However, this would not significantly increase the perception of artificial lighting in view. The lighting would appear as cones of light, illuminating the carriageway and traffic. This appearance would extend to the tie in with Williams Adams Way and South Denes Road, both of which have existing street lighting. These changes associated with the Scheme would not significantly increase the perception of lighting in this urban environment.

10.9.204 The additional public realm lighting along Southtown Road and along Cromwell Road would introduce localised but small-scale increases in artificial lighting, which would be additional to the existing street lighting but not anticipated to result in significant effects.

10.9.205 The maturation of planting would not change the effects of artificial lighting; therefore, the effects would be the same in Year 15 as Year 1.

Residual Effects

10.9.206 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Monitoring

10.9.207 No monitoring is considered to be required over and above that which is included in the Outline CoCP (document reference 6.16) and its

subsequent development by the Contractor into a full CoCP. The full CoCP, once detailed, will provide a review, monitoring and audit mechanism to determine the effectiveness of and compliance with environmental control measures.

10.10 Limitations and Assumptions

10.10.1 Limitations and assumptions are as follows:

- Public realm including landscape planting incorporated within the Scheme would be implemented and maintained by the Applicant, commencing with the date of completion of the landscaping works, as per Requirement 6(h) of the draft DCO.
- Full clearance of vegetation within the Application Site has been assumed. Should existing vegetation that is providing screening be retained then effects may be lower than predicted.

10.11 Summary

10.11.1 Summary of effects are listed in Table 10.13.

10.11.2 The assessment predicts that effects would be no greater than Slight Adverse on townscape during construction, with the greatest effects limited to those townscape character areas where the Scheme would be located. There are therefore no significant effects on townscape predicted during construction.

10.11.3 The assessment predicts Slight or Moderate Adverse effects on visual receptors during construction due to the clearance of vegetation, demolition of buildings and construction activities. The greatest effects are predicted to be on associated receptors at Viewpoints 1, 2, 6, 14, 15 and 16.

10.11.4 At Year 1 the greatest operational effects on townscape are predicted to be Slight Adverse to TCA 3 due to a noticeable reduction in tranquillity. A Slight Beneficial effect to TCA 1, and Neutral effects to TCA 2, 4, 5, 6, 7 and 9 are predicted for Year 1. There are therefore no significant operational effects on townscape predicted for Year 1 or beyond.

10.11.5 At Year 1 Moderate Adverse operational effects are predicted on people at Viewpoints 1, 6, 15 and 16, Slight Adverse effects on people at Viewpoints 2, 5, 7, 9 and 14 and neutral effects on Viewpoints 3, 4, 8, 10, 11, 12, 13, 17 and 18.

10.11.6 At Year 15 following establishment of embedded mitigation there would be Slight Beneficial operational effects on people at Viewpoints 1 and 16 with a

Slight Adverse effect on Viewpoints 6 and 15. There are therefore no significant operational effects on visual amenity predicted for Year 15.

Table 10.13: Summary of Significant Effects Table for Townscape and Visual

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
The loss of some characteristics and disturbance to the character of the townscape in which the development would sit	TCA's 1, 3 and 4	Slight Adverse	None	Slight Adverse
The Scheme does not result in any change in the existing townscape quality and character.	TCA's 2, 5, 6, 7 and 9	Neutral	None	Neutral
The Scheme resulting in a noticeable deterioration to the current outlook, involving removal of existing, visually screening elements in the view, exposing the Scheme	Viewpoints 1, 2, 6, 14, 15 and 16	Moderate Adverse	None	Moderate Adverse
The Scheme would not constitute a new point of principal focus but would result in a slight deterioration in the existing receptor view or outlook	Viewpoints 3, 5 7, 9, 11 and 13	Slight Adverse	None	Slight Adverse

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
The Scheme does not lead to a discernible improvement or deterioration in existing receptor view or outlook.	Viewpoints 4, 8, 10, 12, 17 and 18	Neutral	None	Neutral
Operational Phase (Year 1)				
The Scheme would result in some restoration and creation of some sense of place.	TCA1	Slight Beneficial	None	Slight Beneficial
The loss of some characteristics and disturbance to the character of the townscape in which the development would sit.	TCA3	Slight Adverse	None	Slight Adverse
The Scheme does not result in any change in the existing townscape quality and character.	TCA's 2, 4, 5, 6, 7 and 9	Neutral	None	Neutral
Large new structures are introduced as part of the Scheme and a substantial change in the view and deterioration in the existing receptor view or outlook.	Viewpoints 1, 6, 15 and 16	Moderate Adverse	None	Moderate Adverse

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
The Scheme would not constitute a new point of principal focus but would result in a slight deterioration in the existing receptor view or outlook.	Viewpoints 2, 5, 7, 9 and 14	Slight Adverse	None	Slight Adverse
The Scheme does not lead to a discernible improvement or deterioration in existing receptor view or outlook.	Viewpoints 3, 4, 8, 10, 11, 12, 13, 17 and 18	Neutral	None	Neutral
Operational Phase (Year 15)				
The Scheme would result in some restoration and creation of some sense of place.	TCA1	Slight Beneficial	None	Slight Beneficial
The loss of some characteristics and disturbance to the character of the townscape in which the development would sit.	TCA3	Slight Adverse	None	Slight Adverse
The Scheme does not result in any change in the existing townscape quality and character.	TCA's 2, 4, 5, 6, 7 and 9	Neutral	None	Neutral

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
The Scheme results in a barely perceptible improvement	Viewpoints 1 and 16	Slight Beneficial	None	Moderate Beneficial
The Scheme does not lead to a discernible improvement or deterioration in existing receptor view or outlook.	Viewpoints 2, 5, 6, 7, 9, 14 and 15	Slight Adverse	None	Slight Adverse
The Scheme does not lead to a discernible improvement or deterioration in existing receptor view or outlook.	Viewpoints 3, 4, 8, 10, 11, 12, 13, 17 and 18	Neutral	None	Neutral

10.12 References

Ref 10.1: Marine Management Organisation (2012), East Inshore and East Offshore marine plan areas (online) (Accessed April 2019).

Ref 10.2: Department for Transport (2014), National Policy Statement for National Networks. (online) (Accessed April 2019).

Ref 10.3: Department for Transport (2014), National Policy Statement for Ports. (online) (Accessed April 2019).

Ref 10.4: Ministry of Housing, Communities & Local Government (2019), National Planning Policy Framework.

Ref 10.5: Landscape Institute and Institute of Environmental Management and Assessment (2013), Guidelines for Landscape and Visual Impact Assessment 3rd Edition, London: Routledge.

Ref 10.6: Landscape Institute (2017), Technical Guidance Note 02/17 Visual Representation of Development Proposals.

Ref 10.7: Great Yarmouth Borough Council (2008), Great Yarmouth Borough Council Landscape Character Assessment.

Ref 10.8: The Broads Authority (2016), The Broads Landscape Character Assessment.

Ref 10.9: National Character Area 79. North East and Flegg (2014), Natural England.

Ref 10.10: National Character Area 80. The Broads (2015), Natural England.

Ref 10.11: National Character Area 82. Suffolk Coast and Heaths (2015), Natural England.

Ref 10.12: Great Yarmouth Borough Council (2015), Great Yarmouth Local Plan: Core Strategy 2013-2030.

Ref 10.13: Norfolk and Suffolk Broads Act (1988).

Ref 10.14: Landscape Institute (2017), Technical Guidance Note 01/17 Tranquillity – an overview.

Ref 10.15: Landscape Institute (2018), Technical Information Note 05/17 Townscape Character Assessment (TIN-05-2017).

Ref 10.16: Marine Management Organisation (2012), Seascape character area assessment East Inshore and East Offshore Marine Plan Areas.

Ref 10.17 - HM Government (2011), Marine Policy Statement.

11 Road Drainage and the Water Environment

11.1 Introduction

11.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Scheme upon the water environment (surface water and groundwater). The potential effects considered in this assessment include:

- Potential for pollution of surface waters and groundwater during construction;
- Potential for mobilisation of contaminated sediments and associated effects on water quality (surface water and groundwater);
- Potential for pollution of surface water and groundwater from routine road runoff or accidental spillage;
- Potential effects on the tidal and/or hydrological regime;
- Potential effects on channel hydromorphology;
- Potential effects on groundwater aquifers and associated water supplies; and
- Potential effects on surface water supplies.

11.1.2 This chapter also addresses the requirements of the Water Framework Directive (WFD). The WFD compliance assessment is incorporated into the ES for the Scheme (Appendix 11E). The WFD assessment makes reference to the findings of the piling risk assessment (document reference 6.2, Appendix 16D), the sediment transport assessment (document reference 6.2, Appendix 11C), the groundwater modelling study completed as part of this chapter (document reference 6.2, Appendix 11F), information provided in the Drainage Strategy (document reference 6.2, Appendix 12C) and findings in the ES in respect of aquatic ecology and protected areas included in Chapter 8: Nature Conservation.

11.1.3 The chapter describes the assessment methodology, the baseline conditions at the Application Site (including the Principal and Satellite Application Sites) and in the surrounding area, any embedded and additional mitigation adopted for the purposes of the assessment, a summary of the likely significant effects taking into account national legislation, the further mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

11.1.4 This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES with reference to:

- Chapter 8: Nature Conservation;
- Chapter 12: Flood risk; and
- Chapter 16: Geology and Soils for the potential for contaminant linkages and impacts to controlled waters, the vertical and lateral migration of mobile contaminants into groundwater and/or surface waters.

11.1.5 The specific characteristics of the Scheme and the Study Area enable particular impacts to be considered as highly unlikely to occur. Based on professional judgement and taking account of water environment characteristics, Scheme design and Scoping Opinion, the following items have been scoped out of the assessment and are not considered further:

- Loss or change to Groundwater Dependent Terrestrial Ecosystems - scoped out due to the urban setting of the Study Area and the lack of such ecosystems below or adjacent to the Scheme; and
- Changes to groundwater level or flows due to in-land cuttings and related dewatering associated with cuttings, scoped out as no cuttings are anticipated for the Scheme. Changes in groundwater levels or flows relating to dewatering during construction of the bascule bridge structure is covered in the assessment.

11.1.6 Section 11.4 provides further details on the scope of the assessment.

11.2 Competent Expert

11.2.1 The surface water environment lead, Claire Storer, is a Chartered Engineer (Member of the Institution of Civil Engineers) who holds a MEng (Hons) degree in Civil Engineering, Design and Management from Cardiff University (2000). Claire has experience in the assessment and mitigation of highway schemes on the water environment and the preparation of Environmental Impact and Water Framework Directive Assessments.

11.2.2 The groundwater environment lead, Alex Gallagher, is a chartered geologist and technical director at WSP who holds a degree in applied geology and an MSc in hydrogeology from the University of Birmingham. Alex has 17 years' experience working on multidiscipline environmental and engineering projects, and regularly leads the assessment of the impacts of proposed infrastructure on the water environment.

11.2.3 William King is a Principal Hydrogeologist with over 9 years of experience within the environmental sector. William has been involved in an array of

environmental projects which include environmental impact assessments, water framework directive assessments, hydrogeological risk assessment, groundwater feasibility studies, environmental monitoring, basement groundwater impact studies, hydrological studies, abstraction licensing, water feature surveys, and numeric groundwater modelling. William holds a MSc degree in Environmental Hydrogeology from the University of Cardiff (2010).

11.3 Legislation, Policy and Guidance Summary

11.3.1 Table 11.1 provides a summary of the key legislation, policy and guidance for this assessment.

11.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 11A (document reference 6.2).

Table 11.1: Summary of Key Legislation, Policy and Guidance

Legislation/ Policy/ Guidance	Summary	Chapter Reference
The Water Framework Directive (2000/60/EC) (Ref 11.19)	The Water Framework Directive (WFD) makes provision for the maintenance and improvement of the 'ecological and chemical status' of the water environment, which includes rivers, lakes, wetlands, artificial waterbodies, groundwater, estuaries and coastal waters. For groundwater the overall status has a quantitative and a chemical component. The aim is for designated waterbodies to achieve 'good overall status' and prevent deterioration of status of surface waters and groundwater. Under the WFD, the Environment Agency has prepared River Basin Management Plans (RBMP) which define the current status of designated waterbodies, their objectives and the planned	This chapter uses the WFD assessment (Appendix 11E) to assess the Scheme against the key objectives of the WFD. The assessment has shown that the Scheme will be compliant with the requirements of the WFD. Also see Section 11.4 and Table 11.16 in this chapter.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	measures to achieve these objectives. Guidance published by the Environment Agency provides further information on assessing the risk of activities in relation to the RBMP and WFD objectives.	
Groundwater Directive (2006/118/EC) (Ref 11.20)	The WFD and the Groundwater Daughter Directive (GDD) (2006/118/EC), which were enacted in 2000 and 2006 respectively, replacing the original Groundwater Directive (80/68/EEC) which was repealed in 2013. The GDD introduces procedures for assessing the 'Chemical Status' of groundwater as per the WFD and protects groundwater by preventing direct discharge of 'hazardous pollutants' and limiting the direct discharge of non-hazardous pollutants.	This chapter uses the WFD assessment (Appendix 11E) to assess the Scheme against the key objectives of the WFD. The assessment has shown that the Scheme will be compliant with the requirements of the WFD. Also see Section 11.4 and Table 11.16 in this chapter.
National Policy Statement for National Networks (NPS NN) (Ref 11.22)	NPS NN sets out detailed policy on environmental mitigations for development including pollution control, and assessment and management of water quality and resources: Chapter 4: Assessment principles: Environmental Impact Assessment: This section sets out the fact that all proposals are subject to the EIA Directive (2011/92/EU) which requires "*an environmental impact assessment to identify, describe and assess effects on…fauna and flora, soil, water…and the interactions between them*".	The chapter fulfils the assessment requirements of the NPS. Consents and permitting requirements are considered as part of the DCO application, details of which are provided in the Consents and Agreements Position Statement (document reference 7.3).

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	Pollution control and other environmental protection regimes: This section sets out the fact that "*issues relating to discharges or emissions from a proposed project which affect…water quality…and the marine environment…may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes. Relevant permissions will need to be obtained for any activities within the development that are regulated under those regimes before the activities can be operated*."	
	Chapter 5: Generic impacts: Water quality and resources: This section sets out the requirements of the EIA in which "….*the applicant should ascertain the existing status of, and carry out an assessment of the impacts of the proposed project on water quality, water resources and physical characteristics as part of the environmental statement.*" This section also states that "*any environmental statement should describe:* • *the existing quality of waters affected by the proposed project;* • *existing water resources affected by the proposed project and the impacts of the proposed project on water resources;*	See Section 11.5 for the existing status of the water environment and Section 11.7 for the assessment of likely significant effects. The Drainage Strategy for the Scheme considers appropriate treatment measures and SuDs (document reference 6.2; Appendix 12C).

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	• *existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project, and any impact of physical modifications to these characteristics;* • *any impacts of the proposed project on water bodies or protected areas under the Water Framework Directive and source protection zones (SPZs) around potable groundwater abstractions; and* • *any cumulative effects."* Furthermore, this section identifies the requirements of appropriate mitigation measures during operation and construction and that "*the project should adhere to any National Standards for sustainable drainage systems (SuDs)."*	
National Planning Policy Framework (NPPF) (Ref 11.21)	The revised National Planning Policy Framework (NPPF) for England was published in February 2019. In particular, Section 15 of the NPPF (Conserving and enhancing the natural environment) is relevant to the assessment of impacts on the	This chapter conforms with this policy by considering appropriate mitigation measures to minimise the risks on the water environment from the Scheme. See Section 11.7 for embedded mitigations adopted for the Scheme

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	water environment from the Scheme. Paragraph 170 states that the planning system should contribute to and enhance the natural environment by *"preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability".* It goes on to state that "*Development should, where possible, help to improve the local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans*"	and Section 11.8 for any proposed additional mitigation.
National Policy Statement for Ports (Ref 11.23)	This statement provides the framework for decisions on proposals for new port development. It applies, wherever relevant, to associated development, such as road and rail links, for which consent is sought alongside that for the principal development. Section 4.7 Environmental Impact Assessment sets out the requirement for all proposals "*that are subject to the European EIA Directive to be accompanied by an Environmental Statement (ES) describing the aspects of the environment likely to be significantly affected by the project.*" This includes "*a*	The chapter fulfils the assessment requirements of this policy. See Section 11.4 for the description of likely significant effects; Section 11.5 for the existing status of the water environment and Section 11.7 for the assessment of likely significant effects.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	description of the likely significant effects of the proposed project on the environment, covering the direct effects and any indirect, secondary, cumulative, short-, medium and long-term, permanent and temporary, positive and negative effects of the project, and also of the measures envisaged for avoiding or mitigating significant adverse effects." Section 5.6 Water quality and resources sets out the requirements of the ES to assess "*the existing status of, and impacts of, the proposed project on water quality, water resources and physical characteristics of the water environment*."	
Environment Agency's approach to groundwater protection (Ref 11.24)	This document contains non-statutory position statements which provide information about the Environment Agency's approach to managing and protecting groundwater and adopts a risk based approach where legislation allows.	This chapter, with consideration of appropriate mitigation measures to minimise the risks and effects of pollution to groundwater and, protection of it as a resource, has been completed in line with the Environment Agency's approach to groundwater protection 2018. See Section 11.8 in the chapter.
Design Manual for Roads and Bridges (DMRB) HD45/09 (Ref 11.15)	The standard HD45/09 Road Drainage and the Water Environment, Volume 11, Section 3, Part 10 provides guidance on the assessment and management of the impacts that road projects may have on the water environment. These include possible impacts on the quality of water bodies and on the existing	The assessment, with consideration of the likely significant effects arising from the Scheme upon the water environment (surface water and groundwater), has been completed in line with this guidance.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	hydrology of the catchments through which roads pass.	See Section 11.4 for the description of likely significant effects; Section 11.5 for the existing status of the water environment and Section 11.7 for the assessment of likely significant effects. The HAWRAT assessment (document reference 6.2, Appendix 11D), which evaluates the pollution impacts from routine (operational) runoff and accidental spillage, has been completed in line with the identified guidance.
PINS Advice Note 18: Water Framework Directive Assessment 2017; Water Framework Directive risk assessment (EA 2016); Water Framework Directive Assessment: Estuarine and Coastal Waters (Refs 11.25 and 11.16)	These documents provide guidance on the requirement and approach to the Water Framework Directive (WFD) assessment.	A WFD assessment (document reference 6.2, Appendix 11E) has been completed in line with the identified guidance to assess the Scheme against the key objectives of the WFD. Also see Section 11.4 and Table 11.16 in this chapter.

11.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

11.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

11.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

11.4.3 Table 11.2 and 11.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 11.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
"The Inspectorate agrees that the loss of standing water can be scoped out of the ES. However, should the design of the Scheme change such that it impacts on standing waterbody/waterbodies, the ES should assess these impacts if likely significant effects could occur." (Scoping Opinion Ref 4.6, ID1)	PINS	Further field surveys have confirmed the presence of several small ponds within the MIND Centre and Grounds north of William Adams Way that will be removed to construct the Scheme. Qualitative assessment has been undertaken to determine the likely significant effects on these standing waterbodies as a result of the development of the Scheme (see Section 11.8 in this chapter).
"The Inspectorate is content that effects associated with cuttings can be scoped out on the basis that this technique would not be employed. ES should include an assessment of effects on groundwater levels or flows of any other intrusions to the	PINS	Qualitative assessment has been undertaken to determine the likely significant effects on surface water receptors due to changes in groundwater flows (See Section 11.8). Quantitative assessment has been undertaken for groundwater receptors and a

Scoping Opinion Item	Consultee	Response
groundwater aquifer, where likely significant effects could occur. Indirect loss and/or changes to surface water receptors as a result of changes in groundwater flow should also be assessed." (Scoping Opinion Ref 4.6, ID3)		numeric groundwater model constructed to determine a dewatering zone of influence to quantify impacts to local groundwater receptors (see Section 11.8). Groundwater level monitoring has been undertaken at designated borehole locations across the Principal Application Site and in locations where intrusive works i.e. piling activities are proposed (see Section 11.5).
"The ES must clearly define the chosen study area." (Scoping Opinion Ref 4.6, ID4)	PINS	Study Area clarified and figure provided (Figure 11.1).
"ES should consider all abstractions whether licensed or unlicensed. Confirmation should be obtained from Great Yarmouth Borough Council (GYBC) regarding the presence of any unlicensed abstractions." (Scoping Opinion Ref 4.6, ID5)	PINS	Consultation has been carried out with different stakeholders (see Table 11.4), including the Environment Agency, GYBC and the Norfolk County Council as Lead Local Flood Authority (LLFA), to confirm the presence of licensed and unlicensed abstractions within the Study Area. GYBC and LLFA have confirmed that they do not hold any information on unlicensed abstractions within the Study Area. The Environment Agency has confirmed that they do not have any records of surface water abstractions within the Study Area. With respect to groundwater abstractions, they confirmed there are one licensed and three unlicensed

Scoping Opinion Item	Consultee	Response
		abstractions within the Study Area.
"Information with regard to the road drainage catchment and the Water Level Management Plan (WLMP) for the Waveney Lower Yare & Lothingland drainage district should be obtained from the Internal Drainage Board (IDB). *ES should include an assessment of potential effects on the drainage district and WLMP."* (Scoping Opinion Ref 4.6, ID6)	PINS	The WLMP has been obtained from the IDB. CCTV survey has confirmed that majority of the existing highway in vicinity of the Principal Application Site drains into the IDB watercourse network. Discussion is ongoing with the IDB regarding the Drainage Strategy (Appendix 12C (document reference 6.2)). Qualitative assessment has been undertaken to address the likely effects on the IDB drainage district and WLMP (see Section 11.8).
"The ES should make use of Anglian Water's sewer flooding register to inform the assessment of baseline conditions and note the records of incidences of internal flooding provided by NCC in their consultation response." (Scoping Opinion Ref 4.6, ID7)	PINS	This item is related to flooding and therefore has been addressed in Chapter 12: Flood Risk.
"Consultation with relevant stakeholders should be undertaken to agree on the details of the proposed sampling and modelling of sediment, including the potential mobilisation of contaminated sediment, in the river bed. *A description of the modelling and sampling methodology undertaken should be included in and/or appended to the ES."*	PINS	Consultation on the sampling/modelling approach has been carried out with the Environment Agency. A summary of the assessment approach is provided in Section 11.4. Consultation with the Marine Management Organisation (MMO) has confirmed that they do not have any specific water environment concerns, except the requirement for assessment of potential

Scoping Opinion Item	Consultee	Response
(Scoping Opinion Ref 4.6, ID8)		disturbance of contaminated sediments, which is being carried out as part of the ES. They confirmed they typically defer to the Environment Agency in this respect.
"The ES should assess inter-related impacts occurring between the Water Environment aspect chapter and the Nature Conservation aspect chapter. The assessment should address impacts on the River Yare and other designated sites for nature conservation that are hydrologically linked to the Proposed Development." (Scoping Opinion Ref 4.6, ID9)	PINS	Findings within Chapter 8: Nature Conservation, in respect of effects on aquatic ecology and protected areas, have been used to inform the WFD assessment. The EIA has been undertaken in collaboration between relevant technical specialists to determine inter-related impacts.
"The PINS Advice Note 18: Water Framework Directive (WFD) should be used to guide the assessment." (Scoping Opinion Ref 4.6, ID10)	PINS	The WFD assessment has been carried out in accordance with PINS Advice Note 18 (Ref 11.25) and can be found in Appendix 11E. Furthermore, consultation on the approach to the WFD assessment has been completed with the Environment Agency.
"The ES will need to make clear whether any residual risk is deemed to be significant. Where professional judgement has been used to determine significance, this should be stated." (Scoping Opinion Ref 4.6, ID11)	PINS	Comment acknowledged and has been addressed in Section 11.8.
"ES should consider the implication of the Scheme on existing sewers and pumping	Anglian Water 3rd May 2018	The Drainage Strategy (Appendix 12C (document reference 6.2)) has been developed in consultation with

Scoping Opinion Item	Consultee	Response
stations within the study area."		Anglian Water, who agreed on a surface water discharge rate of 10l/s into their system. Furthermore, Anglian Water has confirmed that the agreed rate of 10l/s would have a negligible effect on existing assets, including the existing sewage treatment system and pumping stations.
"EA Response Page 2 Contamination in groundwater must not be mobilised by the works for the Proposed Development; remediation may be required if contamination is present in the area of the works and any necessary measures must be identified." (Scoping Opinion Ref AE/2018/122731/01-L01)	Environment Agency 3rd May 2018	The potential for contaminant linkages and impacts to controlled waters within the Principal Application Site has been assessed in Chapter 16: Geology and Soils.
"The ES should include consideration of all abstractions whether licensed or unlicensed." (Scoping Opinion Ref AE/2018/122731/01-L01)	Environment Agency 3rd May 2018	Consultation has been carried out with different stakeholders (see Table 11.4), including the EA, GYBC and the LLFA (NCC), to confirm the presence of licensed and unlicensed abstractions within the Study Area. GYBC and the LLFA have confirmed that they do not hold any information on unlicensed abstractions within the Study Area. The Environment Agency has confirmed that they do not hold any records of surface water abstractions within the Study Area. With respect to groundwater abstractions, they confirmed there are one licensed and three unlicensed

Scoping Opinion Item	Consultee	Response
		abstractions within the Study Area.
"The ES should include indirect loss or change to surface water receptors as a result of changes in groundwater flow (as well as dewatering)." (Scoping Opinion Ref AE/2018/122731/01-L01)	Environment Agency 3rd May 2018	Qualitative assessment has been undertaken for surface water receptors. Quantitative assessment has been undertaken for groundwater receptors and a numeric groundwater model constructed to determine a dewatering zone of influence to quantify impacts to local groundwater receptors for the proposed cofferdam groundwater dewatering (see Section 11.8).
"The ES should include details on how any proposed emergency containment of pollution during an acute incident would be constructed." (Scoping Opinion Ref AE/2018/122731/01-L01)	Environment Agency 3rd May 2018	Spillage control penstocks have been proposed as part of the Drainage Strategy (document reference 6.2, Appendix 12C) Control measures to be employed during the construction phase are summarised in the Outline CoCP (document reference 6.16).
"WFD assessment will be required and the potential impacts on surface water bodies should be used to establish the likely effects on fish, benthic invertebrates and aquatic ecosystems." (Scoping Opinion Ref AE/2018/122731/01-L01)	Environment Agency 3rd May 2018	A WFD assessment can be found in Appendix 11E.
"If the requirement for consents and permits is to be disapplied under the DCO more detail may be required with the application." (Scoping Opinion Ref AE/2018/122731/01-L01)	Environment Agency 3rd May 2018	Details regarding the current consents strategy are provided in the Consents and Agreements Position Statement (document reference 7.3).

Scoping Opinion Item	Consultee	Response
"EA methodology for assessing hydrogeological impact of coffer dams / dewatering should be referenced. Assessments should consider saline intrusion risk. Construction activities are no longer exempt from abstraction licenses. If dewatering is to be undertaken, additional detail may be required with the DCO application to determine the requirement for an abstraction licence." (Scoping Opinion Ref AE/2018/122731/01-L01)	Environment Agency 3rd May 2018	EA guidance has been referenced in the assessment. Intrusive works, proposed within the Principal Application Site, and the impacts to shallow groundwater quality and potential for saline intrusion to fresh groundwater resources has been assessed (see Section 11.8.) Quantitative assessment has been undertaken for groundwater receptors and a numeric groundwater model constructed to determine a dewatering zone of influence to quantify impacts to local groundwater receptors for the proposed cofferdam groundwater dewatering (see Section 11.8). The management of this water, and potential consents and permits required to manage this water will be completed by the Contractor (see Consents and Agreements Position Statement (document reference 7.3).
"The ES should assess the potential for the disturbance of contaminated river bed sediment." (Scoping Opinion Ref DCO/2018/00010)	MMO 4th May 2018	Hydraulic modelling and associated sediment transport assessment (Appendix 11C (document reference 6.2)) have been completed to inform the assessment of the potential disturbance of contaminated river bed sediment (see Appendix 11C (document reference 6.2) and Section 11.8).

Scoping Opinion Item	Consultee	Response
"The ES should be accompanied by a detailed surface water drainage strategy to address how surface water will be managed on site and how Sustainable Drainage Systems (SuDS) for the management of runoff are put in place. Any SuDS proposed are required to demonstrate that the SuDS hierarchy has been followed both in terms of surface water disposal and management train to address water quality mitigation. *The delay of discharge due to high tides should be considered; contamination and groundwater levels being influenced by tide should be also considered for infiltration as disposal method."* If discharging to an existing discharge location, this needs to be shown to be connected to the wider watercourse network. Consultation with Anglian Water if discharging into existing sewer network. Detailed information, obtained through a CCTV survey, is likely required on the current drainage scheme and how the development will alter or improve from the existing situation. Reference to CIRIA titled C768 – Guidance on the construction of SuDS (2017). NCC acknowledged that storage design may be	NCC (LLFA) 4th May 2018	The Drainage Strategy for the Scheme (Appendix 12C (document reference 6.2)), including storage design and the requirement for pollution treatment measures, has been developed with consultation with different stakeholders, including the IDB and the Environment Agency. A highway CCTV survey has been carried out, which confirmed that majority of the existing highway in vicinity of the Scheme drains into the IDB watercourse network and consultation with the IDB has confirmed that no known treatment measures are incorporated into the existing system. There are currently two discharge options for the Principal Application Site (west) to either outfall into the River Yare or the IDB watercourse adjacent to the Scheme which is connected to the wider drainage network within the IDB catchment. For the Principal Application Site (east) consultation with AW has been completed to agree on the discharge location and rates to existing combined sewer network Protective provisions have been agreed with Anglian Water. The Drainage Strategy has taken into consideration the requirement of pollution control measures to treat runoff prior to discharge into the combined

Scoping Opinion Item	Consultee	Response
limited by the available space within an existing built up area. (Scoping Opinion Ref H/G/2018/6004)		sewer, as requested by Anglian Water. The CIRIA titled C768 – Guidance on the construction of SuDS (Ref 11.26) is referenced in the development of the Drainage Strategy (Appendix 12C (document reference 6.2)).
"Additional information may be required to show how phasing of the development will affect the overall drainage strategy and what arrangements, temporary or otherwise, will need to be in place at each stage of the development. Adequate measures are required to be put in place to minimise temporary additional runoff and this is diverted away from any final drainage scheme." (Scoping Opinion Ref H/G/2018/6004)	LLFA (NCC) 4th May 2018	Temporary drainage procedures will be employed during the construction phase where existing drainage routes will be maintained. Details of this measure are provided in the Outline CoCP (document reference 6.16)
"Any drainage strategy should also contain a maintenance and management plan detailing the activities required and details of who will adopt and maintain all the surface water drainage features for the lifetime of the development." (Scoping Opinion Ref H/G/2018/6004)	LLFA (NCC) 4th May 2018	Details regarding maintenance are provided in the Drainage Strategy (Appendix 12C (document reference 6.2)). It has been confirmed that Norfolk County Council would adopt any new gullies and pipes in the highway and bridge structure. Discussions are currently being undertaken with the IDB regarding the maintenance of the watercourse/culvert network on the western side of the Scheme.
"Any works proposed as part of this application that are	LLFA (NCC) 4th May 2018	Consultation has been undertaken with the IDB to

Scoping Opinion Item	Consultee	Response
likely to affect flows in an ordinary watercourse will likely require the approval of the appropriate authority body, in this case the local IDB." (Scoping Opinion Ref H/G/2018/6004)		inform the design of new watercourses and culverts, details of which are provided in the Drainage Strategy (Appendix 12C (document reference 6.2)). Details regarding the current consents strategy are provided in the Consents and Agreements Position Statement (document reference 7.3).
"The WLMP for the drainage district is available on request. *The ES should assess the potential impact and mitigation proposed for the WLMP and drainage district."* (Scoping Opinion Ref 140447.180/DL)	Waveney Lower Yare & Lothingland IDB 24th April 2018	The WLMP has been obtained from the IDB. Consultation with the IDB, as reported in Table 11.4, has confirmed that they do not have any specific concerns on WLMP objectives or on water quality for the drains within the immediate area of the Scheme. Qualitative assessment has been undertaken to address the likely effects on the IDB drainage district and WLMP.

Table 11.3: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
There is a lack of information and data regarding flow rates with IDB drains receiving road runoff and therefore there is no modelled dilution.	Environment Agency	Consultation with the IDB has confirmed that they do not carry out or hold any flow measurements for the drains within the Principal Application Site. The potential lack of dilution in the drains receiving road runoff has been taken into account in the assessment of water quality impacts of road runoff. A worst-case assessment has been undertaken assuming negligible flow in the receiving IDB watercourse

Section 42 Item	Consultee	Response
		(HAWRAT assessment, Appendix 11D).
The PEIR does not identify further treatment remediation for road runoff other than an oil separator. Further consideration of additional treatment steps is necessary. Further information on the specifications of the oil separator will also be required.	Environment Agency	Additional treatment measures have been considered as detailed in the Drainage Strategy (Appendix 12C (document reference 6.2)) and summarised in Section 11.7. Consultation with the IDB has confirmed that they do not have any specific concerns with respect to water quality for the drains within the immediate area of the Principal Application Site, particularly as the proposals are likely to provide better treatment than the existing drainage.
Further information is required on potential WFD, water quality or morphology impacts at runoff discharge point to IDB, from IDB pump to the River Yare and within the river channel at the crossing point. Careful consideration of the interconnectivity of the waterbodies is required as well as the sensitivity of each.	Environment Agency	The ES includes assessment of impacts on water quality or morphology on surface water waterbodies that are located within the Principal Application Site and Application Site or are hydraulically connected to the Principal Application Site. A separate WFD assessment (Appendix 11E (document reference 6.2)) is included in the ES to address the potential WFD impacts on the waterbodies. Qualitative assessment of the potential effects of highway discharge to the wider IDB catchment has been undertaken.
The ES should consider the potential water quality impacts and mitigation to waterbodies during construction is required.	Environment Agency	Control measures to be employed during the construction phase are summarised in the Outline CoCP (document reference 6.16). Qualitative assessment has been undertaken to address the potential water quality impacts during construction (see Section 11.8)
Unless disapplication is sought, Discharge	Environment Agency	Details regarding the current consents strategy are provided in the Consents

Section 42 Item	Consultee	Response
Consents for treated effluent will be required		and Agreements Position Statement (document reference 7.3).
A full sediment model should be used to assess the impact of each design, Particle Size Analysis (PSA) should feed into this model to correctly account for potential areas for scour and deposition. Further information, including bathymetry, PSA of bed sediments and the existing tidal regime and the tidal prism of the River Yare should be used to inform the hydromorphological assessment. The modelling should consider the potential effects of sea level rise on patterns of scour and deposition along the tidal River Yare.	Environment Agency	Consultation on the sampling/modelling approach has been carried out with the Environment Agency. The sediment transport assessment (Appendix 11C (document reference 6.2)), which incorporates a full sediment model, has been completed with consideration of the recommendations provided by the Environment Agency. The sediment transport assessment (Appendix 11C (document reference 6.2)) has taken into account the listed information or data as recommended by the Environment Agency, as well as the effects of sea level rise on patterns of scour and deposition.
The cumulative impact of the proposed project along with all the bridges crossing the Yare with structures in channel should be made in the ES particularly for the worst-case design in terms of channel constriction and encroachment into the waterbody.	Environment Agency	The hydraulic modelling and the subsequent hydromorphological assessment have considered cumulative impact of the Scheme along with existing bridge crossings along the River Yare (see Section 11.8).
Ad hoc ecological improvements to any new structures within the channel to increase biodiversity would be favourable.	Environment Agency	It is unlikely this can be incorporated into the Scheme as it may interfere with ship impact protection measures to the bascule coffer dams.

Section 42 Item	Consultee	Response
The ES should include full details of any proposed treatment trains from discharge to soakaway in order to assess their impacts on groundwater receptors.	Environment Agency	No soakaways proposed. All drainage features will be designed for high groundwater levels and impermeable lining will be included (see Drainage Strategy (Appendix 12C) (document reference 6.2).
A quantitative assessment may be required if any of the potential changes to groundwater are found to be significant via a qualitative assessment.	Environment Agency	Groundwater sampling and analysis have been undertaken at designated borehole locations across the Principal Application Site. A quantitative assessment has been undertaken for groundwater receptors and a numeric groundwater model constructed to determine a dewatering zone of influence to quantify impacts to local groundwater receptors of the Principal Application Site (see Section 11.8). The potential for contaminant linkages and impacts to controlled waters within the Principal Application Site has been assessed in Chapter 16: Geology and Soils.
The ES should include a detailed assessment of groundwater quality which is specific to each aquifer.	Environment Agency	Groundwater sampling and analyses has been assessed in Chapter 16: Geology and Soils.
Full details of piling design will be required to confirm whether or not the new subsurface structures will have any significant effect on groundwater flow and discharge.	Environment Agency	A piling risk assessment has been completed (see Appendix 16D (document reference 6.2)). Quantitative assessment has been undertaken for groundwater receptors and a numeric groundwater model constructed to determine a dewatering zone of influence to quantify impacts to local groundwater receptors (see Section 11.8). Impacts to shallow groundwater flow and quantity as a result of intrusive works undertaken during construction phase within the Principal Application Site has been assessed (see Section 11.8)

Section 42 Item	Consultee	Response
WFD assessment to be completed with mitigation and improvement measures considered.	Environment Agency	A WFD assessment is included in Appendix 11E (document reference 6.2).
Any requests for alteration or removal of sewers to be conducted in accordance with the Water Industry Act 1991.	Anglian Water	No alteration or removal of sewers are anticipated as part of the development of the Scheme. However, the drainage strategy for the eastern side of the Scheme is to discharge into the Anglian Water combined sewer network on South Denes Road. Consultation with Anglian Water has been completed, which confirmed that a restricted discharge rate of 10l/s is acceptable
A number of sewage pumping stations and outfalls appear to be located within the proposed site boundary. We would welcome further discussions in relation to the implication of the project for the existing sewers and pumping stations.	Anglian Water	Consultation with Anglian Water has confirmed that based upon the surface water discharge rate of 10l/s, any anticipated impacts on the existing sewage treatment system and pumping stations within the Study Area would be negligible.
It is recognised that further consultations and assessment, as identified through the Preliminary Environmental Information Report, are due to take place regarding drainage of surface water.	GYBC	GYBC has confirmed that they do not have any specific concerns regarding the drainage strategy for the Scheme.

11.4.4 Table 11.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

11.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 11.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
Environment Agency	Sustainable Places Planning Specialist	Email consultation on 29th August 2018 and later on 11th January 2019 to follow up on information regarding water quality monitoring (surface water and groundwater), surface water and groundwater abstractions (licensed/unlicensed), consented and unconsented discharges, detailed river network and borehole construction data within the area of interest. Request for information on groundwater flooding within the area of interest.	Locations provided for licensed groundwater abstractions and total yields (as an estimate) for each location. Information on water quality monitoring (surface water only), surface water and groundwater abstractions (licensed/unlicensed), consented discharges and detailed river network provided. The Environment Agency does not have authorisation to share details on unconsented discharges. No information available on groundwater flooding or borehole construction. Advised to check alternate sources of information i.e. British Geological Survey GeoIndex online database and LLFA.
Environment Agency	Sustainable Places Planning Specialist and relevant coastal and water environment specialists	Consultation meeting on 4th October 2018 to discuss the proposed drainage strategy, Environment Agency's concerns and mitigation requirements regarding the Scheme and the approach to the WFD and the supporting HAWRAT and hydromorphological assessments.	As described in Chapter 3: Consideration of Alternatives, following assessment of both options against a range of criteria, Option 1 has been taken forward. It was agreed the Scheme is highly unlikely to have any significant effects on the coastal waterbody. In summary the Environment Agency would like the following to be considered:

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
		Subsequent consultation specifically with respect to the methodology and approach to the sediment transport assessment (Appendix 11C).	▪ Tidal range of the estuary; ▪ Impacts on the tidal prism of the estuary; ▪ Scour assessment at the bridge structure; ▪ Requirements for additional sediment transport modelling; ▪ Potential effects on water quality within the wider IDB catchment; and • Appropriate and maximum treatment measures to be considered in the proposed drainage strategy.
Norfolk County Council	Landfill Strategy Manager, LLFA (NCC)	Email consultation 7th September 2018 regarding information on surface water and groundwater abstractions (licensed/unlicensed), unconsented discharges, notable assets managed by the Council, borehole construction data within the area of interest and information on groundwater flooding susceptibility. Consultation regarding the Council's requirements in terms	The LLFA holds no information on groundwater flooding susceptibility. NCC does not hold copies of groundwater flooding susceptibility maps. With respect to mitigation, the LLFA requires to see that flood risk is not increased for surface water flooding.

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
		of mitigation and design of the Scheme.	
Broads & Norfolk Rivers IDB & the Pevensey and Cuckmere Water Level Management Board	Project Engineer	Email consultation on 29th August and 17th September 2018 regarding information on the Water Level Management Plan, water quality monitoring, surface water abstractions (licensed/unlicensed), consented and unconsented discharges and details of significant structures within the IDB catchment. Further email consultation on 25th October 2018 regarding information on water quality and flow rates of the IDB drains in vicinity of the Scheme.	WLMP provided for the assessment (Ref 11.9) The IDB has no specific concerns on WLMP objectives and have advised that discussion is being carried out and is ongoing with the drainage team regarding the highway CCTV survey and the proposed drainage strategy. The IDB does not carry out or hold any flow measurements, and do not have any specific concerns with respect to water quality for the drains within the immediate area of the Scheme. The IDB expects industry best practice for pollution control measures in the drainage strategy.
GYBC	Head of Planning and Growth	Email consultation on 29th August and 20th September 2018 regarding the Council's concerns on the Scheme and if they hold any records of unlicensed abstractions (surface water and groundwater) and unconsented discharges within the area of interest.	GYBC are not aware of any unlicensed abstractions or discharges and do not have any particular water environment concerns with respect to the Scheme. However, they highlighted the need for the Habitat Regulations Assessment (HRA), which has been completed as part of the ES (document reference 6.11) to fully consider the effects on nearby SPAs/SACs.

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
MMO	Marine Licensing Case Manager	Email consultation on 29th August 2018 regarding MMO's concerns on the Scheme and licensing requirements. Telephone consultation 26th September 2018.	The MMO does not have specific water environment concerns except the requirement for benthic ecology surveys (document reference 6.2 Appendix 8I) and assessment of potential disturbance of contaminated sediments (Appendix 11C (document reference 6.2)), which has been carried out as part of the ES. It was noted by the MMO that a deemed marine licence will be applied as part of the DCO. The MMO seeks to apply a holistic approach to all matters affecting marine environment. The MMO is likely to defer in the main to the Environment Agency in relation to the potential effects of the Scheme on the water environment.
Norfolk County Council	LLFA (NCC)	Email consultation response – 6th September 2018	NCC as LLFA holds no information on groundwater flooding susceptibility. The LLFA would require that flood risk is not increased for surface water flooding and the mitigations implemented alleviate this risk.
Norfolk County Council	Highway Engineer	Email consultation on 3rd January 2019 regarding highway drainage adoption.	Norfolk County Council confirmed it would adopt the new drainage systems in the highway and bridge structure.

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
Anglian Water	Spatial Planning Manager	Email consultation on 13th December 2018 regarding AW's concerns of the implications of the Scheme on the performance of the existing sewage treatment system and pumping stations within the Study Area.	Anglian Water confirmed that based upon the surface water discharge rate of 10l/s (agreed rate of discharge into existing Anglian Water combined sewer system as part of the Drainage Strategy for the eastern side of the Scheme) (Appendix 12C (document reference 6.2)) any anticipated impacts on the existing sewage treatment system and pumping stations within the Study Area would be negligible.

Insignificant Effects

11.4.6 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would be insignificant and have therefore not been considered further in the assessment:

- Changes to coastal processes, such as sediment transport, erosional and depositional patterns and beach development along the Great Yarmouth shoreline. The findings of the sediment transport assessment (Appendix 11C (document reference 6.2)) show the Scheme will only result in localised impacts on the hydromorphological regime of the River Yare and the effects will not extend to cause any significant changes to coastal processes. Furthermore, consultation with the Environment Agency has agreed that the Scheme would unlikely to cause any significant impacts on coastal processes hence the effects on coastal change and processes have not been assessed further within the ES.

- The surface water features directly affected by the Scheme are not known to be used for water supply. It is unlikely the IDB watercourses are used for water supply, as the size and location would not support a regular supply. Abstractions from the River Yare and the River Bure are more likely to be present, but consultation with relevant stakeholders, including the Environment Agency, Norfolk County Council and GYBC, has confirmed that they do not hold any records of surface water

abstractions within the Study Area. Based on the current available information and nature of the watercourses, the Scheme is not expected to cause any significant changes or loss of surface water supplies within the Study Area. As such, the effects on water supplies have not been assessed further within the ES.

- The confluence between the River Waveney and the River Yare is located approximately 8km upstream of the Scheme. The distance to the River Waveney is considered sufficient such that no impact is likely to result from the Scheme, hence the River Waveney has not been considered further within the ES.

- The Study Area for the assessment of impacts has incorporated the Principal Application Site and the Satellite Application Sites, but given no surface water features are found within the Satellite Application Sites (for the installation of VMS), and that physical works associated with these will be minimal, their effects on the water environment have not been assessed further within this ES.

- Anglian Water has confirmed that the proposed highway discharge from the east of the Scheme into the combined sewers will have a negligible effect on the performance of their sewage treatment works or pumping stations. Highway runoff will be treated as it passes through their system and considering the small flow rates and volumes is highly unlikely to have any significant effect on subsequent discharges to the water environment. Thus, any effects have not been considered further in this ES.

- All temporary works associated with the construction of the bridge substructures will occur within the cofferdams, which will be integrated into the permanent works bridge foundation. No additional temporary works are proposed outside of the cofferdams and no dredging is planned during construction. Furthermore, soft start piling techniques will be employed to minimise the disturbance of contaminated sediment within the River Yare. These mitigation measures are captured in Section 6.2 of the Outline CoCP (document reference 6.16). Hence the construction of the cofferdams is not expected to cause any significant changes to the hydrological/morphological regime of the River Yare and/or deterioration to water quality in the river due to mobilisation of contaminated sediment additional to those which occur during operation of the Scheme. Therefore, construction stage effects have not been considered further in the ES. The assessment, which is informed by hydraulic modelling and associated sediment transport assessment, considers operational impacts of the bridge substructures.

- Since the submission of the Scoping Report, further assessment has shown that impacts on the underlying Chalk Group aquifer and

associated water users as a result of the Scheme are likely to be insignificant due to the vertical separation between the aquifer (the Chalk Group aquifer is approximately 150m below ground level) and the overlying London Clay Formation, which provides a substantially thick low permeable layer. There is no direct interaction with the Chalk Group aquifer and construction activities relating to the Scheme. As a result, the effects on groundwater level, flows and quality of the Chalk Group aquifer have not been considered further within this ES.

- As per the Drainage Strategy (Appendix 12C (document reference 6.2)) drainage features will be lined where necessary to prevent surface and groundwaters coming into direct contact. Therefore, no groundwater quality assessment for the operation of these features will be required.

Likely Significant Effects

Effects on surface water receptors

11.4.7 This topic area covers the assessment of the following potential effects of the Scheme on the surface water receptors.

Construction Phase

- Pollution to surface water due to increased generation and release of sediments and suspended solids; or dust and debris associated with demolition works.
- Pollution to surface water due to increased risk of accidental spillage of pollutants such as oil, fuel and concrete.
- Impact to surface waters due to abstraction and subsequent discharge of groundwater from the cofferdams.
- Temporary alterations to the hydrological regime of the ordinary watercourses and IDB drains, such as changes to the flow path and rate associated with the construction of new watercourses and culverts as part of the proposed Drainage Strategy (Appendix 12C (document reference 6.2)).
- Temporary alterations to the hydromorphological regime of the IDB drains, such as changes to erosion, deposition and channel migration processes associated with channel modifications, temporary in-channel structures and drainage outfalls. Changes to the hydromorphological regime of the River Yare are assessed under operational effects. No temporary in-channel works are proposed and therefore the construction phase effects will be the same as the operation phase effects.

Operation Phase

- Pollution to surface water due to contaminants contained within routine road runoff.
- Pollution to surface water due to accidental spillages and subsequent discharges of contaminants through road drainage systems.
- Pollution to surface water due to mobilisation of contaminated sediments.
- Alterations to the tidal/hydrological regime of the River Yare, such as changes to the tidal prism associated with channel modifications and in-channel structures.
- Alterations to the hydrological regime of the ordinary watercourses and IDB drains, such as changes to the flow path and rate associated with the new watercourses and culverts constructed as part of the proposed Drainage Strategy (Appendix 12C (document reference 6.2)).
- Alterations to the hydromorphological regime, such as changes to erosion, deposition and channel migration processes associated with channel modifications, in-channel structures and drainage outfalls.
- Loss of standing water within the MIND Centre and Grounds due to development of the Scheme.

11.4.8 Chapter 16: Geology and Soils should be referred to for the assessment of the potential effects for contaminant linkages and impacts on controlled waters, the vertical and lateral migration of mobile contaminants into groundwater and/or surface waters.

11.4.9 Chapter 8: Nature Conservation should be referred to for specific assessment of potential effects on designated sites, habitats and species.

Effects on groundwater receptors

11.4.10 This topic area covers the assessment of the following potential effects of the Scheme on the groundwater receptors.

Construction Phase

- Intrusive works and the impacts to groundwater quality: Potential for saltwater contamination of the superficial aquifers, the Crag Group aquifer and groundwater supported supplies as a result of construction activities i.e. dewatering during construction may create or expand existing saline intrusion(s). The London Clay Formation is a substantially thick, approximately 100m, low permeability formation that will provide vertical separation of the Chalk Group aquifer (see paragraph 11.5.40);

- Intrusive works and the impacts to groundwater quality: Mobilisation of pre-existing contamination due to invasive works such as temporary excavations, piling and dewatering of the cofferdams;

- Intrusive works and the impacts to groundwater levels and flow: Temporary loss of water from storage and the reduction in water levels within superficial aquifers, the Crag Group aquifer, and at associated superficial groundwater abstractions, due to groundwater control measures. Considerations have been given to the effects associated with intrusive activities, such as piling and excavations during construction works; and

- Pollution to shallow groundwater receptors via drainage construction: Temporary change to groundwater discharge pathways creating direct access for surface activities to be received by groundwater aquifer receptors.

Operational Phase

- Impact to shallow groundwater flow and quantity as a result of intrusive works undertaken during the construction phase: Changes to groundwater flow paths due to cofferdam foundation; and

- Impact to groundwater recharge: Change to groundwater recharge due to introduction of impermeable hardstanding.

11.4.11 Chapter 16: Geology and Soils should be referred to for the assessment of the potential effects for contaminant linkages and impacts on controlled waters.

Extent of the Study Area

11.4.12 The Scheme is located at and adjacent to the River Yare in Great Yarmouth (NGR 6524 3059), approximately 2.5km upstream from the outlet to the North Sea at Gorleston-on-Sea. The Study Area has been defined as the area within 1km of the Application Site, which incorporates the Principal Application Site area and the Satellite Application Sites, for the assessment of impacts on surface water and 2km for the assessment of impacts on groundwater. The surface water Study Area has been extended along the River Yare to its outfall to the North Sea. Figure 11-1 shows the Study Area and key features.

Method of Baseline Data Collation

Desk Study

11.4.13 The following information has been gathered through desk studies to establish the existing conditions of the surface and groundwater environment. The data has been provided with reference to the following key sources of information, where necessary:

- Environment Agency Catchment Data Explorer (WFD data) (Ref 11.1);
- Ordnance Survey Mapping and terrain data;
- DEFRA 'Magic Map' online GIS portal (Ref 11.2);
- British Geological Survey (BGS) GeoIndex Database (Ref 11.3);
- Great Yarmouth Third River Crossing Stage 2 Environmental Impact Assessment Report 2009 ('Stage 2 Report') (Ref 11.4);
- WSP (2018) Great Yarmouth Third River Crossing Preliminary Environmental Information Report (Ref 11.5);
- Environment Agency data on groundwater including aquifer type, aquifer vulnerability and SPZs (Ref 11.6);
- Collation of British Geological Survey (BGS) data in relation to geological and hydrogeological data;
- Environment Agency data on licensed/unlicensed abstractions and consented discharges;
- Datasets available from data.gov.uk, including:
    - LIDAR terrain data;
    - Location of designated sites;
    - EA Asset Information Management System (AIMS) data;
    - Historic landfill sites;
    - EA data on pollution inventory and incidents;
    - EA Coastal Design Sea Levels;
- Flood Estimation Handbook (FEH) web service portal (river catchment boundaries) (Ref 11.7);

- GroundSure Report (2017) (Ref 11.8);
- Burgh Castle District Water Level Management Plan 2014 (Ref 11.9);
- UK Estuaries Database (Ref 11.10); and
- Great Yarmouth Third River Crossing Site Investigation Factual Report 2007 (Ref 11.11).

Site Visit

11.4.14 A site walkover was conducted on the 3rd October 2018 to inform the assessment. The site walkover included the River Yare at the proposed bridge crossing, Breydon Water and surrounding IDB drains, with a focus on verifying the baseline and identifying the potential impacts of the Scheme on sensitive receptors.

Field Surveys and Investigations

11.4.15 The following surveys and investigations have been completed for the Scheme and inform the assessment:

- Bathymetric surveys undertaken in April 2017;
- Ground investigation, including groundwater chemical analysis, groundwater monitoring and sediment sampling (chemical analysis and particle size distribution);
- Baseline groundwater level monitoring from 2007 Ground Investigation (GI), and
- Benthic ecology and fish survey (reported in Chapter 8: Nature Conservation).

11.4.16 Chapter 8: Nature Conservation provides more information on the findings of the benthic ecology and fish survey.

11.4.17 Chapter 16: Geology and Soils, provides more information with respect to completed ground investigation works.

Assessment Methodology

11.4.18 The water environment assessment has involved the following key tasks:

- Consultation with the relevant statutory and non-statutory bodies to establish the principal water environment issues to be assessed;

- Desk studies and field surveys to ascertain the current baseline conditions on site;
- Assessment of the potential impacts related to the construction and operation of the Scheme; and
- Identification of measures to avoid, minimise or mitigate predicted impacts.

11.4.19 This assessment has focused on defining the characteristics and subsequently the potential impacts of the Scheme on identified surface water and groundwater receptors, including the wider hydrological catchments as categorised by the Environment Agency under the WFD. This hydrological catchment-based approach enables due consideration to be given to both individual locations where interactions occur and any cumulative impacts resulting from the Scheme working in combination with existing pressures to water features. In particular, in respect to effects of existing structures (hydromorphological effects) along the River Yare.

11.4.20 The assessment has been carried out based on existing published datasets, information from more recent site investigations/field surveys and findings of quantitative assessments, including the HAWRAT1 assessment and hydraulic modelling, with consideration of the Scheme and specific mitigation measures.

Pollution of Surface Water during Construction

11.4.21 Evaluation of the potential for pollution of surface waters during construction as a result of spillage and of the release of sediments into watercourses or waterbodies included a review of areas where construction would be required or where construction compounds will be sited within or in close proximity (i.e. within 50m) to surface watercourses and waterbodies. Beyond this distance it is unlikely that there would be any significant effects as silt will be deposited and any pollutants treated and dispersed prior to water reaching surface waters.

11.4.22 A qualitative assessment of the potential impact of groundwater discharges (due to dewatering of cofferdams) into surface water has been undertaken considering the quantity and quality of the discharges relative to that in the receiving watercourse. As the discharge location is not yet confirmed both the River Yare and IDB drains have been included. The assessment also considered that discharges will be subject to appropriate Environment

[1] Highways Agency Water Risk Assessment Tool.

Agency permits (as detailed in the Consents and Agreements Position Statement document reference 7.3).

Pollution from (Operational) Routine Runoff

11.4.23 DMRB HD 45/09 (Ref 11.15) specifies procedures for the assessment of pollution impacts from routine (operational) runoff on surface waters, known as 'Method A'.

11.4.24 The Method A assessment comprises two separate elements:

- HAWRAT Assessment: The Highways Agency Water Risk Assessment Tool (HAWRAT) is a Microsoft Excel application designed to assess the short-term risks related to the intermittent nature of road runoff. It assesses the acute and chronic pollution impacts on aquatic ecology associated with soluble and sediment-bound pollutants, respectively; and

- Environmental Quality Standards (EQS) Assessment: EQS are the maximum permissible annual average concentrations of potentially hazardous chemicals, as defined under the WFD. The long-term risks over the period of one year are assessed through comparison of the annual average concentration of pollutants discharged with the published EQS for those pollutants.

11.4.25 To carry out these assessments a variety of baseline and drainage design information is required, including: traffic volumes, areas of impermeable and permeable road surfaces to be drained, proposed treatment train, receiving watercourse dimensions and flow data, water hardness, presence of sensitive sites (considered as international / national designated conservation sites) and in-stream structures or features which may influence the flow.

11.4.26 The Drainage Strategy for the Scheme (Appendix 12C (document reference 6.2)) (for the western part of the Principal Application Site) includes options to discharge either via gravity into exiting IDB watercourse network adjacent to the Scheme or via a pumped system into the River Yare. The HAWRAT assessment (Appendix 11D (document reference 6.2)) investigates the potential impacts of both discharge options.

11.4.27 The IDB watercourse network located within the Principal Application Site is connected to the wider network of dykes and drains within the Waveney, Lower Yare & Lothingland IDB administrative area. Consultation with the Environment Agency and the IDB has confirmed that they do not carry out or hold any flow measurements for these watercourses. It is expected that flows would be intermittent due to tidal influences and the largely urbanised nature of the catchment. Hence it is difficult to produce representative annual 95%ile river flows (Q95s) that feed into the HAWRAT Method A

assessment to determine the in-river pollutant concentrations after dilution and dispersion in the receiving watercourse. Furthermore, given the potential ephemeral nature of these watercourses, the dilution capacity is likely to be limited, in particular for the drier summer months.

11.4.28 Due to the uncertainties associated with the flow rates and duration of the receiving watercourse, the assessment has been carried out based on a Q95 value of 0.001m^3/s, i.e. the lowest value that can be used in the assessment, to reflect the limited dilution capacity of the watercourse. A qualitative assessment of potential impacts to the wider IDB catchment, in particular the more sensitive marshland south of Breydon Water, has also been completed considering the hydrological regime and dilution potential of the wider network of drains downstream of the Scheme.

11.4.29 The River Yare is a transitional tidal waterbody through Great Yarmouth. The HAWRAT tool, used in the assessment, was designed to assess the impacts to freshwater bodies and is therefore not directly applicable to the assessment of impacts to transitional waters. Furthermore, estimating an appropriate Q95 for the River Yare is problematic due to the combination of fluvial influence from the upper catchment and tidal inflows from the North Sea. However, in order to quantify the scale of potential impact on the river, the HAWRAT assessment process has been applied to a freshwater scenario to enable consideration of likely pollutant concentrations and dilution requirements. The fluvial Q95 value for the River Yare was therefore used to inform the HAWRAT without consideration of tidal inflows. This is considered a reasonable worst-case scenario as it represents the lowest flows, during periods of slack tide, when fluvial flows dominate.

11.4.30 The assessment method for groundwater receptors is known as 'Method C', applied to drainage design features designed to discharge to groundwater specifically. The disposal of road runoff via infiltration (e.g. soakaway) is not proposed in the Drainage Strategy (Appendix 12C (document reference 6.2)) due to high groundwater levels in the Principal Application Site and any drainage features will be lined where necessary to limit any infiltration of polluted runoff to the underlying groundwater. As such the effects of routine runoff on groundwater are considered insignificant, therefore Method C of the DMRB has not been undertaken as part of the HAWRAT assessment.

Pollution from Accidental Spillage

11.4.31 The DMRB document HD 45/09 (Ref 11.15) specifies procedures for the assessment of pollution impacts from accidental spillage, known as 'Method D'. A summary of the methodology is provided below, with full details provided in HD 45/09 (Ref 11.15).

11.4.32 The assessment takes the form of a risk assessment, where the risk is expressed as the annual probability of a serious pollution incident occurring. This risk is the product of two probabilities:

- The probability that an accident will occur, resulting in a serious spillage of a polluting substance on the carriageway; and
- The probability that, if such a spillage did occur, the polluting substance would reach the receiving waterbody and cause a serious pollution incident.

11.4.33 The probability of a serious spillage occurring is dependent on a variety of factors; namely, traffic volumes, percentage of heavy goods vehicles in the traffic volumes, whether the road is a motorway, rural or urban trunk road, the road type categories within the road drainage catchment under assessment (i.e. 'no junction', 'slip road', 'cross road' or 'roundabout'), and the length of each road type within the catchment.

11.4.34 The probability of a serious spillage subsequently causing a serious pollution incident is dependent on the receiving surface waterbody and the response time of the emergency services; i.e., less than 20 minutes, less than one hour, or greater than one hour.

11.4.35 The magnitude of impacts arising from accidental spillage causing pollution to surface water environment has been assessed in the ES, with reference to the Drainage Strategy for the Scheme (Appendix 12C (document reference 6.2)).

Pollution to surface water due to mobilisation of contaminated sediments

11.4.36 Sediment sampling has been undertaken for the Scheme as part of the ground investigation, and the sample data has been used to inform the understanding of the presence of contaminated sediments within the River Yare in the vicinity of the Scheme. Chemical analysis results have been reviewed against the pollutants measured under the WFD (Ref 11.12) and the CEFAS (Ref 11.13) criteria which is relevant to potential disposal of dredged material. The WFD EQS does not include specific criteria for sediment, and it is understood that there are no relevant sediment quality guidelines in the UK. Therefore, the samples have also been assessed against the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (Ref 11.14) and relevant threshold values contained in the DMRB for assessment of chronic impacts associated with road runoff.

11.4.37 The assessment of the potential effects on water quality of contaminants released into the River Yare and of disturbed sediment has been informed by hydraulic modelling. The assessment considers the expected changes in flow regime, with respect to flow velocities and directions, and morphological

characteristics in terms of bottom velocity, movement of channel bed and suspended solids. This has informed the assessment of potential for scour and the transportation of disturbed sediment and contaminants, and associated impacts on water quality.

11.4.38 The methodology of the sediment transport assessment has been developed in consultation with the Environment Agency.

Hydromorphological Changes

11.4.39 A hydromorphological assessment, informed by hydraulic modelling of the Scheme, has been undertaken to understand the impact of the presence of the bridge infrastructure on the hydromorphology of the River Yare. The assessment considers the potential effects on tidal flows, river bed scour/erosion, sediment deposition and any implications for Breydon Water designated site to the north from potential changes to sediment erosion and depositional patterns. The methodology has been developed in consultation with the Environment Agency.

11.4.40 A qualitative assessment has also been undertaken to evaluate the effects of the proposed watercourse realignment and new culverts on the flow and morphological regime of the ordinary watercourses and IDB drains in the immediate area of the Scheme. The assessment considers the existing nature of the watercourses/ drains and the expected changes on flow and morphological quality of these features as a result of the Scheme.

Pollution of Groundwater during Construction

11.4.41 Groundwater sampling and testing has been undertaken for the Scheme as part of the ground investigation works. The potential for contaminant linkages and impacts to controlled waters has been assessed in Chapter 16: Geology and Soils. Chemical analysis results have been reviewed against the WFD EQS in this chapter.

11.4.42 The potential for salt water intrusion is assessed qualitatively based on the difference between water levels in the River Yare and those in groundwater and the permeability of the intervening sediments. The potential for the mobilisation of pre-existing contaminants has been assessed in Appendix 16D as part of the Piling Work Risk Assessment (document reference 6.2).

11.4.43 Groundwater impacts have been assessed quantitatively and a numeric groundwater model constructed (see Section 11.7), to determine a dewatering zone of influence and to quantify impacts to local groundwater abstractor receptors within the Principal Application Site.

Water Framework Directive Assessment

11.4.44 A WFD assessment has been undertaken to assess the Scheme against the key objectives of the WFD (Appendix 11E (document reference 6.2)). The approach to the assessment is based on Environment Agency guidance (Ref 11.16) and PINS Advice Note 18 (Ref 11.25) and considers the potential impacts of the Scheme against the quality elements of the WFD waterbodies to determine whether the Scheme will affect the waterbody status and/or achieving the objectives stated in the RBMP. The assessment is informed by the assessment of effects of the Scheme on aquatic ecology and designated sites, as detailed in Chapter 8: Nature Conservation, effects of land-based contaminants on groundwater and surface water, as detailed in Chapter 16: Geology and Soils, as well as the aspects covered in this chapter.

11.4.45 The WFD stipulates that groundwater waterbodies must achieve 'good quantitative status' and 'good chemical status' (i.e. not polluted) by their objective year. Groundwater waterbodies are classified as either 'good' or 'poor'. The quantity status considers elements such as impacts of saline intrusion, ability to serve groundwater and surface water abstractions, and ability to support groundwater dependent terrestrial ecosystems. The chemical status refers to the EQS for river basin specific pollutants and the priority substances specified under the WFD. The assessment is informed by the ground investigation, groundwater chemical analysis, groundwater level monitoring, and groundwater modelling and considers the effect on groundwater receptors during both construction and operational phases of the Scheme.

Significance Criteria

11.4.46 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme.

11.4.47 The significance of impacts on surface waters and groundwater has been assessed based on the importance or sensitivity of the relevant waterbody and the magnitude of change due to the Scheme, as recommended in DMRB document HD 45/09 (Ref 11.15).

11.4.48 The importance or sensitivity of the waterbodies is evaluated taking into account their quality, rarity, scale and substitutability. The criteria used is based on the guidance and examples given in HD 45/09 (Table A4.3) and WebTAG guidance and is provided in Appendix 11B.

11.4.49 The magnitude of the various impacts is evaluated taking into account the extent of loss and effects on integrity of the relevant waterbody attributes. The criteria used is based on the guidance and examples given in HD 45/09 (Table A4.4) and WebTAG guidance and is provided in Appendix 11B.

11.4.50 The assessment of the impact significance is derived by combining the importance of the affected waterbodies and the magnitude of the impacts, taking into account any embedded mitigation and the guidance provided in HD 45/09 (Ref 11.15) Table A4.5. Details for the methodology and criteria are provided in Chapter 4: Approach to EIA and should be read in conjunction to this chapter.

11.4.51 Where there is more than one option for significance rating, professional judgement is used to determine the significance for the particular impact. Any residual effects assessed as Moderate, Large or Very Large are deemed to be significant.

Effect Significance

11.4.52 The following terms, as detailed in Chapter 4: Approach to EIA (see Table 4.6), have been used to define the significance of the effects identified:

- Very Large effect: where the Scheme could be expected to have a very significant effect (only adverse) on receptors;
- Large effect: where the Scheme could be expected to have a considerable effect (either beneficial or adverse) on receptors;
- Moderate effect: where the Scheme could be expected to have a noticeable effect (either beneficial or adverse) on receptors;
- Slight effect: where the Scheme could be expected to result in a small, barely noticeable effect (either beneficial or adverse) on receptors; and
- Neutral: where no discernible effect is expected as a result of the Scheme on receptors.

11.5 Baseline Conditions

Surface Water Environment

11.5.1 Figure 11.1 shows the Study Area and key features. Surface water features within and around the Study Area have been identified from OS mapping and site walkovers. Defined waterbodies under the WFD have also been referenced. The Scheme is located in the Anglian River Basin and the Study Area includes land within the Broadland Rivers and Anglian Transitional and Coastal (TRaC) Management catchments. The Study Area covers land within the Waveney Operational Catchment, which incorporates the Waveney, Lower Yare & Lothingland IDB drainage district, The Bure operational catchment, and the Norfolk East TraC Operational Catchment, includes the River Yare, the River Bure, Breydon Water and the coastal waters of Great Yarmouth.

River Yare

11.5.2 The main surface water feature in the Study Area is the River Yare which flows north to south through the Principal Application Site. As a Main River, it is under the jurisdiction of the Environment Agency. The River Yare has a large catchment, estimated at around 3,000km2. The river rises south of Dereham to the west of the village of Shipdham. It flows in a generally eastward direction, along the southern fringes of the city of Norwich before entering into The Broads, a significant area of low-lying land drained by a network of ditches and channels, near Whitlingham. The river passes the villages of Brundall, Cantley and Reedham as it flows eastward through The Broads and at the village of Burgh Castle it is joined by the River Waveney before discharging into the inland tidal estuary of Breydon Water. The confluence between the River Waveney and the River Yare is located approximately 8km upstream of the Scheme. Beyond Breydon Bridge, which marks the downstream extent of Breydon Water, the River Yare confluences with the River Bure before turning south, flowing through the town of Great Yarmouth, and discharging into the sea through a gap in the spit of land at Gorleston-on-Sea.

11.5.3 Through the Study Area the river is around 100m wide, with banks consisting of engineered quay walls (Plate 11.1). A typical cross section of the river channel at the Principal Application Site is illustrated in Plate 11.2. This is derived based on bathymetry data provided by Peel Ports, collected in 2017. It can be seen that the River Yare channel is affected by continuous dredging activity, where the river bed is lowered to around -7mAOD and the channel is characterised by steep banks (walls). This channel profile is consistent along the full length of the river through Great Yarmouth. The channel bed level is several metres below the Mean Low Water Spring level (-0.6mAOD) and therefore the channel does not provide inter-tidal habitat.

11.5.4 The Environment Agency Asset Information Management System (AIMS) database shows numerous outfalls to the River Yare along both banks as it passes through Great Yarmouth. Several control gates and penstocks are also present near the confluence with the River Bure. The Haven Bridge crosses the River Yare approximately 1.5km upstream of the Scheme, with Breydon Bridge (Plate 11.3) a further 800m upstream. Both are bascule bridges with piers in the river channel.

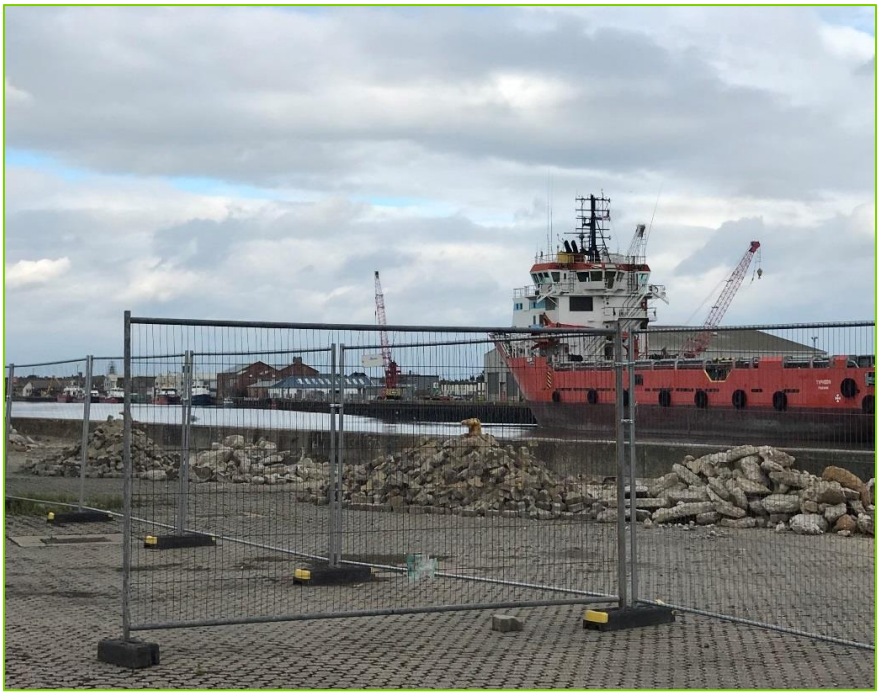


Plate *11.1*: The River Yare at the approximate crossing location

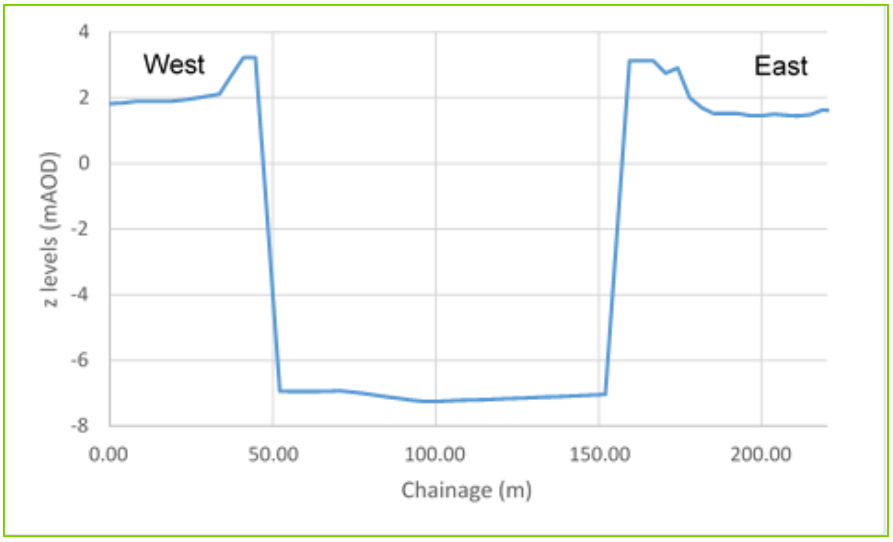


Plate 11.2: A typical cross section of the River Yare channel at the Principal Application Site

Plate 11.3: Breydon Bridge

11.5.5 The River Yare is included in the Outer Thames Estuary Special Protection Area (SPA), which extends from Caister on Sea south to the Thames Estuary. Connecting upstream is the Breydon Water SPA, an internationally important RSPB nature reserve, and also a designated Ramsar and Site of Special Scientific Interest (SSSI). Breydon Water covers an area of approximately 500ha. Extensive areas of mud are exposed at low tide and these intertidal mudflats support large numbers of wintering birds and diverse species of flora and fauna. Further information on the designated sites located in vicinity of the Principal Application Site is provided in Chapter 8: Nature Conservation.

11.5.6 Benthic ecology and fish surveys have been undertaken to inform the ES, details of which are provided in Chapter 8: Nature Conservation. The findings from the surveys suggest the subtidal environment of the River Yare supports a range of benthic and epibiota communities. Benthic populations found in the subtidal sediment are characterised by varying proportions of common worms in moderate to high numbers as well as typical estuarine bivalves and amphipod crustaceans, whilst epibiota are dominated by barnacles and sea anemones. The fish trawl survey identified large numbers of brown shrimp, which is considered of commercial importance, and gobies, which are widespread and abundant in estuarine habitats. Commercially important fish (several flatfish species) were also found but in low numbers. In summary, the aquatic communities identified within the Study Area are of limited conservation value with habitat modification due to dredging activities along the River Yare causing existing pressures.

Tidal and Hydromorphological Regime

11.5.7 The River Yare is a tidal river and the estuary boundary incorporates the section through Great Yarmouth and Breydon Water. There are two tidal gauges located in close proximity to the Study Area, Great Yarmouth at South Pier (NGR 653420 303690), approximately 2.7km south of the Scheme and Haven Bridge (NGR 652172 307513), approximately 1.5km north. The highest tide recorded at Great Yarmouth is 3.32 m on 1st January 1970. More recently, a high tidal event was recorded on the 5th/6th December 2013, which saw the tidal defences being overtopped, causing flooding in parts of the town of Great Yarmouth.

11.5.8 According to the UK Estuaries Database (Ref 11.17), the River Yare estuary has a spring tidal range of 1.9m, indicating it is microtidal as characterised by the small tidal range (<3m). A sediment transport assessment (Appendix 11C) has been undertaken for the Scheme to assess the existing tidal regime of the estuary and the results confirm the narrow tidal range of the estuary, where the Mean High-Water Spring (MHWS) was estimated to be 1mAOD and the Mean Low-Water Spring (MLWS) -0.6mAOD. Based on the above and the general profile of the River Yare channel through Great Yarmouth, which is deep due to dredging, the channel bed and associated habitat will not be exposed during low tide. Breydon Water is however characterised by a deep central channel with sloped sections either side representing the extensive mudflats and saltmarsh. During low tide, the central channel will remain wet but a significant proportion of the mudflats will be exposed providing a suitable environment for inter-tidal habitat. The wetted areas within Breydon Water and the River Yare during high and low tides are provided in Appendix 11C.

11.5.9 The results of the assessment suggest that the estuary has a tidal prism2 of approximately 5 million m3 and that the estuary is ebb dominant with the Dronkers tidal asymmetry ratio3 estimated at 0.49 i.e. there is a net export of sediment from the system. However, the engineered channel through Great Yarmouth has the potential to restrict sediment movement through the estuary, hence sediment is transporting out of Breydon Water at a slower rate than would be expected in an ebb dominant system.

11.5.10 The sediment transport assessment (Appendix 11C (document reference 6.2)) provides a detailed analysis of the hydromorphological regime of estuary. Four tidal events were simulated, the everyday spring and neap

[2] The tidal prism of an estuary is defined as the volume of water between the mean high-water level and mean low-water level and it is this volume of water that contains the sediment and directly links to the transportation of sediment through the estuary.

[3] The Dronkers tidal asymmetry ratio provides a numerical measure of tidal dominance and is calculated using the surface area and volume of the high and low tidal levels in the estuary following DEFRA and Environment Agency guidance on tidal asymmetry analysis (Ref 11.18). If the ratio is less than 1, the estuary is considered ebb dominant (net export of sediment); if the ratio is greater than 1, the estuary is considered flood dominant (net import of sediment).

tides and the extreme events whereby the everyday tides were simulated with 5% AEP sea surge. The main driver for sediment transport is velocity magnitude, which is used to calculate the bed shear stress, a parameter used to predict sediment transport with respect to deposition and erosion.

11.5.11 The model results suggest the baseline velocity magnitude at the Principal Application Site peaks at approximately 1m/s and 0.7m/s for the spring and neap tide events, respectively. Lower velocities are observed in Breydon Water and at the harbour mouth, whilst the highest velocities (reaching up to 1.6m/s for the spring tide event) are observed at Haven Bridge due to flow constriction caused by the bridge piers. The pattern of bed shear stresses (as shown in Plate 11.4 and Plate 11.5) and erosion/deposition rates within the estuary generally mirrors that of the flow velocities, whereby the highest bed stresses and erosion rates are observed at Haven Bridge whereas lower stresses and erosion rates (i.e. greater deposition) are observed in Breydon Water and at the harbour mouth for the everyday tidal events. At the Principal Application Site, the average erosion rate is estimated at 1.87kg/m2/h and 1.13kg/m2/h for the spring and neap tide events, respectively.

11.5.12 The model results suggest that during an extreme event, water is flowing through the River Yare channel at a higher ambient velocity magnitude than the everyday events, which subsequently raises the bed shear stresses and erosion rates within the estuary. At the Principal Application Site, the average erosion rates are estimated at 3.86kg/m2/h and 2.21kg/m2/h during the extreme spring and neap tidal events, respectively.

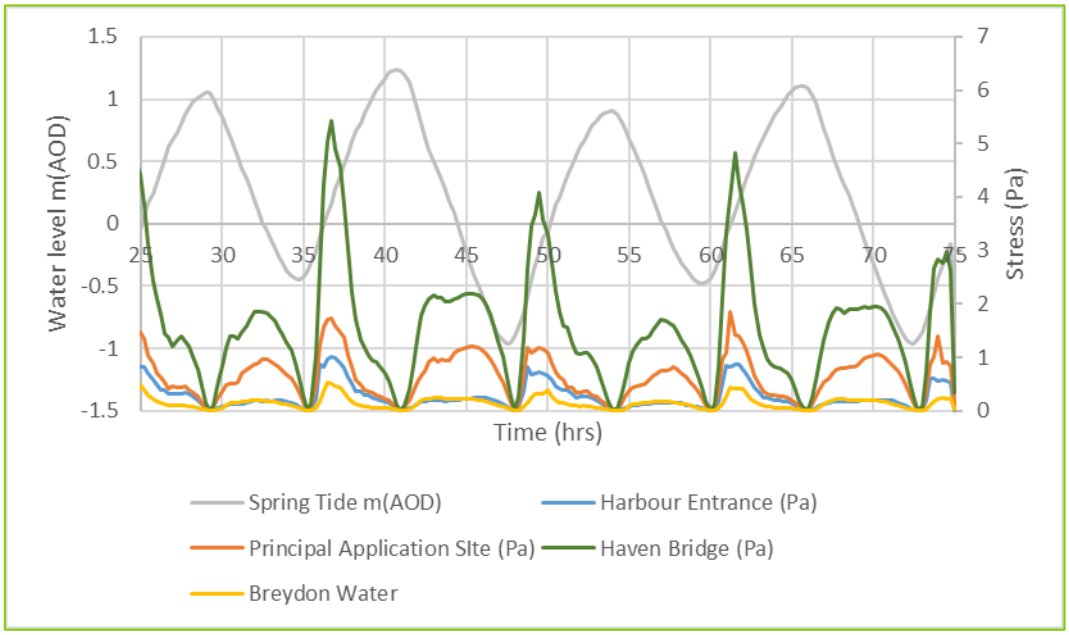


Plate 11.4: Baseline bed shear stresses during the spring tide event

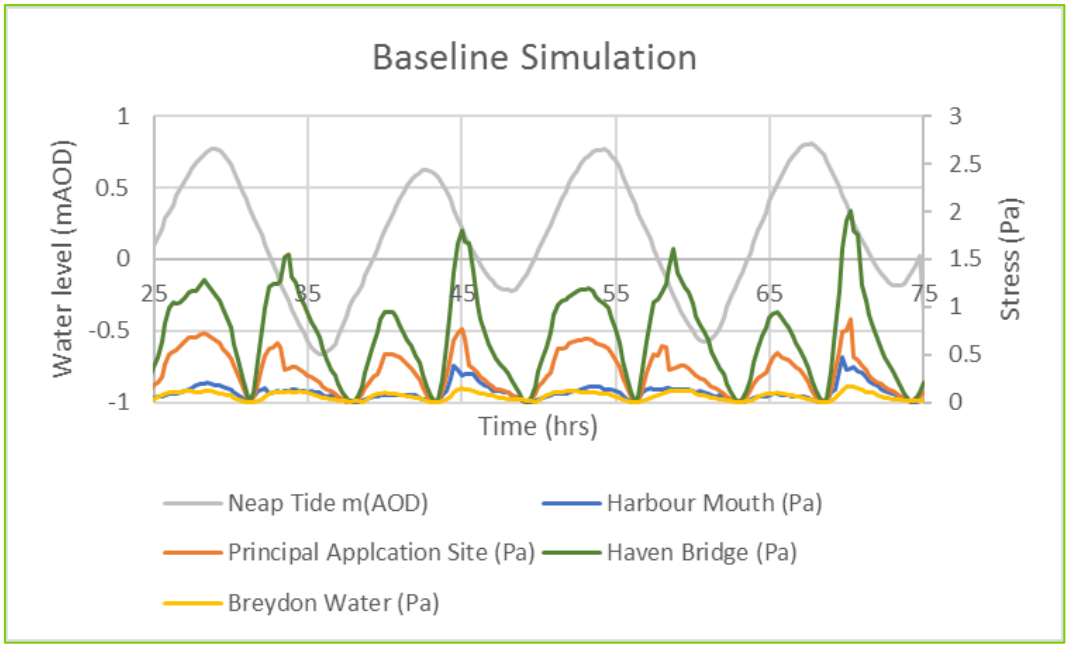


Plate 11.5: Baseline bed shear stresses during the neap tide event

Water Quality

11.5.13 Under the WFD, the River Yare, the River Bure and Breydon Water are all part of the Bure & Waveney & Yare & Lothing transitional waterbody within the Norfolk East Transitional/Coastal Operational Catchment. This transitional waterbody is linked with several protected areas, including the Breydon Water SPA, but is also heavily modified, consisting of engineered flood protection, bridge and navigational infrastructure. The ecological and chemical quality of this waterbody is assessed by the Environment Agency in accordance with the objectives of the WFD. It was assessed to have an ecological status of Moderate, chemical status of Good and an overall status of Moderate in 2016. The reasons for not achieving overall Good status are primarily related to sewage discharge and also some unknown activities which are pending investigation. The objective for this waterbody is to achieve/maintain Moderate status by 2027, however no known measures have been identified at present to achieve this objective.

11.5.14 Consultation has been carried out with the Environment Agency to request relevant water sampling data or information within the Study Area. Water quality sampling for the Bure & Waveney & Yare & Lothing waterbody was subsequently provided and the data showed that both the maximum and annual mean concentrations of the sampled elements, including Arsenic, Ammonia, Mercury, heavy metals such as Cadmium, Lead, Copper, Iron, Zinc, and Tributyltin compounds, are all below the EQS used in the chemical WFD assessment. This reflects the Good chemical status of the waterbody and suggests the waterbody is not at pressure relating to these elements, which are contaminants that can be found in road runoff.

11.5.15 A review of the Environment Agency's 2017 pollution inventory (Ref 11.28), which provides a record of annual routine releases of specific substances to air, controlled waters and sewers, suggests that there is an authorised discharge site to controlled waters (i.e. the River Yare) within 1km of the Application Site. This is the Great Yarmouth Power Station at South Denes Road, approximately 720m south of the Principal Application Site. Substances released from this site include heavy metals, such as Copper, Lead, Mercury, Zinc and Cadmium, Arsenic, Halogenated Organic Compounds, Nitrogen, Phosphorus and Total Organic Carbon. However, quantities released are all below reporting threshold, except for Arsenic where the quantity released is double the reporting threshold of 5kg.

Sediment Sampling

11.5.16 As part of the ground investigations undertaken for the Scheme, ten marine boreholes were sunk in the channel of the River Yare, as presented in Chapter 16: Geology and Soils, and on Figure 16.1. These boreholes were drilled to determine the ground, groundwater, sediment composition and contamination conditions at the site.

11.5.17 Particle Size Distribution (PSD) analysis was undertaken for the sediment samples taken from the boreholes. It showed that the majority of the sediment in the river bed is made up of a combination of fine to coarse sand, with several samples showing higher content of silt and clay. The average D50 of the analysed samples is 0.27mm. The sediment sample taken from MBH2 on the right side of the channel, immediately upstream of the proposed crossing, is showing significantly higher content of silt and clay, with a D50 of 0.03mm. However, on the opposite side of the channel at MBH7, the sediment sample was analysed to have a D50 of 0.55mm, indicative of medium to coarse sand. This suggests that the river channel around MBH2 is likely to be an area of lower velocity, where finer sediments deposit. Conversely the left side of the channel around MBH7 is likely to be an area of higher velocity where larger sediments settle.

11.5.18 Chemical analysis was completed for the sediment samples taken from the marine boreholes to determine the level of contaminants within the River Yare. The analysis showed that the majority of the samples exceeded CEFAS Action Level 1 for heavy metals. Comparison with the DMRB thresholds showed that several samples exceed the Threshold Effect Level4 (where contamination may have an effect on water quality) for heavy metals, with samples taken from MBH4 exceeding both the Threshold Effect Level and Probable Effect Level5 for Zinc and Copper. The sample from MBH4 also exceeds the Probable Effect Level for Zinc and Copper under the

[4] Threshold effect level (TEL) represents the concentration below which adverse biological effects are expected to occur rarely.

[5] Probable effect level (PEL) defines the level above which adverse effects are expected to occur frequently.

Canadian thresholds. The sample taken from MBH6 is showing high levels of Polycyclic Aromatic Hydrocarbons (PAHs), with the Threshold Effect Levels being exceeded for all of the measured contaminants under the DMRB thresholds. Exceedance of Threshold Effect Level standards suggest that remobilisation could result in an occasional adverse biological effect.

11.5.19 Leachate analysis was also undertaken for the sediment samples and the results were screened against the WFD EQS for transitional waters. The majority of the samples were shown to exceed the WFD EQS for heavy metals, including Copper, Zinc, Nickel and Lead, with the sample taken from MBH2 showing the highest concentrations of the above elements. The sample from MBH2 also exceeds the EQS for Arsenic and Benzyl butyl phthalate. In addition, the samples show high levels of Cyanide, which is a specific pollutant, and Mercury, Hexachlorobenzene, Hexachlorobutadiene and PAHs, which are all characterised as priority hazardous substances under the WFD. However, it is identified in Chapter 16: Geology and Soils that the leachate exceedances are only marginal, generally less than one order of magnitude above the screening values. Furthermore, the exceedances are not consistent across the sampled sites, i.e. some sites are showing higher exceedances than others, whereas some exceedances, e.g. Arsenic, are only found in one or two sites. This indicates there is a theoretical potential for an impact to occur but the concentrations recorded suggest this would not pose a significant risk. It is also expected that pollutant concentrations due to sediment suspension in the River Yare will be lower than obtained from the leachate analysis, due to the increased dilution and dispersion that will occur in the river under the normal tidal and fluvial regime.

11.5.20 Regular suspension of sediments occurs in the River Yare during the normal tidal cycle and the current WFD data for the River Yare suggests this contaminated sediment is not significantly affecting the water quality and chemical status of the waterbody, which is classified as Good for all chemical status elements and High for specific pollutants, such as Copper and Zinc.

River Bure

11.5.21 The River Bure, an Environment Agency Main River, joins the River Yare approximately 2km upstream of the Scheme and is part of the Bure & Waveney & Yare & Lothing transitional waterbody within the Norfolk East Transitional/Coastal Operational Catchment. Although the Scheme has only indirect connectivity to the River Bure (via the River Yare), contaminated sediments mobilised as a result of the construction of the Scheme could migrate upstream to impact on this watercourse. As such, potential impacts on the Bure as a result of the development of the Scheme has been assessed within the ES.

11.5.22 The River Bure is one of the largest tributaries of the River Yare, with a catchment area estimated at around 1000km2. The river rises near the village of Melton Constable. From its source, it flows in a generally eastward direction towards Aylsham before turning southeast and draining towards the low-lying land of The Broads. Downstream of Wroxham, it is joined by the River Ant and then the River Thurne before discharging into the River Yare at the downstream extent of Breydon Water.

11.5.23 The lower River Bure, from downstream of Runham to the confluence with the River Yare, is included in the Outer Thames Estuary SPA.

Great Yarmouth Coast and the North Sea

11.5.24 The River Yare discharges to the North Sea at Gorleston-on-Sea. The coastal waters of Great Yarmouth, which incorporate part of the North Sea, are included in the Norfolk East waterbody within the Norfolk East TraC Operational Catchment. This heavily modified waterbody is located approximately 3km downstream of the Scheme and covers the coastal area of Sheringham to Great Yarmouth. The entire waterbody is included in the Outer Thames Estuary SPA and a proportion, from Caister-on-Sea to the suburb of Newtown in Great Yarmouth is included in the Great Yarmouth North Denes SPA.

11.5.25 This coastal waterbody is linked with several protected areas, including a number of bathing waters protected areas along the beach of Great Yarmouth. It is also heavily modified, consisting of engineered structures of flood and coastal protection. It has an overall status (2016) of Moderate, comprising an ecological status of Moderate and chemical Status of Good. The reasons for not achieving overall Good status are primarily related to diffuse and point source pollution associated with poor nutrient management and sewage discharge. The objective for this waterbody is to achieve Moderate status by 2015, however no known measures have been identified at present to maintain this objective.

11.5.26 The Environment Agency also provided water quality sampling data for the Norfolk East waterbody. Similar to the Bure & Waveney & Yare & Lothing transitional waterbody, the data showed that both the maximum and annual mean concentrations of the measured elements, including Benzene and Toluene, are below the WFD EQS. This again reflects the Good chemical status of the waterbody as discussed above.

Other Surface Water Features

11.5.27 To the west of Great Yarmouth, land either side of the main rivers is mainly marshland, drained via a network of ditches and small watercourses. The land generally lies below ordnance datum and land north of Breydon Water is managed by the Broads Internal Drainage Board (IDB). The land to the

south is managed by the Waveney, Lower Yare & Lothingland IDB (Figure 11.3). These areas drain to the Breydon Water and then the River Yare. The majority of this marshland area lies outside the Study Area although a small part, located within the drainage district of the Waveney, Lower Yare & Lothingland IDB adjacent to Great Yarmouth, is included in the Study Area for surface water features.

11.5.28 The Waveney, Lower Yare & Lothingland IDB administrative area comprises 750ha of agricultural and urban land close to or below mean sea level. In order to avoid damage to the land through excessive waterlogging, effective drainage of the area is dependent on pumping handled by the Burgh Castle pump, which removes excessive runoff from the marshes, urban area and the upland catchment to the River Yare. The network of dykes and drains within the district contain a wide range of aquatic vegetation communities, both brackish and freshwater, as well as several nationally scarce plant species and notable invertebrates. The marshland also supports a range of wintering birds and breeding waders. This has been considered within Chapter 8: Nature Conservation.

11.5.29 There are a number of smaller drains and watercourses located within the 1km Study Area of the Scheme. These are likely to form part of the surface water drainage for the urban areas comprising the eastern part of the IDB district, and they are connected to the main dyke system in the west by a series of culverts underneath the main A47 road. One of the main culverts under the A47 and the connecting drain, adjacent to the Gapton Hall Retail Park, was inspected during the site walkover on 3rd October 2018 (Plate 11.6). The photograph was taken standing on Pasteur Road looking west towards the culvert. The drain is approximately 3 to 4m wide at this location and it is connected to the IDB main drain that feeds the Fisher's Marshes within the district.

11.5.30 A couple of the smaller drains located within the urbanised part of the IDB district are found within the Principal Application Site, including the drains around Southtown Common, the A47 roundabout and the ditch within the community garden/allotments, north of William Adams Way (Plates 11.7 to 11.9). The drain within Southtown Common is fed by a network of ditches and open watercourses from the Gapton Hall Industrial Estate. It is connected to the drain adjacent to the A47 roundabout via a culvert underneath William Adams Way. Beyond Queen Anne's Road, the drain is conveyed west, via a series of culverts and ditches, towards the Gapton Hall Road culvert before discharging into the IDB main drain within Gapton Marshes.

11.5.31 The minor ditch that drains the MIND Centre and Grounds flows from east to west towards the watercourse downstream of William Adams Way culvert. Discussion with personnel within the MIND Centre and Grounds suggests that the ditch is ephemeral and would dry out during the summer months.

Several small ponds were also observed in the MIND Centre and Grounds during the walkover on 3rd October. Based on the observations of the staff, the ponds and the ditch are believed to be in a relatively healthy state and support wildlife including dragonflies and frogs.

11.5.32 A water vole survey, undertaken in August 2017 and later in September 2018, has recorded feeding remains and water vole droppings along the IDB drain that runs along the western and northern edge of Southtown Common. Details of water vole surveys are reported in Chapter 8: Nature Conservation and the supporting Water Vole Survey report, presented in Appendix 8E (document reference 6.2).

11.5.33 The Environment Agency's catchment data explorer shows that the Waveney, Lower Yare & Lothingland IDB drainage district is located within the Waveney Operational Catchment, which is a freshwater operational catchment under the WFD. However, based on the watercourse network plan, it is understood that the IDB catchment ultimately drains into Breydon Water and then into the River Yare. Hence it is more likely to contribute to the water quality of these surface water features, which form part of the Bure & Waveney & Yare & Lothing transitional waterbody, rather than the water quality of any freshwater bodies located within the Waveney Operational Catchment. The network of dykes and drains within the western part of the IDB district, south of Breydon Water, is prone to pollution from tidal sea water seeping through the river wall which can have high salt and nutrient levels during dry weather conditions. In order to prevent the spreading of polluted water through the marsh dyke system, a sluice, which can be temporarily closed, has been installed upstream of the Burgh Castle pump.

11.5.34 The IDB drains and smaller ditches/watercourses located in the urban area of Great Yarmouth, including those within the Principal Application Site are vulnerable to pollution from drainage or runoff from roads and developed areas. However, consultation with the IDB has confirmed that they do not have any specific concerns with respect to water quality for the drains within the immediate area of the Scheme.

Plate 11.6: On Pasteur Road looking downstream (west) towards the A47 Culvert

Plate 11.7: The drain within Southdown Common (looking north toward William Adams Way)

Plate 11.8: The drain that runs from south to north, downstream of the William Adams Way culvert

(standing on Queen Anne's Road looking upstream; this drain is culverted underneath Queen Anne's Road)

Plate 11.9: The ditch within the community allotments

(this section approximately 25 m east of Suffolk Road, appeared to be dry during the site walkover on 3rd October, however, standing water was observed in the section slightly downstream)

Pollution Incidents

11.5.35 Based on the information provided in the Groundsure Report (July 2017) (Ref 11.8), the Environment Agency has recorded one major pollution incident and several minor incidents within 500m of the Principal Application Site. The major incident occurred on 21st November 2002 and involved the spillage of oils and fuel on Pleasure Beach, causing impacts to the coastal environment.

Surface Water Abstractions and Discharges

11.5.36 A review of the Environment Agency's consented discharge database (Ref 11.27) shows that there are 29 discharge consents within the 1km Study Area of the Scheme. Half of these discharge directly into the River Yare, whilst the remaining discharge into smaller drains/watercourses within the IDB catchment. The consents include sewerage, trade effluent, storm overflow discharges and site drainage. Contaminants associated with these processes include faecal material, bleaches and cleaning products. As noted previously, there is also a controlled discharge from Great Yarmouth Power Station. Consultation with relevant authorities, including the Environment Agency, Norfolk County Council and GYBC, has confirmed that they do not hold any information on unregulated or unlicensed discharges within the Study Area.

11.5.37 Consultation with the Environment Agency, Norfolk County Council and GYBC has confirmed that they do not have any records of surface water abstractions within the Study Area.

Groundwater Environment

Geology

11.5.38 The main characteristics of the geology (superficial and bedrock) within the Principal Application Site are described in Chapter 16: Geology and Soils, and considers both published information and the findings of the ground investigation completed between 18 September 2017 and 27 March 2018 undertaken by Norfolk Partnership Laboratory on behalf of the Applicant.

Hydrogeology

11.5.39 Superficial deposits, comprising the North Denes Formation, Breydon Formation and Happisburgh Glaciogenic Formation are low productivity aquifers of limited or local potential, where borehole yields are expected to be small. The Environment Agency (Ref 11.6) designates these units as Secondary A Aquifers and Unproductive Strata, respectively. The ground investigation (2017-2018) has confirmed that these formations directly underlie, or are at shallow depths within the Study Area.

11.5.40 The Crag Group and Chalk Group Aquifer are major aquifers and are designated as Principal Aquifers by the Environment Agency deemed capable of supporting water supplies at a regional scale (Ref 11.6). Please note that no direct interaction with the Chalk Group Aquifer and construction activities related to the Scheme is expected, because the overlying London Clay Formation provides a substantially thick low permeable layer.

11.5.41 The Environment Agency designates the Crag Group as a Principal Aquifer however, the BGS (Ref 11.3) classify the Crag Group as a minor aquifer (legacy terminology for Secondary Aquifer), as per The Physical Properties of Minor Aquifers in England and Wales (Ref 11.6). The BGS Minor Aquifer Properties report shows that the Crag Group storage coefficients (dimensionless) in the area of Great Yarmouth are recorded at 0.11 – 0.62. For this reason, the Crag Group is considered a Principal Aquifer where no on site permeability tests have been recorded to confirm the properties of the Crag Group. This is a conservative approach and the assessment therefore is based on a reasonable worst-case scenario.

11.5.42 Based on the geological information, the following hydrogeological units are present within the Study Area and are summarised in Table 11.5 below (in chronological order).

Table 11.5: Hydrostratigraphy of the Study Area

Group	Formation	Thickness (m)	Aquifer Designation
British Coastal Deposits Group	North Denes Formation	Up to 11.0	Secondary A Aquifer
	Breydon Formation	1.50 to 12.0	Unproductive Strata
	Crag Group	22.0 to 35.0	Principal Aquifer
Thames Group	London Clay Formation	Up to 100*	Unproductive Strata
Montrose Group	Thanet Formation	Up to 30*	Secondary A Aquifer
Chalk Group	Chalk	200+*	Principal Aquifer

Notes: Total thickness of all formations that make up the British Coastal Deposits Group taken from the 2017 – 2018 ground investigation borehole logs.

* Denotes thickness taken from BGS Map Sheet 162 Great Yarmouth where the formation was not intercepted in the 2017 – 2018 ground investigation boreholes.

11.5.43 Given the findings of the recent ground investigation, it is anticipated that the superficial deposits (North Denes Formation, Breydon Formation and Happisburgh Glaciogenic Formation) will comprise a weakly permeable, low productivity aquifer of limited or local potential. The variable lithology of the

superficial deposits presents an inconsistent multi-layered aquifer with dedicated flow paths potentially occurring within the more permeable layers, although this will be locally restricted both horizontally and vertically. On a regional basis, it is anticipated that the superficial geologies are likely to be hydraulically connected where non-laterally extensive clay lenses exist.

11.5.44 The sands and gravel beds associated with the Crag Group Aquifer are anticipated to comprise high productivity, locally important aquifers. The groundwater potential of these deposits will be dependent on the ground material permeabilities and thickness of the saturated material.

11.5.45 The BGS Hydrogeological Map of North East Anglia indicates that the Crag Group is exploited for supplies where the Chalk Group Aquifer is present at significant depth, with abstraction yields between 1.9 to 4.4 L/sec recorded.

11.5.46 Locally, groundwater flow direction in the superficial deposits, while generally towards the River Yare, will be variable and influenced by local changes in topography as well as the aquifer geometry e.g. the presence of clay layers, tidal fluctuations and rainfall.

11.5.47 Groundwater observations from the ground investigation (2017-2018) found water levels to be variable across the site (Table 11.6). Shallow groundwater levels were recorded at 1.09 m OD (0.8m BGL) in BH8 and the deepest recorded at -1.13 m OD (2.51m BGL) in BH4D(d).

11.5.48 Ten (10 no.) borehole and three (3 no.) window sample locations are available for groundwater level monitoring purposes and installation details are summarised in Table 11.6 below. BH04D has a dual installation for shallow BH4D (s) and deep BH4D (d) strata. The location figure of these boreholes is provided in Chapter 16: Geology and Soils within Annex B Appendix 16C.

Table 11.6: Installation Summary

Borehole ID	Easting	Northing	Ground Level (m)	Borehole Depth (m)	Response Zone (mBGL)	Formation
BH4	652233	305880	1.77	30.0	6.5 – 9.5	Breydon Formation / Crag Group
BH4A	652315	305800	1.25	5.0	0.5 – 1.7	Made Ground / Alluvium
BH4D (s)	652290	305818	1.38	30.0	1.0 – 3.5	Made Ground

Borehole ID	Easting	Northing	Ground Level (m)	Borehole Depth (m)	Response Zone (mBGL)	Formation
BH4D (d)	652290	305818	1.38	30.0	8.0- 11.0	Crag Group
BH6	652283	305963	0.93	30.0	9.0 – 15.0	Crag Group
BH7	652307	305946	1.23	6.0	0.3 – 1.15	Made Ground / Breydon Formation
BH10	652407	305990	2.45	50.0	0.5 – 3.5	Made Ground / Alluvium
BH11	652411	305966	2.46	50.0	4.5 – 20.5	Breydon Formation / North Denes Formation / Crag Group
BH12B	652506	306024	2.33	50.0	4.0 – 10.0	Made Ground / Alluvium / Breydon Formation
BH13	652516	305980	2.27	50.0	3.5 – 14.5	Breydon Formation / Crag Group
BH15	652637	306021	1.92	30.0	1.0 – 7.0	North Denes Formation
WS20	652545	305995	1.49	5.0	1.0 – 3.0	Alluvium
WS21	652537	305984	1.96	5.0	1.0 – 3.0	Alluvium
WS22	652572	306017	2.00	6.0	1.0 – 3.0	Alluvium

Notes: Window Sample denoted by WS and borehole denoted by BH. Comprehensive details of the ground investigation are provided in Chapter 16: Geology and Soils.

11.5.49 Thirteen (13 no.) rounds of groundwater level monitoring data have been completed and are summarised in Table 11.8. The groundwater level data predominantly reflects groundwater levels for summer months with some recorded during the onset of winter (November and December 2018) within the superficial deposits. A maximum summer groundwater level of 0.21

mAOD was recorded at BH4 and a maximum winter groundwater level of 1.10mAOD was recorded in BH6 during the monitoring period.

11.5.50 The superficial deposits and Crag Group Aquifer are considered highly sensitive to possible factors which may potentially affect their quantity regimes from near surface influences. The underlying Chalk Group Aquifer is considered of low sensitivity and is considered well protected by the overlying London Clay Formation.

Groundwater Permeability

11.5.51 No in-situ permeability tests i.e. falling head tests were completed in the superficial deposits during the ground investigation (2017-2018) to confirm ground material flow rates. This section relies on the interpretation of the recorded ground materials as described within the site specific and third party BGS borehole logs. The BGS offers direct, online access to the National Geoscience Data Centre collection of onshore scanned boreholes. shafts and well records, and will provide an indication of local ground conditions i.e. historic permeability tests completed in local BGS boreholes in proximity to the Scheme. Where available this data has been relied upon.

11.5.52 The North Denes Formation Secondary A Aquifer consists of fine to coarse sand with gravels and, occasional silt and clay bands. This Formation is likely to have a low permeability, meaning that water is slowly transmitted through the ground material.

11.5.53 The Crag Group Principal Aquifer comprises fine to medium grained silty sand with some gravel and occasional silty clay layers. This bedrock is likely to have a moderate permeability where the strata is predominantly composed of sand, with permeability increasing to high where high proportions of gravel are present.

Groundwater Quality

11.5.54 Groundwater water quality sampling and testing was undertaken as part of the ground investigation works. The potential for contaminant linkages and impacts to controlled waters, the vertical and lateral migration of mobile contaminants into groundwater and/or surface water, has been assessed in Chapter 16: Geology and Soils and includes the potential for piling works to open new migration pathways which are discussed in more detail in Chapter 16: Geology and Soils, and Appendix 16D Piling Works Risk Assessment.

11.5.55 The superficial deposits (North Denes Formation, Breydon Formation and Happisburgh Glaciogenic Formation) are not considered to be in hydraulic continuity with the underlying Crag Group Aquifer locally. The variable lithology of the superficial deposits which comprises a mixture of clayey, gravel, silt and sand present an inconsistent multi-layered aquifer with

dedicated flow paths potentially occurring in the more permeable layers, although this will be restricted both horizontally and vertically. On a regional basis, it is anticipated that the superficial geologies are likely to be hydraulically connected where non-laterally extensive clay lenses exist.

11.5.56 Superficial groundwater quality characteristics will be dominated by the proximity to the River Yare; the mixing of surface water and groundwater is anticipated at and near the contact between the two waterbodies. Vertical groundwater flow to the Crag Group aquifer from the Superficial Secondary A aquifer is likely to be restricted horizontally and vertically due to the low permeabilities of the superficial geology.

11.5.57 Table 11.7 summarises the results of groundwater water quality across the Principal Application Site for 2018. The results below are based on a groundwater quality campaign carried out in twelve (12 no.) boreholes in 2018 and represent the latest data available. The results are screened against annual average EQS concentrations of potentially hazardous chemicals as defined under the WFD for freshwater waterbodies and exceedances are highlighted in bold against the maximum allowable EQS concentration defined for a specific contaminant. Not all determinants have a defined EQS, thus not all have been screened against an EQS value.

11.5.58 Groundwater water quality testing included results for electrical conductivity (EC) to assess for potential saline intrusion in groundwater within the Principal Application Site. The results conclude that there is some influence from seawater within the Principal Application Site with higher average concentrations recorded on the western bank of the River Yare (Plate 11.6). A maximum concentration record for EC is 43,600 µS/cm at BH6 and a minimum concentration recorded is 819.0 µS/cm at BH10.

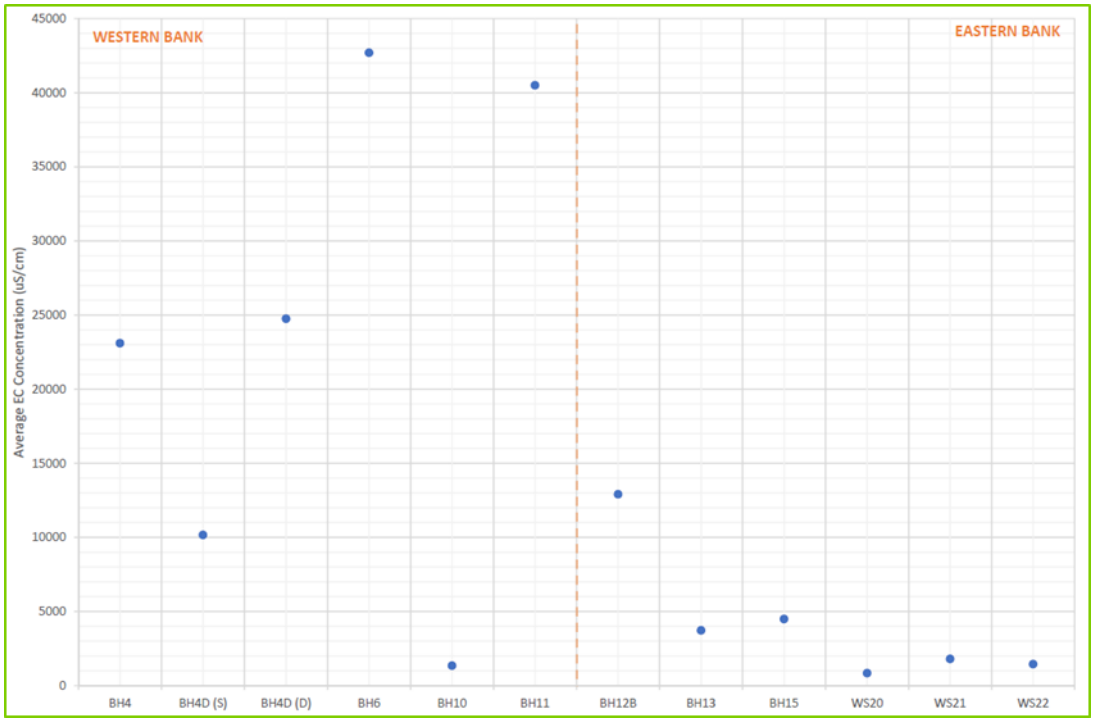


Plate 11.10: Average electrical conductivity concentrations for borehole locations within the Principal Application Site.

11.5.59 The average concentrations recorded for EC in groundwater samples within the Principal Application Site are not unexpected. The River Yare is a tidal river and EC concentrations are expected to increase near the coast and tidal reaches of rivers due to saline infiltration. The high EC in the western (right hand) bank shows that the River Yare is in hydraulic continuity with groundwater at the Principal Application Site. The low EC on the eastern bank indicates that there is less mixing, potentially because of an absence of groundwater abstractions and a different hydraulic gradient.

11.5.60 The regional Chalk Group Aquifer is considered well protected by the overlying London Clay Formation, which significantly reduces the risks of potential groundwater pollution to the chalk within the Principal Application Site.

Table 11.7: Groundwater Water Quality Results (2018)

Determinant	EQS	Unit	Concentration	
			Minimum	Maximum
pH	Between 6.5 and 9.5	pH Units	7.11	**11.90**
EC	-	µS/cm	819.00	43,600.00
BOD	-	mg/L	1.00	16.00

Determinant	EQS	Unit	Concentration	
			Minimum	Maximum
Total Hardness	-	mg/L $CaCO_3$	244.00	5670.00
TSS	-	mg/L	11.00	8822.00
Ammoniacal Nitrogen	-	mg/L	0.21	12.90
Ammoniacal Nitrogen as NH_4	-	mg/L	0.27	16.69
Chloride	-	mg/L	113.00	18,400.00
Fluoride	-	mg/L	0.10	1.59
Nitrite	-	mg/L	0.10	19.00
Nitrate	50.0	mg/L	0.10	15.80
Nitrate as N	-	mg/L	0.02	3.58
Total Oxidised Nitrogen	-	mg/L	0.10	9.40
Total Nitrogen	-	mg/L	0.40	15.70
Total Phosphorous*	-	µg/L	20.00	1247.00
Sulphate	-	mg/L	1.00	2380.00
DOC	-	mg/L	0.40	14.30
Oil & Grease	-	mg/L	1.00	9.00
Arsenic*	50.0	µg/L	1.00	**75.00**
Boron*	-	µg/L	57.00	4340.00
Cadmium* (0.08)	0.08	µg/L	0.08	0.08
Calcium*	-	mg/L	66.00	405.00
Copper*	-	µg/L	4.00	74.00
Chromium*	-	µg/L	1.00	15.00
Chromium (hexavalent)	-	mg/L	0.01	0.01
Iron*	-	µg/L	10.00	7690.00
Lead*	7.2	µg/L	1.00	2.00
Manganese*	-	µg/L	1.00	9460.00
Magnesium*	-	mg/L	1.00	1130.00
Mercury*	0.05	µg/L	**0.10**	**0.20**
Nickel*	20.0	µg/L	1.00	6.00

Determinant	EQS	Unit	Concentration	
			Minimum	Maximum
Potassium*	-	mg/L	27.00	320.00
Selenium*	-	µg/L	1.00	3.00
Sodium*	-	mg/L	106.00	10,100.00
Zinc*	1.4	µg/L	1.00	**60.00**
Ethylene Glycol	-	mg/L	0.10	0.10
Benzo(a)pyrene**	0.05	µg/L	0.01	**0.30**
Benzo(b)fluoranthene**	0.03	µg/L	0.01	**0.35**
Benzo(ghi)perylene**	0.002	µg/L	0.01	**0.59**
Benzo(k)fluoranthene**	0.03	µg/L	0.01	**0.13**
Indeno(123)pyrene**	-	µg/L	0.01	0.47
Total PAH	-	µg/L	0.01	4.04
Total Aliphatics	-	µg/L	5.00	80.00
Total Aromatics	-	µg/L	10.00	388.00

Notes:

* dissolved concentration.

**PAHs.

EC electrical conductivity, BOD biochemical oxygen demand, TSS total suspended solids, DOC dissolved organic carbon.

Bold text denotes exceedances in annual average EQS concentrations for freshwater waterbodies.

Table 11.8: Records of Groundwater Level Monitoring (to date) for the Scheme

Borehole ID	Elevation (mOD)	Rest Water Level (mOD)													
		01/06/2018	21/06/2018	03/07/2018	19/07/2018	02/08/2018	17/08/2018	30/08/2018	04/10/2018	18/10/2018	01/11/2018	14/11/2018	29/11/2018	11/12/2018	20/12/2018
BH4	1.77	-0.13	-0.29	-0.20	-0.22	-0.21	-0.33	-0.27	-0.32	-0.23	-0.33	-0.28	0.62	-0.18	NR
BH4A	1.25	0.10	-0.05	-0.75	-0.45	-0.55	0.07	0.07	-0.03	0.05	-0.06	0.14	0.15	0.15	NR
BH4D (s)	1.38	-0.19	-0.12	-0.28	-0.27	-0.27	-0.26	-0.21	-0.22	-0.14	-0.12	-1.12	-0.29	-0.12	NR
BH4D (d)	1.38	-0.08	-0.17	-0.32	-0.17	-0.22	-0.18	-0.08	-0.17	-0.01	-0.22	-1.13	-0.31	-0.15	NR
BH6	0.93	-0.77	-0.21	-0.45	-0.58	-0.53	-0.40	-0.39	-0.47	-0.53	-0.49	-1.17	-0.58	-0.57	NR
BH7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	DRY
BH10	2.45	NR	0.08	0.01	-0.21	-0.25	0.07	0.11	-0.29	-0.16	-0.30	-0.14	-0.11	0.02	NR
BH11	2.46	NR	0.16	0.01	-0.05	-0.20	0.14	0.19	-0.30	-0.14	-0.30	-0.28	-0.04	0.06	NR
BH12B	2.33	NR	0.55	NR	NR	NR	NR	0.63	0.57	0.62	0.59	0.60	0.50	0.42	NR
BH13	2.27	NR	0.52	NR	NR	NR	NR	0.66	0.54	0.61	0.52	0.54	0.40	0.31	NR
BH15	1.92	0.57	0.50	0.5	0.48	0.49	-0.18	0.36	0.56	0.58	0.54	0.62	0.56	0.66	NR
WS20	1.49	NR	NR	NR	NR	NR	NR	NR	0.27	0.26	0.26	0.23	0.26	0.29	NR
WS21	1.96	NR	NR	NR	NR	NR	NR	NR	0.77	0.67	0.76	0.86	0.79	0.81	NR
WS22	2.00	NR	NR	NR	NR	NR	NR	NR	1.05	1.06	1.10	1.07	1.05	1.14	NR

Notes:
NR denotes no record of groundwater level available where borehole inaccessible.
Window sample denoted by WS and were completed October 2018 thus NR prior to this date.
NR at BH7 when access has been restricted over the duration of the monitoring schedule.
BH7 dry when revisited December 2018.

Water Framework Directive Status

11.5.61 The Principal Application Site falls within WFD groundwater waterbody 'Broadlands River Chalk & Crag' (GB40501G400300) classified as holding a 'Poor' status for both quantitative and chemical classifications. There is an objective to reach 'Good' quantitative and chemical status by 2021 and 2027, respectively. The waterbody is protected under the Drinking Water Protected Area and Nitrates Directive (Appendix 11E (document reference 6.2)).

Groundwater Sinks and Sources

11.5.62 The source of local groundwater recharges is predominantly from rainfall. The superficial deposits (notably North Denes Formation, Breydon Formation and Happisburgh Glaciogenic Formation) will receive groundwater recharge locally. The variable lithology of the superficial deposits presents an inconsistent multi-layered aquifer and where clay occurs this will restrict groundwater recharge (vertically and horizontally) locally to the underlying Crag Group Aquifer.

11.5.63 The Crag Group Aquifer is an extensive Principal Aquifer that will receive recharge from multiple sources within the wider catchment. Any change to recharge locally will be negligible because the overlying superficial deposits restrict recharge to the Crag Group aquifer.

11.5.64 Due to the low permeability of the superficial deposits and impermeable surfaces associated with an urbanised area, groundwater recharge in the area is considered low at the Principal Application Site location (particularly to the underlying Crag Group Aquifer) and runoff and evaporation relatively high.

11.5.65 There is no formally designated groundwater Source Protection Zone (SPZ) within 2.0km of the Study Area. Two licensed groundwater abstractions (NGR TG 49800 05100 and NGR TG 49800 04100) and three unlicensed groundwater abstractions are located within 2.0km of the Scheme. Details for the licensed groundwater abstractions are provided in Table 11.9 below and Figure 11.1. The Environment Agency holds no information relating to borehole construction, target aquifer, water quality or volumes for the three unlicensed groundwater abstractions. Herein, groundwater abstractions (licensed and unlicensed) are referred to as Water Users.

Table 11.9: Licensed Groundwater Abstractions (Environment Agency)

Licence No.	Name	Easting	Northing	Aquifer	Max Daily Volume (m^3)	Distance * (km)
AN/034/0015/020	Campling s Limited	651820	306080	Groundwater – sand / gravel	210 (60ML/year)	0.70
7/34/15/*G/0220	B&M Leisure	653140	307460	Groundwater – presume shallow aquifer	Unknown	1.20

Notes:

Licensed abstraction details from consultation with Environment Agency (September 2018) and GroundSure Report (2017) – shallow aquifer is presumed to be Crag Group.

Distance is approximate distance from the Principal Application Site.

Future Baseline

11.5.66 The effects of climate change are expected to lead to increased sea levels and more extreme storm events, which not only has the potential to increase the risk of flooding but also may alter the tidal regime and patterns of scour and deposition within the estuary. These effects have been considered in the sediment transport assessment (Appendix 11C), whereby the tidal prism of the estuary and the Dronkers tidal asymmetry ratio have been re-calculated based on an increase in sea level of 1.88m. This level has been obtained using the Met Office's UK Climate Projection 2018 (UKCP18) dataset and extrapolated for a 120-year design life (Ref 11.28). The increase of 1.88m creates an average high-water level of 2.88m but the effects are negligible on the tidal prism of the estuary. Conversely, the increase in sea level would result in the estuary to switch from an ebb dominant system to a flood dominant system, with the Dronkers tidal asymmetry ratio estimated at 2.01 i.e. there would be a net import of sediment to the system as a result of climate change. However, as noted for the current situation, the narrow channel of the River Yare may restrict the rate of sediment movement and import.

11.5.67 The effects of sea level rise are also expected to lead to higher groundwater levels in the Study Area, due to hydraulic connectivity and tidal influence on the local groundwater levels. The combined climate change effects of sea level rise, increased storm surge and extreme rainfall may lead to greater interaction between surface waters and groundwater in the future.

11.5.68 For the future baseline, the WFD objectives for both the Bure & Waveney & Yare & Lothing and the Norfolk East waterbodies are assumed to be met, however no changes in status are predicted in RBMP. As such, no changes to the current baseline conditions which define the receptor importance and sensitivity are expected for the River Yare, the River Bure and the North Sea.

11.5.69 Based on the current available information, no changes to the current baseline are expected for the other surface water features.

11.5.70 With respect to groundwater, the WFD objectives are assumed to be met for the future baseline. The groundwater waterbody 'The Broadlands River Chalk & Crag' (GB40501G400300), which currently holds 'Poor' quantitative and chemical status will be assessed to a future 'Good' status. The Environment Agency expects the groundwater waterbody to achieve 'Good' status of all assessment parameters (quantitative and chemical) by 2021 and 2027 respectively. Any potential change in status would not affect the importance of the receptor which remains a regionally important aquifer irrespective of designation.

11.5.71 Based on the current available information, no other changes are expected in baseline conditions for groundwater.

11.6 Sensitive Receptors

11.6.1 Table 11.10 and Table 11.11 below summarise the importance of water features/receptors identified within the Study Area. In all cases an assessment of importance for the water environment baseline is provided. Although some changes in future baseline conditions are expected, as detailed above, this does not affect the assessment of importance of the receptors.

Table 11.10: Sensitive Surface Water Receptors

Receptor	Key Features	Importance / Sensitivity
River Yare	• Main River; • Large tidal watercourse, navigable; • WFD Moderate status (objective Moderate by 2027); • Heavily modified, engineered channel; • Within Outer Thames SPA; • Hydraulically linked to Breydon Water (SSSI, Ramsar); • Numerous existing discharges; • One licensed abstraction identified; no unlicensed/unregulated abstractions identified; • WFD waterbody supports aquatic ecology; and • Some contamination but WFD quality status generally good / moderate.	Very High (size, linked to international designations)
River Bure	• Main River; • Large tidal watercourse;	Very High (size, linked to international designations)

Receptor	Key Features	Importance / Sensitivity
	• WFD Moderate status (objective Moderate by 2027); • Within Outer Thames SPA; • Hydraulically linked to Breydon Water (SSSI, Ramsar); • No licensed or unlicensed abstractions identified; • WFD waterbody supports aquatic ecology; and • Some contamination but WFD water quality generally good / moderate.	
Breydon Water	• SSSI, SPA, Ramsar; and • Intertidal mud-flats, some saltmarsh.	Very High (international designations)
Great Yarmouth coast / North Sea	• Open sea; • Bathing water protected areas; • Wild birds and species protected areas; • WFD Moderate (physico-chemical); • Chemical status generally good; and • Within Outer Thames estuary SPA.	Very High (international designations, bathing waters)

Receptor	Key Features	Importance / Sensitivity
Ditches and watercourses within marshland upstream of Great Yarmouth (south of Breydon Water)	• Small watercourses; • Managed watercourses - likely some pumping, sluice gates & modifications; • WFD Moderate (overall waterbody catchment); • Hydraulically linked to Breydon Water (SSSI, Ramsar); and • Likely some agricultural function.	Medium (size, link to international designated sites but not directly providing key features, WFD status)
Ditches and watercourses within urban area of Great Yarmouth	• Small watercourses; • Urban drains; • Likely engineered watercourses; • WFD Moderate (overall waterbody catchment), but locations suggest watercourses will receive urban discharges; • Urban drainage; and • Some local amenity value (parks etc.).	Low (size, potential contamination, likely modification)
Surface water ponds located within the MIND Centre and Grounds directly affected by the Scheme	• Small standing waterbodies; • Likely man-made features;	Medium (size, potential contamination, likely modification, amenity value)

Receptor	Key Features	Importance / Sensitivity
	• WFD Moderate (overall waterbody catchment); • Unlikely to support any significant or sensitive aquatic species but some ecological interest; • Likely to receive urban drainage; and • Some amenity value to community garden.	

Table 11.11: Sensitive Groundwater Receptors

Receptor	Key Feature	Importance / Sensitivity
Crag Group Aquifer (GB0501G400300)	• Principal Aquifer; • Shallow groundwater level; • No known biodiversity significance supported by local aquifer; • Hydraulic connectivity with overlying superficial deposits (regionally). • Hydraulic connectivity with the River Yare; • Groundwater Vulnerability: Major Aquifer High; • Groundwater Nitrate Vulnerable Zone; and	High (Principal Aquifer supporting supply on a regional scale)

Receptor	Key Feature	Importance / Sensitivity
	• WFD Groundwater – Quantitative and Chemical status 'poor'.	
North Denes Formation (GB0501G400300)	• Secondary A Aquifer: may form a contiguous component of local aquifer system designated under the WFD (as being 'Poor' status); • Shallow groundwater level; • Hydraulic connectivity with the River Yare (locally) and underlying Crag Group Aquifer (regionally); • Groundwater vulnerability: Major Aquifer High; • Groundwater Nitrate Vulnerable Zone; and • May provide support to abstractions in the local area of the Scheme (within 2.0km)	Medium (Secondary A Aquifer supporting supply on a local scale)

Receptor	Key Feature	Importance / Sensitivity
	however, considered poor quality due to saline intrusion and contamination from surface.	
Water Users (licensed)	• Non-potable, industrial supplies within 2.0km of the Principal Application Site.	Medium (non-potable and low yielding supplies)
Water Users (unlicensed)	• Presumed shallow aquifer; • No information on purpose of supply or yield – assumed potable as worse-case; and • Unlicensed abstractions can take up to 20m^3/d.	High (may provide potable supply)
Notes: There is limited evidence available concerning the sensitivity of local abstractions. The available evidence on local abstraction sensitivity is consistent with a moderate sensitivity to water quality and water quantity related impacts, respectively. The available evidence suggests moderate sensitivity to water quality and water quantity related impacts respectively. Baseline sensitivity assigned conservatively.		

11.7 Establishing the Scenario for Assessment

Construction Phase

11.7.1 Details of construction activities and temporary works are provided in Chapter 2: Description of the Scheme but aspects most relevant to the water environment are summarised below:

- Construction of cofferdams to facilitate in-channel works within the River Yare. The cofferdams will eventually be integrated into the permanent works bridge foundation and have therefore been assessed under operation phase effects. Temporary works associated with the construction of the bridge substructures will occur within the cofferdams. No dredging is proposed.
- Cofferdam piles founded in groundwater aquifers.
- Temporary groundwater control systems and associated water disposal arrangements to facilitate the construction of the bascule pit cofferdams.
- Creation of two main construction compounds to facilitate the construction of the Scheme. One would be located on the east side of the River Yare on land between the river and South Denes Road, immediately north of the new crossing. The other would be located on the west side of the river on land between William Adams Way and Queen Anne's Road, west of Suffolk Road. Following the construction of the Scheme, areas used temporarily for construction compounds would be restored to their previous condition, unless otherwise agreed with the landowner.
- Temporary drainage arrangements and temporary works associated with the IDB drains and ordinary watercourses within the Principal Application Site, such as temporary culverting or diversion to maintain existing drainage routes.
- Demolition of a number of existing residential and commercial / business properties.
- Provision of Vessel Waiting Facilities to the north and south of the new crossing, either as floating pontoons or additional fendering to the existing berths.
- The embedded mitigation measures for the construction phase will be implemented through development of the Outline CoCP (document reference 6.16). The Outline CoCP (document reference 6.16) includes details regarding the management of accidental spillages, the control of runoff from temporary construction compounds, areas of stockpiling, the

disposal of contaminated sediments, as well as information regarding training and monitoring procedures during construction. Specific mitigation measures to be implemented through the Outline CoCP (document reference 6.16) include the following:

- The use of cofferdams to exclude work areas from the main River Yare waterbody, thus reducing the risk of increased sediment loads or hazardous substances entering the main water flow;
- The use of soft start piling techniques to minimise the disturbance and subsequently mobilisation of contaminated sediment within the River Yare during construction of the bridge substructures;
- Temporary drainage arrangements will be employed to ensure existing IDB drainage routes are maintained during construction;
- The use of silt fences, silt traps, filter bunds, settlement ponds and/or proprietary units such as a 'siltbuster' to treat sediment laden water generated on site before discharge;
- Oil absorbent booms will be made available on site and deployed in the event of a significant spillage;
- Procedures to control dust and contain debris associated with demolition works;
- Temporary cut-off drains will be used uphill and downhill of the working areas to prevent clean runoff entering and dirty water leaving the working area without appropriate treatment;
- Control and treatment measures will be regularly inspected to ensure they are working effectively;
- Emergency response plans will be developed by the Contractor and spill kits made available on Site;
- Fuels and potentially hazardous construction materials will be stored in bunds that have areas with external cut-off drainage; fuel will be stored in double skinned tanks with 110% capacity;
- Fuelling and lubrication of construction vehicles and plant will generally be on hardstandings, where reasonably practical, with appropriate cut-off drainage and located away from watercourses. In the event of plant breakdown drip trays will be used during any emergency maintenance and spill kits will be available on site;

- Construction plant will be checked regularly for oil and fuel leaks, particularly when construction works are undertaken in or near the existing site waterbodies;
- Avoid pumping or similar processes of concrete over or adjacent to open water where possible and close observation to swiftly shut off any pumps if a spillage occurs;
- Waste fuels and other fluid contaminants will be collected in leak-proof containers prior to removal from construction site to an approved recycling processing facility, and
- Sewage generated from site welfare facilities will be disposed of appropriately. This may be by discharge to the foul sewer or by collection in septic tank for disposal off site.
- Cofferdam dewatering rates will be such that the spread of saline intrusion will not infringe upon the licensed abstractor zone of influence.

11.7.2 Potential impacts to the surface water ponds present within the existing MIND Centre and Grounds during construction have not been explicitly assessed as the existing ponds will be lost due to the Scheme. The effect of the loss of the ponds is assessed under operational effects.

Operational Phase

11.7.3 Chapter 2: Description of the Scheme provides full details on the operational phase. With respect to the water environment, key features of the Scheme are as follows:

- A new double-leaf bascule bridge providing an opening span to facilitate vessel movement within the river. This would include structures to support and accommodate the operational requirements of the bridge-opening mechanism, including counterweights below the level of the bridge deck. The bridge would be supported on driven piles;
- New substructures, supported by driven piles, to support the double leaf bascule bridge within the existing quays either side of the river and within the river itself, requiring new permanent “knuckle” walls, creating cofferdams in the waterway;
- Dredging may be required during operation to remove any sediment build up within the navigation channel. Any operational dredging will be incorporated into the current dredging regime along the River Yare and is not expected to significantly alter the current dredging regime;
- Associated changes, modifications and/or improvements to the existing local highway network;

- The relocation of existing allotments to compensate for an area to be lost as a result of the Scheme and other accommodation works, including those at the MIND Centre and Grounds. It is not yet established whether the new site will include replacements ponds therefore the assessment has assumed the worst-case scenario where these are not replaced;

- Changes in groundwater flows and levels as a result of increased impermeable surface, which will have an impact on the rainfall infiltration and volume of groundwater recharge to the superficial deposits and Crag Group Aquifer.

- The cofferdams have the potential to act as groundwater flow barriers and impact on groundwater quality, where the superficial deposit aquifers and the Crag Group Aquifer are considered to potentially be hydraulically connected; and

- New highway drainage. The key principles of the Drainage Strategy (Appendix 12C (document reference 6.2) are stated as follows:

<u>The western side of the Principal Application Site (the section of the Scheme due-west of the bridge mid-point)</u>

- Runoff from the western side of the Scheme will be attenuated and discharged either via gravity into the existing IDB ordinary watercourse network adjacent to the Scheme or via a pumped system into the River Yare.

- Runoff to be attenuated to as close as practical to greenfield runoff rates for the 1 in 100-year event, including climate change. Where this is not achievable, the post development runoff rates and volumes should not exceed existing scenario values. The required attenuation storage will, as a minimum, consist of an underground storage tank and a pond/wetland feature.

- Runoff will be treated before discharge. Pollution control measures currently proposed include proprietary treatment devices (vortex separator) that treat runoff that discharges into the underground storage and natural treatment in the form of wet pond/wetland feature. Penstocks are also proposed as control of spillages.

- Realignment of existing IDB watercourse and extension and/or replacement of existing culverts in the vicinity of the new roundabout.

The eastern side of the Principal Application Site (the section of the Scheme due east of the bridge mid-point)

- Runoff from the eastern side of the Scheme will be discharged into existing Anglian Water combined sewer.
- Runoff to be attenuated, via oversized pipes and/or underground storage tanks, to achieve the restricted discharge rate of 10l/s as agreed with Anglian Water.
- Runoff to be treated, via proprietary devices, before discharge into the Anglian Water combined sewer.

11.7.4 Embedded mitigation measures to be incorporated into the Scheme will include the provision of treatment of highway runoff as detailed in the Drainage Strategy (document reference 6.2, Appendix 12C). The vortex separator is effective in the removal of fine sediment, sediment-bound pollutants and hydrocarbons, whilst the pond/wetland feature is efficient in removing soluble metals as well as suspended solids. Penstocks are proposed as control of spillages and they have the potential to reduce the risk of a serious pollution incident by 60%. Due to high groundwater levels in the Principal Application Site, any drainage features will be lined where necessary to limit any infiltration of polluted runoff to the underlying groundwater.

11.8 Assessment of Effects, Mitigation and Residual Effects

Construction Phase: Surface Water Effects

Pollution of surface water due to increased generation and release of sediments and suspended solids

11.8.1 Site runoff containing elevated suspended sediment levels can result from land clearance, excavation, dewatering of excavations, stockpiles, wheel washings and movement of materials to and from the site. Abstracted water from dewatering activities may also contain elevated levels of total suspended solids. Runoff and discharge water with high sediment loads can have direct adverse effects on adjacent water bodies through increasing turbidity (thus reducing light penetration and reducing plant growth and affecting aesthetics), and by smothering vegetation and bed substrates (thus impacting on invertebrate and fish communities through the destruction of feeding areas, refuges and breeding / spawning areas). Indirect adverse effects can also be associated with suspended sediments that have inorganic or organic contaminants (e.g. heavy metals and pesticides, respectively).

11.8.2 The magnitude of the impact is likely to be most significant when working in areas adjacent to a waterbody and in periods of heavy rainfall. The impacts will be direct and temporary - water quality within the affected waterbody will improve over time and distance from the Scheme as sediments settle or are trapped by vegetation.

11.8.3 The sensitivity of the River Yare is considered to be Very High, however it is a large tidal waterbody which is subject to increased sediment levels during large tidal flows and where sediment entering the watercourse will be dispersed quickly through the tidal flow regime. Furthermore, compared to the estimated tidal prism of the estuary, which is in the order of 5 million m^3, sediment loads from runoff and discharge water are highly unlikely to be sufficient to significantly affect the intertidal regime of the system. The magnitude of change to the River Yare is therefore considered to be negligible adverse. Consequently, there is likely to be a direct but temporary effect on the River Yare, with the significance assessed as **slight adverse (not significant)**.

11.8.4 Given the distance from the Scheme, significant increases in sediment load in Breydon Water, the River Bure and the North Sea are considered unlikely. Furthermore, sediment loads are unlikely to be sufficient to impact on the characteristics and intertidal regime of these receptors and any sediments entering the main water flow are expected to disperse quickly through tidal flows. The sensitivity of Breydon Water, the River Bure and the North Sea are considered to be Very High but no change is predicted to these receptors and the likely significance of the effect will be **neutral (not significant)**.

11.8.5 Increased sediment loads entering the local watercourses/IDB drains within the urban area of Great Yarmouth adjacent to the Scheme could have a more significant impact as sediment may take longer to settle out or be dispersed through normal processes. The sensitivity of these water features is considered to be Low, but the magnitude of change is considered to be Moderate Adverse, as there is the potential for sediment to be washed into these watercourses, temporarily increasing turbidity and affecting water quality. Therefore, there is likely to be a temporary effect of **slight adverse (not significant)** on these water features.

11.8.6 Due to the distance between the Scheme and the IDB drains/watercourses located within the marshland south of Breydon Water, significant increase in sediment load in these IDB watercourses is considered unlikely as any sediments washed away from the construction site would have been settled or dispersed prior to reaching these watercourses. The sensitivity of the marshland drains/watercourses is considered to be Medium, but no change is predicted to this receptor and the likely significance of the effect will be **neutral (not significant)**.

Mitigation

11.8.7 No additional mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16).

Residual Effects

11.8.8 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Pollution to surface water due to dust and debris associated with demolition works

11.8.9 Construction activities located on site have the potential to release dust and debris that may be blown into adjacent water features. Demolition activities would pose the greatest risk by creating the greatest volumes of dust and debris. Increased dust levels in water bodies may reduce the levels of light reaching aquatic plant and animal species. Debris blown into water bodies can decrease the recreational and aesthetic quality of the waterbody. It is anticipated that measures included in the Outline CoCP (document reference 6.16) will reduce the likelihood of larger debris entering surface water, however where works take place immediately adjacent some dust is inevitable. Impacts would be direct and temporary.

11.8.10 The sensitivity of the River Yare is considered to be Very High due to the SPA status of the watercourse. However, dust and debris entering the river will be dispersed through the usual tidal flow regime and any impacts on the water quality are likely to be short term and minor. The volume of any dust and small debris entering the river is likely to be very small in comparison to the river flows (tidal prism volume approximately 5 million m^3). The magnitude of change is considered to be Negligible Adverse. Therefore, there is likely to be a direct and temporary effect on the River Yare, with the significance assessed as **slight adverse (not significant)**.

11.8.11 Given the distance from the Scheme, a significant volume of debris or dust reaching Breydon Water, the River Bure and the North Sea is considered unlikely. Furthermore, any pollutants deposited in these waterbodies would quickly disperse through tidal flows. The sensitivity of Breydon Water, the River Bure and the North Sea are considered to be Very High but no change is predicted to these receptors and the likely significance of the effect will be **neutral (not significant)**.

11.8.12 Dust and debris entering the local watercourses/IDB drains within the urban area of Great Yarmouth adjacent to the Scheme, could have a more significant impact as dust and debris entering these waterbodies will take a longer time to be dispersed. The sensitivity of these water features is

considered to be Low but the magnitude of change is considered to be Moderate Adverse, as there is the potential for dust and debris to be washed into these waterbodies, temporarily increasing turbidity and affecting water quality. Therefore, there is likely to be a temporary effect of **slight adverse (not significant)** on these waterbodies.

11.8.13 Due to the distance between the Scheme and the IDB drains/watercourses located within the marshland south of Breydon Water, a significant decrease in water quality as a result of dust and debris entering these watercourses is considered unlikely as any pollutants washed away from the construction site would have been dispersed prior to reaching these watercourses. The sensitivity of the marshland drains/watercourses is considered to be Medium. However, no change is predicted for this receptor, hence there is likely to be an effect of **neutral (not significant)** on this receptor.

Mitigation

11.8.14 No further mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16).

Residual Effects

11.8.15 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

<u>Pollution to surface water due to increased risk of accidental spillage of pollutants such as oil, fuel and concrete</u>

11.8.16 The release of hydrocarbons into on-site drainage systems or from direct runoff and infiltration to groundwater is likely to increase during the construction period due to a large number of vehicles, including heavy vehicles, accessing the site, refuelling of vehicles and plant, leakage from oil/fuel storage tanks and accidental spillages.

11.8.17 Hydrocarbons form a film on the surface of the waterbody, deplete oxygen levels and can be toxic to freshwater fish. Even at very low concentrations, the film can negatively impact on the visual appearance of the waterbody. The impact will be direct and temporary - water quality within the affected waterbody will improve over time and distance as pollutants disperse and are treated by natural processes.

11.8.18 The use of hazardous products on site can present a pollution risk because of the potential for accidental spillages, and the uncontrolled release of washdown water and runoff. If materials and activities are not stored and carried out in designated areas, runoff and washdown may enter a

waterbody, adversely affect the aquatic environment or contaminated surface and groundwater water abstractions.

11.8.19 The most common source of pollution is from concrete and cement products. These products are highly alkaline and corrosive - fish can be physically damaged and their gills blocked, and both vegetation and the bed of the receiving waterbody can be smothered.

11.8.20 During construction, there is an elevated risk of potential leaks or accidental spillage of hazardous chemicals used on site infiltrating to groundwater or migrating to nearby water bodies and resulting in an adverse impact.

11.8.21 For the most part, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the waterbody, that a significant risk of acute toxicity would arise in the receiving water. The magnitude of any impact would depend on the scale and nature of any potential incident and is therefore difficult to predict.

11.8.22 For the most part, water quality within the affected waterbody would improve over time as pollutants are dispersed and diluted. However, a significant direct spillage of a toxic substance could cause long term damage to the receiving waterbody.

11.8.23 The high flows in the River Yare mean that any contaminants entering the watercourse will be quickly diluted and dispersed although there is potential for contaminants to be transported upstream of the Principal Application Site. The River Yare is already heavily modified and, due to the current land uses and presence of existing outfalls, there already exists a reasonable potential for contamination through spillages or accidental release of hazardous substances. Effects will be temporary as the contaminants will be diluted and dispersed via natural processes. Furthermore, the embedded mitigation incorporated as part of the Outline CoCP (document reference 6.16) would reduce the likelihood and the impacts of a spillage should it occur. Therefore the magnitude of change is considered to be negligible adverse. The sensitivity of the River Yare is considered to be Very High and therefore an accidental spillage would lead to a direct and temporary effect on the River Yare of **slight adverse (not significant).**

11.8.24 Given the distance from the Scheme, contaminants entering the River Yare are unlikely to significantly reduce the water quality of the River Bure, Breydon Water and the North Sea. Furthermore, any potential effects will be temporary as the contaminants will be diluted and dispersed over time via natural tidal and fluvial processes. The sensitivity of the River Bure, Breydon Water, and the North Sea are considered to be Very High but no change is predicted to these receptors and the likely significance of the effect will be **neutral (not significant)**.

11.8.25 Contaminants or spillages entering the local watercourses/IDB drains within the urban area of Great Yarmouth adjacent to the Scheme, could have a more significant impact as contaminants may take longer to be dispersed or diluted through normal processes. However, it should be noted that the risk of pollution already exists in these waterbodies due to urban and highway runoff. The sensitivity of these water features is considered to be Low and the magnitude of change is considered to be moderate adverse. Therefore, there is likely to be a temporary effect of **slight adverse (not significant)** on these water features.

11.8.26 Due to the distance between the Scheme and the IDB drains/watercourses located within the marshland south of Breydon Water, significant reduction in water quality is considered unlikely as any spillages from the construction site would have been diluted or dispersed prior to reaching this receptor. The sensitivity of the marshland drains/watercourses is considered to be Medium, but no change is predicted to this receptor and the likely significance of the effect will be **neutral (not significant)**.

Mitigation

11.8.27 No additional mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16).

Residual Effects

11.8.28 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

<u>Impact to surface water due to discharge of abstracted water from the cofferdams</u>

11.8.29 Temporary groundwater control systems i.e. dewatering will be required to facilitate the construction of the bascule pit cofferdams, but the method of discharge of the abstracted water has yet to be determined. The abstracted groundwater will either be discharged to surface water, sewer, disposed off site or a combination of these three methods. If the water is to be discharged into the River Yare or the IDB watercourse, there may be detrimental effects on the receiving watercourse in relation to the quantity and quality of the discharges. However, it is important to note that discharges into surface waterbodies will be subject to relevant permitting and consent requirements from relevant authorities, as detailed in the Consents and Agreements Position Statement (document reference 7.3).

11.8.30 Groundwater modelling has been carried out to better quantify the impacts of the dewatering (Appendix 11F) and the model results suggest that the total abstraction rates will be in the range of 0.16l/s (0.00016m3/s) to 15.5l/s (0.0155m3/s) per cofferdam. If all abstracted water is discharged into the

River Yare, these rates are still several orders of magnitude smaller than the flow rates experienced in the River Yare. To put this into context, the 95 percentile (%) flow for the river at the Principal Application Site was estimated to be approximately 4.5m3/s and this represents the lowest flow rate in the River Yare, during periods of slack tide when tidal flows are at a minimum. Therefore, the impact of groundwater discharges on the hydrological regime of the River Yare is considered to be **negligible**.

11.8.31 The quality of the discharge water should reflect the quality of groundwater across the Principal Application Site, in which the water quality sampling shows EQS exceedances in Arsenic, heavy metals and PAHs. These contaminants and exceedances are also found in the leachate sediment samples collected in the River Yare. Groundwater quality sampling also suggests the influence of saline intrusion in groundwater across the Principal Application Site, indicating hydraulic connection between the local groundwater system and the River Yare. Based on the above, it is expected that the water quality of the groundwater discharge would be similar to that in the River Yare. As the discharge volume is very small any differences will not affect the water quality in the river.

11.8.32 The sensitivity of the River Yare is considered to be Very High but the magnitude of change to the river as a result of groundwater discharge is considered to be no change. Consequently, there is likely to be a direct but temporary effect on the River Yare, with the significance assessed as **neutral (not significant)**.

11.8.33 The rates and volume of groundwater discharge are considered too small to influence the natural tidal and fluvial processes of Breydon Water, the River Bure and the North Sea, and given the distance from the Scheme, any contaminants from the discharge water would be sufficiently diluted and dispersed before reaching these waterbodies. The sensitivity of Breydon Water, the River Bure and the North Sea are considered to be Very High but no change is predicted to these receptors and the likely significance of the effect will be **neutral (not significant)**.

11.8.34 Given the ephemeral nature of the IDB watercourses adjacent to the Scheme, groundwater discharge could have a more significant impact on these waterbodies but the rates and volume are still considered too small to significantly alter the fluvial processes of these watercourses. Furthermore, any potential effects will be temporary and the hydrological regime of these watercourses will return to its current state when dewatering and discharge ceases. The high groundwater levels in the Principal Application Site means the IDB watercourse network adjacent to the Scheme is likely to be in hydraulic connection to the local groundwater and the watercourses are expected to receive groundwater recharge especially during the winter months. Hence groundwater discharge is not expected to significantly alter the water quality in these watercourses. Furthermore, the risk of pollution

already exists in these water features due to existing highway discharges, therefore any contaminants from the discharge water are not expected to cause significant deterioration in water quality. The sensitivity of the IDB watercourses adjacent to the Scheme is considered to be Low and the magnitude of change is considered to be minor adverse. Therefore, there is likely to be a temporary effect of **neutral (not significant)** on these water features.

11.8.35 Similarly, the rates and volume of groundwater discharge are too small to significantly influence the hydrological regime of the wider IDB catchment. Given the distance from the Scheme, any contaminants from the discharge water would be sufficiently diluted and dispersed before reaching these waterbodies. According to the WLMP, the marshland south of Breydon Water is already prone to pollution from saline intrusion, hence elevated salinity in the discharge water is not expected to significantly modify the water quality in the network of dykes and drains within the marshland. The sensitivity of the marshland drains/watercourses is considered to be Medium and the magnitude of change is considered to be no change. Therefore, there is likely to be a temporary effect of **neutral (not significant)** on these water features.

11.8.36 The groundwater modelling assessment (Appendix 11F) shows that the dewatering will have a local influence on groundwater flows, within a zone of approximately 400m, towards the cofferdam. Impacts to flows in the River Yare have been assessed as a reduction in baseflow of between 6 and 31 l/s and losses due to induced flow into shallow geological formations of up to 0.1 Ml/day. These are both insignificant compared with the flows in the River Yare as described above. The sensitivity of the River Yare is considered to be Very High but the magnitude of change to the river as a result of groundwater discharge is considered to be no change. Consequently, there is likely to be a direct but temporary effect on the River Yare, with the significance assessed as **neutral (not significant)**.

11.8.37 The effects on groundwater flows may be more significant for the local IDB drains close to the Principal Application Site as the dewatering represents a greater proportion of the flow. However, these drains are situated in an urban environment, with site observations indicating they are already ephemeral with levels and flows influenced by tide levels and local urban runoff. It is therefore unlikely the dewatering will have a significant effect on then hydrological regime in these watercourses. The sensitivity of these water features is considered to be Low and the magnitude of change is considered to be minor adverse. Therefore, there is likely to be a temporary effect of **neutral (not significant)** on these water features.

11.8.38 The modelling showed the dewatering has a minimal effect on groundwater levels further from the Principal Application Site. Hence no change is predicted to Breydon Water, the River Bure and the North Sea, which have a

Very High sensitivity, and the wider IDB catchment, and there is likely to be an effect of **neutral (not significant)** on these waterbodies.

Mitigation

11.8.39 No further mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16).

Residual Effects

11.8.40 There are no significant residual effects (where significance of effect is assessed as being moderate or greater) on the surface water receptors.

Temporary alterations to the hydrological/morphological regime of the ordinary watercourses and IDB drains, such as changes to the flow path and rate associated with the construction of new watercourses and culverts as part of the proposed Drainage Strategy

11.8.41 During construction the existing ditches close to William Adams Way may be temporarily diverted, culverted or blocked. In line with usual good practice, appropriate drainage would be maintained at all stages of construction, with temporary diversions, culverts or over pumping used as required. It is unlikely the works will have any significant effect on the hydrological regime, as existing drainage routes and outfall locations will be maintained. The works may have some temporary impact on the morphological quality of these ditches, but they are assessed of Low sensitivity, with significant culverting already present. The magnitude of change to these watercourses, is considered to be moderate adverse. Therefore, there is likely to be a direct and temporary effect of **slight adverse (not significant)** on these water features and this is considered not significant.

11.8.42 No direct works are proposed in the IDB drains/watercourses located within the marshland south of Breydon Water, which have a Medium sensitivity. As such, no change is predicted to these surface water features and there is likely to be an effect of **neutral (not significant)** significance on this receptor.

Mitigation

11.8.43 No additional mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16).

Residual Effects

11.8.44 As no additional mitigation has been identified at this stage residual effects are assessed to be the same as those described above.

Construction Phase: Groundwater Effects

Intrusive works and the impacts to groundwater quality

11.8.45 The Scheme directly overlays, and will therefore directly interact with, superficial deposits hosting Secondary A Aquifers deemed to have medium sensitivity. Additionally, and for the most part, the superficial deposits have low permeability characteristics. Therefore, if the superficial deposits are subject to a significant quality related impact, any effect is likely to be highly constrained both spatially and vertically (with depth), as the permeability of these materials is likely to be low to moderate.

11.8.46 The superficial deposits are directly underlain by the Crag Group Principal Aquifer which has a high importance. The Crag Group Aquifer is heterogenous in nature, as it contains fine to medium grained silty sand with gravel and occasional silty clay layers, and therefore has a variable permeability from low to high.

11.8.47 Piling through multiple geologies has the ability to create pathways for pollutants to migrate from one aquifer to another. Marginal levels of soil contamination have been identified in the ground investigation completed between 18 September 2017 and 27 March 2018 undertaken by Norfolk Partnership Laboratory on behalf of the Applicant. A Piling Works Risk Assessment has been completed as part of Chapter 16: Geology and Soils and Appendix 16D (document reference 6.16) which considers these risks.

11.8.48 Chapter 16: Geology and Soils Appendix 16D Piling Works Risk Assessment discusses the different piling techniques although it is likely that driven piles will be used. Driven piles have been considered the most appropriate foundation solution throughout the Scheme. The primary reason is driven piles are the most efficient solution for the fine to medium dense sand ground conditions present across the Principal Application Site. The use of driven piles reduces the geotechnical risks associated with ‘blowing sands’ and the risks associated with containing and disposing of potentially contaminated arisings and bentonite associated with bored piles.

11.8.49 During construction of piled foundations and groundwater dewatering, water pumped from excavations may introduce, or laterally expand any present, saline groundwater to fresh groundwater sources.

11.8.50 For the groundwater quality assessment, the sensitivity of the Crag Group Aquifer and the water users are considered to be high and the sensitivity of the superficial deposits is medium. The change for the superficial deposits aquifer is considered to be **no change** due to the existing saline groundwater quality (Section 11.5). Therefore, there is likely to be a direct, permanent long-term **neutral (not significant)** effect on the superficial deposits aquifer. The magnitude of change for the Crag Group Aquifer and

water users is **moderate** and a likely significance of effect will be **moderate adverse (significant)** as dewatering activities could expand and/or introduce saline groundwater to the Principal Aquifer with its water users. This does not take into account the mitigation measures discussed in the Outline CoCP. The Groundwater Modelling Study of the Bascule Pit Groundwater Control System (Appendix 11F, document reference 6.2) quantifies the impacts to the Principal Aquifer and local water users and shows that the dewatering will have a local influence on groundwater within a zone of approximately 400m away from the cofferdam. This shows no dewatering impacts are likely to occur to the nearest water user (approx. 0.70km from the Principal Application Site (Section 11.5.65)) but the spread of saline water 400m inland cannot be excluded at this stage and therefore requires mitigation measures to be considered at detailed design and are discussed in the Outline CoCP (document reference 6.16). After implementation of these mitigation measures the magnitude of impact is expected to be **minor adverse (not significant).**

Mitigation

11.8.51 No further mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16).

Residual Effects

11.8.52 As no additional mitigation has been identified at this stage residual effects are assessed to be the same as those described above.

<u>Intrusive works and the impacts to shallow groundwater levels and flow</u>

11.8.53 The Scheme directly overlays, and will therefore directly interact with, superficial deposits hosting Secondary A Aquifers deemed to have medium sensitivity. Additionally, and for the most part, the superficial deposits have low permeability characteristics. Therefore, if the superficial deposits are subject to a significant flow related impact, any effect is likely to be highly constrained both spatially and vertically (with depth), as the permeability of these materials is likely to be low to moderate.

11.8.54 The superficial deposits are directly underlain by the Crag Group Principal Aquifer which has a high importance. The Crag Group Aquifer is heterogenous in nature and is variable in permeability at different scales.

11.8.55 Below ground excavations are likely to extend beneath groundwater levels, based on the groundwater level monitoring recorded to date within the superficial deposits and Crag Group Aquifer (Section 11.5).

11.8.56 Modifications to groundwater conditions (locally), including groundwater level and flow, by construction dewatering may potentially reduce the availability of groundwater to local abstractor receptors that are assigned a high value of sensitivity. The Groundwater Modelling Study of the Bascule Pit Groundwater Control System (Appendix 11F document reference 6.2) quantifies the impacts to the Principal Aquifer and local water users and shows that the dewatering will have a local influence on groundwater within a zone of approximately 400m away from the cofferdam. This shows no dewatering impacts are likely to occur to the nearest water user (approx. 0.70km from the Principal Application Site (Section 11.5.65)).

11.8.57 The magnitude of change for the superficial deposits, which are classified as having a medium sensitivity, is considered to be **minor adverse**. There is likely to be a direct and temporary effect on the Secondary A Aquifers, with a significance assessed as **slight adverse (not significant)**.

11.8.58 The magnitude of change for the Crag Group Aquifer, which is classified as having a high sensitivity, is considered to be **minor adverse**. There is likely to be a local direct and temporary effect on the Principal Aquifer, with a significance assessed as **slight adverse (not significant)**.

11.8.59 The magnitude of change for the local water users, which is classified as having a high sensitivity, is considered to be **negligible**. There is an unlikely **neutral (not significant)** significance of effect on local water users.

Mitigation

11.8.60 No further mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Outline CoCP (document reference 6.16).

Residual Effects

11.8.61 As no additional mitigation has been identified at this stage residual effects are assessed to be the same as those described above.

<u>Pollution to Shallow Groundwater Receptors via Drainage Construction</u>

11.8.62 Pollution of shallow groundwater, where localised perched aquifers may be present, will not occur during operation of attenuation ponds and swales as these are to be lined where necessary and not discharge to ground. During the construction phase spills to these below ground features could occur and a hydraulic linkage to groundwater could exist.

11.8.63 The attenuation pond proposed on the western arm of William Adams Way roundabout will be lined where necessary to ensure minimal interference with the current groundwater regime and accordingly a magnitude of change prior to mitigation is considered minor adverse in respect to both

construction and operational phases. This results in a respective minor adverse (not significant) effect prior to the implementation of mitigation measures.

11.8.64 Proposed filter drains within the area of William Adams Way Roundabout will also be lined where necessary to ensure minimal interference with the current groundwater regime. A magnitude of change prior to mitigation is considered **minor adverse** and a **minor adverse (not significant)** effect is assigned prior to the implementation of mitigation measures.

Mitigation

11.8.65 No further mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures, that will be implemented through the Outline CoCP (document reference 6.16), and the design measures as listed in the Drainage Strategy (Appendix 12C, document reference 6.2).

Residual Effects

11.8.66 As no additional mitigation has been identified at this stage residual effects are assessed to be the same as those described above.

Operational Phase: Surface Water Effects

Pollution to surface water due to contaminants contained within routine road runoff

11.8.67 Surface water runoff has the potential to contain silts and hydrocarbons that are washed off hard paved areas and vehicular areas. These can increase water turbidity, deplete oxygen levels and be toxic to the aquatic environment. Uncontrolled discharge via infiltration to ground can also cause permanent deterioration of groundwater quality.

11.8.68 Pollution of waterbodies from surface water runoff containing silts and hydrocarbons is considered a direct permanent impact. Although pollutants can be treated by natural processes in the waterbody the absence of adequate mitigation would result in a continuous discharge of polluting substances to waterbodies.

11.8.69 The Scheme will not lead to any significant increase in highway discharges where the Annual Average Daily Traffic (AADT) traffic flow remains in the same category used in the HAWRAT assessment tool, the lowest range, ≥ 10,000 to < 50,000.

11.8.70 As discussed in Section 11.4, the HAWRAT assessment (Appendix 11D, document reference 6.2) has been completed to investigate the potential

impacts of discharging into the IDB watercourse network adjacent to the Scheme and into the River Yare.

11.8.71 Due to the ephemeral nature of the IDB watercourse, there is insufficient dilution to pass HAWRAT without active mitigation. With the incorporation of the vortex separator as pollution control, the Scheme would pass the assessment of sediment-bound pollutants, but would still fail the assessment of acute impacts of Copper and Zinc due to the limited capability of the vortex separator to remove soluble metals. However, it is important to note that the assessment assumed the worst case whereby the entire western part of the Scheme was assessed to contribute to the underground storage via the vortex separator. It is understood that a proportion of the Scheme would discharge into a wet pond, which has the potential to remove up to 50 - 80% of soluble heavy metals. Furthermore, it has been confirmed through CCTV survey that the majority of the existing highway in the vicinity of the Principal Application Site drains into the network and consultation with the IDB has confirmed that no known treatment measures are incorporated into the existing system. Given the risk of pollution already exists due to existing highway discharges, runoff from the Scheme is unlikely to cause significant deterioration in water quality of the IDB drains, even if runoff is discharged untreated (which is not proposed). The drained area at the point of discharge represents a very small proportion of the wider IDB catchment (less than 2%) therefore these discharges are highly unlikely to have a significant effect on the overall water quality. Consultation with the IDB and the Environment Agency has confirmed that the effects to water quality in these watercourses is unlikely to be a particular concern in respect to the WLMP or the WFD. Based on the above, it is considered that the magnitude of change to these watercourses, which have a Low sensitivity, is negligible adverse and there is likely to be a direct effect of neutral (not significant) on these water features.

11.8.72 Contaminants released into the watercourses in the vicinity of the Scheme could be transported downstream to impact on the water quality of drains and dykes within the marshland south of Breydon Water. Given the size of the catchment, the contaminants would have been sufficiently diluted and dispersed before reaching these watercourses, and it is unlikely the discharges would have any significant effect on the water quality compared with current discharges from the wider urban area. The sensitivity of the marshland drains/watercourses is considered to be Medium, but no change is predicted to these surface water features and there is likely to be an effect of neutral (not significant).

11.8.73 With the option of discharging into the River Yare, the Scheme would pass the HAWRAT assessment without active mitigation due to the significant dilution capacity of the waterbody. It is anticipated that the dilution capacity of the river would be significantly greater than that assumed in the HAWRAT assessment, due to tidal flows which were not considered in the

assessment. Highway runoff discharges from the Scheme represent a very small proportion of the flow in the River Yare and will therefore not have any notable effect on existing pollutant concentrations, particularly with pollution control measures are to be implemented as part of the Scheme Drainage Strategy (Appendix 12C, document reference 6.2). Therefore, it is considered that the magnitude of change to the River Yare, which have a Very High sensitivity, is no change and there is likely to be a direct effect of neutral (not significant) on this receptor.

11.8.74 Given the distance from the Scheme, contaminants entering the River Yare are unlikely to significantly reduce the water quality of the River Bure, Breydon Water and the North Sea. The sensitivity of these receptors is considered to be Very High but no change is predicted and therefore there is likely to be an effect of neutral (not significant) on these waterbodies measures.

Mitigation

11.8.75 No additional mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Drainage Strategy (Appendix 12C, document reference 6.2).

Residual Effects

11.8.76 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

<u>Pollution to surface water due to accidental spillages and subsequent discharges of contaminants through road drainage systems.</u>

11.8.77 The mechanisms for potential contamination through spillage is the same as for pollutants contained in routine road runoff. However, spillage risks tend to be associated with acute pollution (short-term adverse) rather than accumulation over time. Risks of contamination through spillage has been assessed using the HAWRAT assessment tool (Appendix 11D, document reference 6.2).

11.8.78 The DMRB recommends that an annual probability of a serious pollution incident occurring of less than 1% would be acceptable. The results of the HAWRAT assessment indicate an annual probability of 0.035% without active mitigation, which is below this threshold.

11.8.79 Although the estimated spillage risk is below the DMRB threshold, it is considered good practice to incorporate mitigation measures of spillage containment. The use of penstocks has been proposed as part of the Drainage Strategy (Appendix 12C, document reference 6.2) to control

spillage and this has the potential to reduce the risk by 60%, which subsequently reduces the annual probability of a serious pollution incident to 0.014%.

11.8.80 The sensitivity of the smaller watercourses in the immediate area of the Scheme is considered to be Low, and the magnitude of change is considered to be negligible adverse. Therefore, there is likely to be an effect of neutral (not significant) on these watercourses.

11.8.81 Contaminants released into the watercourses in the vicinity to the Scheme could be transported downstream to impact on the water quality of drains and dykes within the marshland south of Breydon Water, which have a Medium sensitivity. However, spillages are only intermittent and therefore there would be recovery over time. Furthermore, the contaminants would be sufficiently diluted before reaching these watercourses. Hence significant reduction in water quality is not expected. Therefore, no change is predicted to these surface water features and there is likely to be a neutral (not significant) effect.

11.8.82 The magnitude of change to the River Yare, which have a Very High sensitivity, is considered to be negligible adverse. Therefore, there is likely to be an effect of slight adverse (not significant) on this waterbody.

11.8.83 Given the distance from the Scheme, contaminants from spillages entering the River Yare would be sufficiently diluted and dispersed via natural tidal and fluvial processes prior to reaching Breydon Water, the River Bure and the North Sea. The sensitivity of these receptors is considered to be Very High but no change is predicted and therefore there is likely to be a **neutral (not significant)** effect on these receptors.

Mitigation

11.8.84 No further mitigation or enhancement measures have been identified in addition to the embedded mitigation measures that will be implemented through the Scheme Drainage Strategy (Appendix 12C (document reference 6.2)).

Residual Effects

11.8.85 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

<u>Pollution to surface water due to mobilisation of contaminated sediments</u>

11.8.86 Increased scouring and erosion due to the flow constriction caused by the bridge substructures has the potential to mobilise sediment and historic contaminants where present. Contaminated sediment, if released into the waterbody, has potential to be transported both upstream and downstream

through the tidal and fluvial flows. Within the waterbody the effects will be temporary however if contaminated sediment is deposited in sensitive areas contamination has the potential to build up over time. The extent and nature of future deposition has been assessed through hydraulic modelling, which considers the expected changes in flow regime and subsequently the potential movement of disturbed sediment and contaminants during the operational phase of the Scheme.

11.8.87 Heavy metals absorbed to sediment particulates, which largely consist of inorganic material (such as found in the river sampling) are more easily re-dissolved when the sediment is disturbed than in sediments constituted with a higher level of organic matter. Heavy metals bound to the sediments are prone to redissolution and easier transport if the sediments become resuspended in the water column. Metals may be transported greater distances in water currents when re-dissolved than when in particulate form. Dissolved heavy metals may thus be subject to greater dilution and eventual dispersion if retained within the water column.

11.8.88 The sediment transport assessment (Appendix 11C, document reference 6.2) has shown that the impacts of the Scheme on the sediment transport regime in the estuary are local, creating some areas of additional sediment erosion and deposition near the Principal Application Site. Additional erosion is observed around the bridge substructures, where disturbed sediments are re-suspended in the water column but the majority of which are transported short distances up and downstream to deposit along the quay walls near the Principal Application Site. Furthermore, the additional volume of disturbed sediments (in the order of 17,500m^3 for a normal tidal event) represents a very small proportion (approximately 0.3%) of the flow i.e. the tidal prism of the estuary. Any contaminants released will be quickly dispersed and diluted through the natural tidal flow regime. The effects will be similar to dredging operations which already take place. Sediment sampling undertaken as part of the ground investigations generally shows marginal EQS exceedances (less than one order of magnitude above the screening values) and the WFD data for the River Yare indicates that the current water quality is good, which suggests contaminants are not significantly affecting water quality at present and the waterbody has capacity for a temporary increase in contamination levels without exceeding the EQSs. The release of sediment bound contaminants is therefore not anticipated to cause significant deterioration in the water quality in the River Yare. The sensitivity of the river is considered to be Very High and the magnitude of change is considered to be Negligible Adverse. Therefore, there is likely to be a direct effect on the River Yare of **slight adverse (not significant).**

11.8.89 The results from the sediment transport assessment (Appendix 11C, document reference 6.2) suggest that there are changes to the hydromorphogical regime along the engineered section of the River Yare

channel but the impacts are local and do not extend downstream to the North Sea or upstream to impact on Breydon Water or the River Bure. Given the volume of disturbed sediments is only marginal compared to the tidal flows in the estuary, any contaminants released into the water column will be sufficiently diluted or dispersed prior to reaching these receptors. Therefore, the magnitude of change to Breydon Water, the River Bure and the North Sea, which have a Very High sensitivity, is considered to be negligible adverse and there is likely to be an effect of **slight adverse (not significant)** on these receptors.

Mitigation

11.8.90 No additional mitigation or enhancement measures have been identified at this stage.

Residual Effects

11.8.91 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Alterations to the tidal/hydromorphological regime of the River Yare, such as changes to the tidal prism and erosion, deposition and channel migration processes associated with channel modifications and in-channel structures

11.8.92 The Scheme includes a new crossing of the River Yare and permanent narrowing of the channel. A sediment transport assessment, (Appendix 11C, document reference 6.2) which incorporates a sediment model, has been completed to investigate the potential change in tidal and hydromorphological regime of the River Yare as a result of the Scheme (Appendix 11C, document reference 6.2).

11.8.93 The results of the assessment suggest that there is negligible change (< 0.1%) in the tidal prism of the estuary post-development. There is also negligible change in the Dronkers tidal asymmetry ratio indicating the Scheme does not alter the estuary type which has been shown to be ebb dominant, i.e. there is net export of sediment from the system. As shown in Plates 11.11 and 11.12, the Scheme has limited impacts on the water level at the Principal Application Site for both the everyday spring and neap tide events. The water level difference at the Principal Application Site is less than 0.15m and 0.1m for the spring and neap tides, respectively. As expected, the effects of the Scheme on water levels at locations up and downstream of the Principal Application Site, such as Breydon Water and the harbour mouth are also negligible. The reason for this is that the area taken up by the bridge substructures is negligible compared to the volume of water that transits through the estuary.

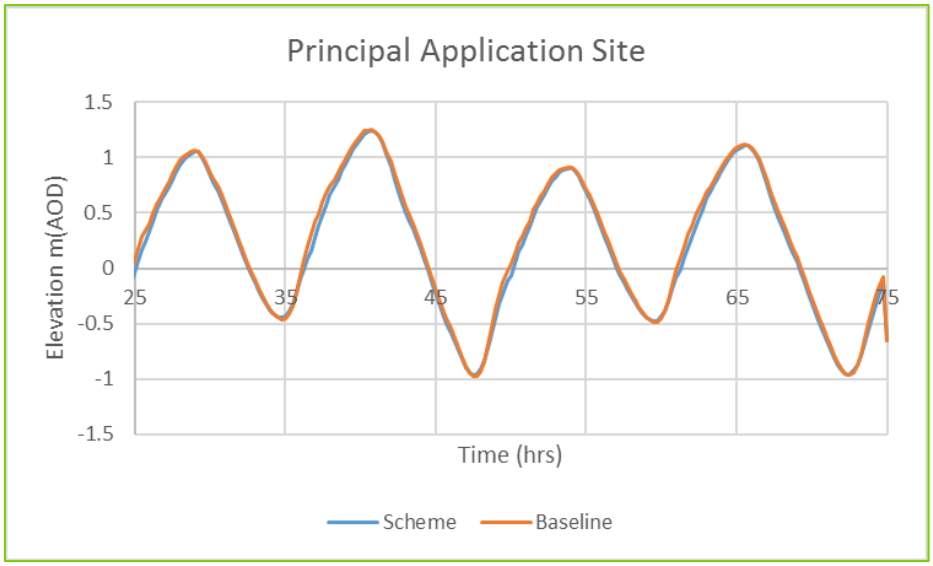


Plate 11.11: Comparison of water level between the baseline and Scheme scenarios at the Principal Application Site during the spring tide event

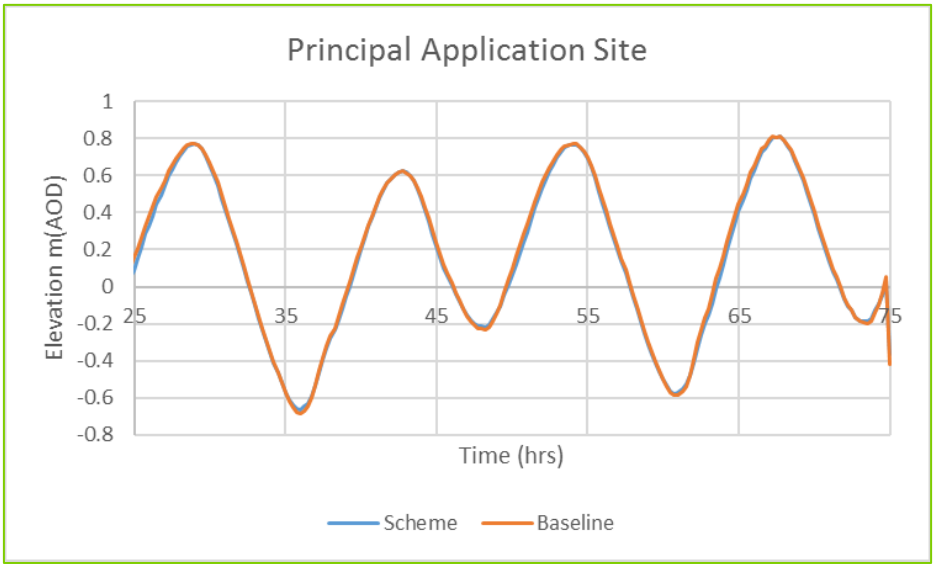


Plate 11.12: Comparison of water level between the baseline and Scheme scenarios at the Principal Application Site during the neap tide event

11.8.94 The results of the sediment transport assessment (Appendix 11C, document reference 6.2) show that the Scheme locally increases the velocity magnitude at the Principal Application Site for both the spring and neap tide events due to the constriction caused by the bridge substructures. This locally increases the scour in the centre of the channel and the eroded material is typically deposited along the quay walls adjacent to the Principal Application Site where velocity is decreased. During the neap tide there is a negligible change in velocity, bed shear stress and erosion/deposition rates in Breydon Water, Haven Bridge and the harbour entrance. Results from the spring tide simulations suggest there is a small change in scour rates at

Haven Bridge which causes a local change in the erosion and deposition pattern around the bridge area, but limited change is predicted in Breydon Water and at the harbour entrance.

11.8.95 Plate 11.13 illustrates the changes in areas of erosion and deposition caused by the Scheme during the spring tide events, where red is showing increased erosion, blue is showing increased deposition and green is showing negligible change. It can be seen that the main impacts are localised and generally contained within 500m up and downstream from the Principal Application Site. The maximum (worst case) scour volume around the bridge substructures was estimated to be in the order of 17,500m^3 for the normal tidal event and the majority of the scoured materials are shown to deposit near the Principal Application Site. There is increased deposition near the quay walls at Haven Bridge, which is likely to be from the small amount of additional scour at the Haven Bridge. There is no net change in sediment volume in the channel, meaning the Scheme will not impact on the volume of dredged material, but may alter the locations where dredging is required. As shown in Plate 11.13, the Scheme has negligible impact on the morphological regime in Breydon Water.

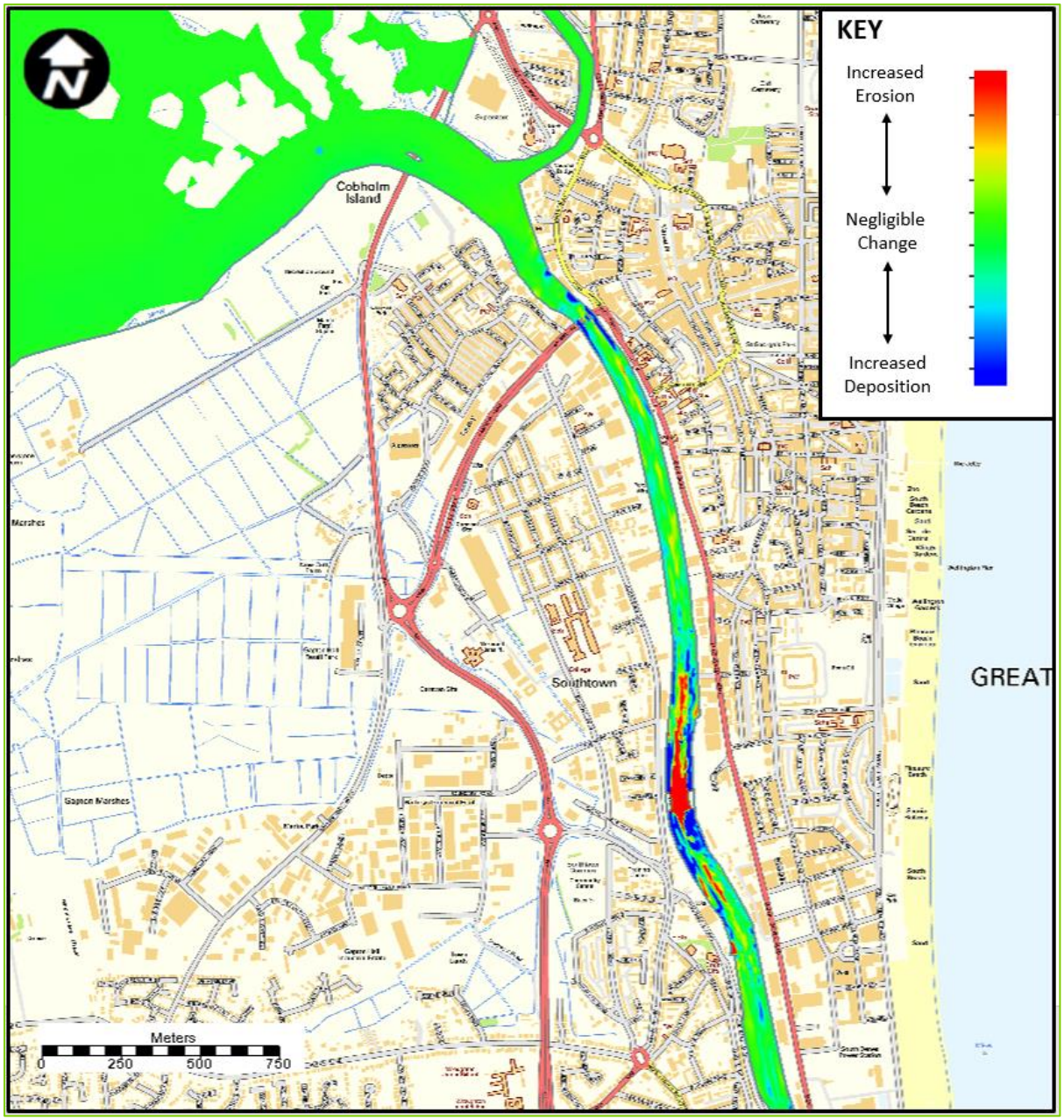


Plate 11.13: Changes in the areas of erosion and deposition caused by the Scheme during the spring tide event

11.8.96 The model results suggest that during an extreme event, the velocity magnitude further increases around the Principal Application Site due to the presence of the bridge substructures as the estuary experiences a higher ambient velocity than during an everyday tidal event. This in turn increases the instantaneous scour near the Principal Application Site for the short period over which the extreme tide occurs. However, the results show that the impacts on erosion/deposition elsewhere are negligible.

11.8.97 In conclusion, the sediment transport assessment (Appendix 11C (document reference 6.2)) has shown that the presence of the new crossing and the permanent narrowing of the River Yare due to the bridge substructures will increase the scour and deposition close to the Principal Application Site. The assessment has shown there are changes to the erosion/deposition pattern in the engineered channel up to Haven Bridge, however the changes do not extend downstream to the harbour mouth or upstream to impact on Breydon Water. Whilst there are slight changes in velocity magnitude (and subsequent erosion) at Haven Bridge the main impact is local to the Principal Application Site. The results show that flow velocities, and erosion, are lower between the two bridges with no significant change resulting from the Scheme. The Scheme is therefore not considered to lead to any significant cumulative hydromorphological impact through the affected reach. The Scheme is shown to have negligible impacts on the tidal regime of the estuary.

11.8.98 Based on the above, the magnitude of change to the River Yare, which has a Very High sensitivity, is considered to be minor adverse. Therefore, there is likely to be a direct **moderate adverse (significant)** effect on the River Yare.

11.8.99 For Breydon Water and the River Bure, which have a Very High sensitivity, the magnitude of change is considered to be negligible adverse. Therefore, there is likely to be an effect of **slight adverse (not significant)** on these receptors.

Mitigation

11.8.100 No additional mitigation or enhancement measures have been identified at this stage.

Residual Effects

11.8.101 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

<u>Alterations to the hydrological/morphological regime of the ordinary watercourses and IDB drains, such as changes to the flow path and rate associated with the new watercourses and culverts constructed as part of the proposed drainage strategy</u>

11.8.102 Existing ditches close to William Adams Way will be realigned and culverted. Highway runoff will be attenuated therefore no significant change in flows entering the watercourses is expected. Thus, no significant effect on the hydrological regime is expected. Increased lengths of culvert and new outfalls into the ditches can lead to some detriment in the morphological quality of the watercourses; however, the ditches are already culverted in

many places and form part of urban and highway drainage infrastructure. The sensitivity of these surface water features is considered to be Low, and the magnitude of change is considered to be negligible adverse. Therefore, there is likely to be a direct effect of **neutral (not significant)** on these watercourses.

11.8.103 No direct works are proposed in the IDB drains/watercourses located within the marshland south of Breydon Water. As such, no change is predicted to these surface water features and there is likely to be a **neutral (not significant)** effect.

Mitigation

11.8.104 No additional mitigation or enhancement measures have been identified at this stage in addition to the embedded mitigation measures that will be implemented through the Drainage Strategy (Appendix 12C, document reference 6.2).

Residual Effects

11.8.105 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Loss of standing water within the MIND Centre and Grounds due to development of the Scheme

11.8.106 A number of small surface water ponds located within the MIND Centre and Grounds, north of William Adams Way, will be removed or disturbed as a result of the development of the Scheme. These surface water features are largely man-made and are, at present, susceptible to pollution from drainage and runoff from roads/developed areas. However, they have amenity value to the local community and consultation with the occupants suggested they do support local wildlife. The sensitivity of these surface water ponds is considered to be Medium, and the magnitude of change is considered to be Major Adverse, therefore there is likely to be a direct **large adverse (significant)** effect on these receptors. Whilst the impacts are large on the ponds themselves, they are insignificant to the overall catchment. Therefore, this does not reflect the significance of effect on the catchment.

Mitigation

11.8.107 No additional mitigation or enhancement measures have been identified.

Residual Effects

11.8.108 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Operational Phase: Groundwater Effects

Impacts to shallow groundwater flow and quantity as a result of intrusive works undertaken during construction phase

11.8.109 The below ground excavations and cofferdams are likely to extend beneath groundwater levels, based on the groundwater level monitoring recorded to date within the superficial deposits (Section 11.5). The cofferdams will be water-proofed and so will the proposed drainage structures.

11.8.110 Groundwater mounding effects could arise on the hydraulically upgradient side of the cofferdam. This could lead to groundwater rise and potentially groundwater emergence. Due to the size of the cofferdam the magnitude impact of groundwater mounding is anticipated to be negligible**.** Therefore, there is likely to be a direct and permanent **negligible (not significant)** effect on the Secondary A aquifers, Principal aquifer and local water users.

Impacts to groundwater recharge and flow as a result of intrusive works undertaken during construction phase

11.8.111 The source of local groundwater recharge to superficial deposits is predominantly from rainfall. The variable lithology of the superficial deposits presents an inconsistent multi-layered aquifer and where clay occurs, this will restrict groundwater recharge (vertically and horizontally) locally to the underlying Crag Group Aquifer. The Crag Group Aquifer is an extensive Principal Aquifer that will receive recharge from multiple sources within the wider catchment.

11.8.112 The sensitivity of the Crag Group Aquifer is considered to be high and the sensitivity of the superficial deposits is medium.

11.8.113 No significant impact on groundwater flow (locally) to the Crag Group aquifer and superficial deposits is expected as a result of the operation phase, as the cross-sectional area occupied by piles is negligible in comparison to the size of both aquifers.

11.8.114 No significant impact on groundwater recharge (locally) to the Crag Group Aquifer and superficial deposits is expected. The magnitude of change prior to mitigation is considered to be **no change**. Therefore, there is

likely to be a direct, permanent long-term **neutral (not significant)** effect on the Crag Group Aquifer and the superficial deposits.

11.9 Monitoring

11.9.1 Regular monitoring of quality of dewatered / discharge water during the construction phase may be required to ensure compliance with permitting and consent requirements, as included in the Outline CoCP (document reference 6.16).

11.10 Limitations and Assumptions

11.10.1 Information provided by the design team contains a number of uncertainties that will be improved and defined through the project life cycle. The main uncertainty is in regard to aquifer permeabilities (rate at which groundwater can transfer through a material). The design team estimated ground material permeabilities based upon site specific groundwater level monitoring information and a series of permeability sensitivities been adopted to achieve model calibration (where model groundwater level matches recorded groundwater levels). These parameters are therefore likely to representative.

11.10.2 The management of cofferdam structures dewatering effluent, and consents and permits required to manage this water, will be completed by the Contractor; it will likely be discharged to surface water, sewer, disposed of off-site or a combination of these three methods. This assessment will rely on the outputs of the numerical modelling and refinement of the model during detailed design.

11.11 Summary

11.11.1 Tables 11.12 to 11.15 summarise the findings of the assessment of potential impacts and resulting significance of effects from the construction and operation of the Scheme on the identified surface water and groundwater receptors. The assessment of the impact significance has been derived by combining the assessed importance of the affected waterbodies and the magnitude of the impacts, taking into account mitigation in line with the guidance provided in HD 45/09 Table A4.5.

11.11.2 A WFD assessment has been completed to investigate the potential effects of the Scheme against the key objectives of the WFD. A summary of the findings is provided in Table 11.16 and the detailed assessment is included in Appendix 11E (document reference 6.2).

Table 11.12: Summary of Potential Effects during Construction to Surface Water Bodies

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Increased sediment loads	River Yare (Very High)	Slight (not significant) - / T / D	None	Slight (not significant) - / T / D
Dust and debris pollution		Slight (not significant) - / T / D	None	Slight (not significant) - / T / D
Pollution due to spillage or hazardous substances		Slight (not significant) - / T / D	None	Slight (not significant) - / T / D
Impact due to dewatering and discharge of abstracted water		Neutral (not significant)	None	Neutral (not significant)
Changes to hydrological/morphological regime		N/A		
Increased sediment loads	River Bure (Very High)	Neutral (not significant)	None	Neutral (not significant)
Dust and debris pollution		Neutral (not significant)	None	Neutral (not significant)

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Pollution due to spillage or hazardous substances		Neutral (not significant)	None	Neutral (not significant)
Impact due to dewatering and discharge of abstracted water		neutral (not significant)	None	neutral (not significant)
Changes to hydrological/morphological regime		N/A		
Increased sediment loads	Breydon Water (Very High)	Neutral (not significant)	None	Neutral (not significant)
Dust and debris pollution		Neutral (not significant)	None	Neutral (not significant)
Pollution due to spillage or hazardous substances		Neutral (not significant)	None	Neutral (not significant)
Impact due to dewatering and discharge of abstracted water		Neutral (not significant)	None	Neutral (not significant)
Changes to hydrological/morphological regime		N/A		

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Increased sediment loads	North Sea (Very High)	Neutral (not significant)	None	Neutral (not significant)
Dust and debris pollution		Neutral (not significant)	None	Neutral (not significant)
Pollution due to spillage or hazardous substances		Neutral (not significant)	None	Neutral (not significant)
Impact due to dewatering and discharge of abstracted water		Neutral (not significant)	None	Neutral (not significant)
Changes to hydrological/morphological regime		N/A		
Increased sediment loads	Ditches and watercourses within marshland upstream of Great Yarmouth (Medium)	Neutral (not significant)	None	Neutral (not significant)
Dust and debris pollution		Neutral (not significant)	None	Neutral (not significant)
Pollution due to spillage or hazardous substances		Neutral (not significant)	None	Neutral (not significant)

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Impact due to dewatering and discharge of abstracted water		neutral (not significant)	None	neutral (not significant)
Changes to hydrological/morphological regime		Neutral (not significant)	None	Neutral (not significant)
Increased sediment loads	Ditches and watercourses within urban area of Great Yarmouth (Low)	Slight (not significant) - / T / D	None	Slight (not significant) - / T / D
Dust and debris pollution		Slight (not significant) - / T / D	None	Slight (not significant) - / T / D
Pollution due to spillage or hazardous substances		Slight (not significant) - / T / D	None	Slight (not significant) - / T / D
Impact due to dewatering and discharge of abstracted water		neutral (not significant)	None	neutral (not significant)
Changes to hydrological/morphological regime		Slight (not significant) - / T / D	None	Slight (not significant) - / T / D

Table 11.13: Summary of Potential Effects during Operation to Surface Water Bodies

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Pollution to surface water due to contaminants contained in routine road runoff	River Yare (Very High)	Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to spillage		Slight (not significant) - / T / D	None	Slight (not significant) - / T / D
Pollution to surface water due to mobilisation of contaminated sediments		Slight (not significant) - / D	None	Slight (not significant) - / D
Changes to hydrological/morphological regime		Moderate (significant) - / D	None	Moderate (significant) - / D
Loss of standing water		N/A		
Pollution to surface water due to contaminants contained in routine road runoff	River Bure (Very High)	Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to spillage		Neutral (not significant)	None	Neutral (not significant)

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Pollution to surface water due to mobilisation of contaminated sediments		Slight (not significant) - / I	None	Slight (not significant) - / I
Changes to hydrological/morphological regime		Slight (not significant) - / I	None	Slight (not significant) - / I
Loss of standing water		N/A		
Pollution to surface water due to contaminants contained in routine road runoff	Breydon Water (Very High)	Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to spillage		Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to mobilisation of contaminated sediments		Slight (not significant) - / I	None	Slight (not significant) - / I
Changes to hydrological/morphological regime		Slight (not significant) - / I	None	Slight (not significant) - / I
Loss of standing water		N/A		

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Pollution to surface water due to contaminants contained in routine road runoff	North Sea (Very High)	Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to spillage		Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to mobilisation of contaminated sediments		Slight (not significant) - / I	None	Slight (not significant) - / I
Changes to hydrological/morphological regime		N/A		
Loss of standing water		N/A		
Pollution to surface water due to contaminants contained in routine road runoff	Ditches and watercourses within marshland upstream of Great Yarmouth (Medium)	Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to spillage		Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to mobilisation of contaminated sediments		N/A		

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Changes to hydrological/morphological regime		Neutral (not significant)	None	Neutral (not significant)
Loss of standing water		N/A		
Pollution to surface water due to contaminants contained in routine road runoff	Ditches and watercourses within urban area of Great Yarmouth (Low)	Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to spillage		Neutral (not significant)	None	Neutral (not significant)
Pollution to surface water due to mobilisation of contaminated sediments		N/A		
Changes to hydrological/morphological regime		Neutral (not significant)	None	Neutral (not significant)
Loss of standing water		N/A		
Pollution to surface water due to contaminants contained in routine road runoff	Surface water ponds located within the MIND Centre	N/A		
Pollution to surface water due to spillage		N/A		

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Pollution to surface water due to mobilisation of contaminated sediments	and Grounds directly affected by the Scheme (Medium)	N/A		
Changes to hydrological/morphological regime		N/A		
Loss of standing water		Large (significant) - / D / P	None	Large (significant) - / D / P

Table 11.14: Summary of Potential Effects during Construction to Groundwater Bodies

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation (Residual)
Intrusive works (incl. mobilisation of pre-existing contamination) and the impact to groundwater quality: potential for saltwater contamination to principal groundwater receptors (i.e. saline intrusion)	Crag Group (High)	Moderate Adverse (significant) -/ T/ D / ST	Outline CoCP (document reference 6.16) to be developed and implemented	Minor Adverse (not significant)

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation (Residual)
Intrusive works (incl. mobilisation of pre-existing contamination) and the impact to groundwater quality: potential for saltwater contamination to groundwater receptors (i.e. saline intrusion)	Superficial Deposits (Medium)	Neutral (not significant) -/ T/ D / ST		Neutral significance
Intrusive works (incl. mobilisation of pre-existing contamination) and the impact to groundwater quality: potential for saltwater contamination to groundwater receptors (i.e. saline intrusion)	Water Users (High)	Moderate Adverse (significant) -/ P / D / ST		Minor Adverse (not significant)
Decrease in groundwater level and flow to principal groundwater receptors due to use of groundwater control measures	Crag Group (High)	Slight Adverse (not significant) -/ T/ D / ST	Outline CoCP (document reference 6.16) to be developed and implemented.	Neutral significance
Decrease in groundwater level and flow to groundwater receptors due to use of groundwater control measures	Superficial Deposits (Medium)	Slight Adverse (not significant) -/ T/ D / ST		Neutral significance
Decrease in groundwater level and flow to groundwater receptors due	Water Users (High)	Neutral (not significant) -/ T/ D / ST		Neutral significance

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation	Significance and Nature of Effects Following Mitigation (Residual)
to use of groundwater control measures				
Pollution of shallow groundwater receptors during development of drainage i.e. attenuation ponds	Superficial Deposits (Medium)	Minor Adverse (not significant) - / T/ D / ST	Outline CoCP (document reference 6.16) and the design measures as listed in the Drainage Strategy (Appendix 12C (document reference 6.2)) to be implemented.	Neutral Significance

Table 11.15: Summary of Potential Effects during Operation to Groundwater Bodies

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation / Enhancement	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Impacts to groundwater water quality as a result of intrusive	Crag Group (High)	Neutral (not significant)	N/A	Neutral Significance

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation / Enhancement	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
works undertaken during construction phase				
Impact to groundwater flow and quantity as a result of intrusive works undertaken during construction phase	Crag Group (High)	Neutral (not significant)	N/A	Neutral Significance
Impact to shallow groundwater flow and quantity as a result of intrusive works undertaken during construction phase	Superficial Deposits (Medium)	Neutral (not significant)	N/A	Neutral Significance
Impact to groundwater flow and quantity as a result of intrusive works undertaken during construction phase to groundwater receptors	Water Users (High)	Neutral (not significant)	N/A	Neutral Significance
Impacts to groundwater recharge and flow as a result of intrusive works undertaken during construction phase	Crag Group (High)	Neutral (not significant)	N/A	Neutral Significance

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation / Enhancement	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Impacts to groundwater recharge and flow as a result of intrusive works undertaken during construction phase	Superficial Deposits (Medium)	Neutral (not significant)	N/A	Neutral Significance

Key to tables: + / - = Beneficial or Adverse; P / T = Permanent or Temporary; D / I = Direct or Indirect; ST / MT / LT = Short-Term, Medium-Term or Long-Term; N/A = Not Applicable

Table 11.16: A summary of the findings of the WFD assessment

Waterbody & Type	Current Status	Current Objective	Scheme Element	Comment
Bure & Waveney & Yare & Lothing Transitional water	Moderate	Moderate by 2027	River Yare bridge crossing	No change to status or objectives - some temporary effects due to mobilised contaminated sediments (chemical status) and longer-term effects on flow characteristics and sediment transport regime but localised. Not sufficient to change ecological status.
			Highway drainage	No change to status or objectives – potential for increased contaminants in receiving watercourses, but will be reduced by road drainage treatment. Runoff volumes and

Waterbody & Type	Current Status	Current Objective	Scheme Element	Comment
				concentrations not sufficient to change the chemical and ecological status of the waterbody.
			Channel realignments and culvert extensions	No change to status or objectives – slight effects on specific IDB watercourses affected but existing drainage routes and catchments maintained. Effects not sufficient to affect the hydromorphological regime of the waterbody and change the ecological status.
Norfolk East (coastal)	Moderate	Moderate by 2015	River Yare bridge crossing	No change to status or objectives – some potential temporary effects due to mobilised contaminated sediments (chemical status). Effects on the hydromorphological regime do not extend to the coast. Hydromorphology is not a measured supporting element and effects are insufficient to affect habitats and measured supporting quality elements. Effects insufficient to change ecological status as waterbody only indirectly connected to the Scheme.
			Highway drainage	No change – potential for increased contaminants in receiving watercourses, but will be reduced by road drainage treatment. Runoff volumes and concentrations insufficient to change chemical and ecological status.

Waterbody & Type	Current Status	Current Objective	Scheme Element	Comment
			Channel realignments and culvert extensions	No change to status or objectives – slight effects on specific IDB watercourses affected but existing drainage routes and catchments maintained. Effects insufficient to change ecological status as waterbody only indirectly connected to the Scheme.
Broadland Rivers Chalk & Crag Groundwater Waterbody (GB40501G400300)	Poor	Good by 2027	River Yare bridge crossing (piled foundations)	No change to status or objectives – some potential for contamination during construction but insufficient to change overall chemical status. No significant long-term change expected to groundwater flow regime.
			Highway drainage	No change to status or objectives – drainage features will be lined where necessary which will limit the potential for contamination to enter groundwater via infiltration.

11.12 References

Ref 11.1: Environment Agency (2018), Catchment Data Explorer 2018 (online).

Ref 11.2: Department for Environmental and Rural Affairs, Natural England, Environmental Agency, Historic England, Forestry Commission and Marine Management Organisation (2019), Multi Agency Geographic Information for the Countryside (MAGIC) (online).

Ref 11.3: British Geological Survey (2019), GeoIndex Online Database (online).

Ref 11.4: Mott MacDonald (2009), Great Yarmouth Third River Crossing Simple Environmental Assessment.

Ref 11.5: WSP (2018), Great Yarmouth Third River Crossing Preliminary Environmental Information Report.

Ref 11.6: Jones, HK., Morris, BL., Cheney, CS., Brewerton, LJ., Merrin, PD., Lewis, MA., MacDonald, AM., Coleby, LM., Talbot, JC., McKenzie, AA., Bird, MJ., Cunningham, J., and Robinson, VK (2000), The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report, WD/00/4. 234pp. Environment Agency R&D Publication 68.

Ref 11.7 Centre for Ecology & Hydrology (2019), Flood Estimation Handbook (FEH) (online).

Ref 11.8: Groundsure Enviro Insight Report Ref: CMAPS-CM-636391-16287-030717EDR, Centre Maps Live, July 2017.

Ref 11.9: The Waveney, Lower Yare & Lothingland Internal Drainage Board (2014), Burgh Castle District Water Level Management Plan.

Ref 11.10: Department for Environment Food and Rural Affairs and Environment Agency (online). UK Estuaries Database.

Ref 11.11: Norfolk Partnership Laboratory (2007), Great Yarmouth Third River Crossing Site Investigation Factual Report.

Ref 11.12: DEFRA / Environment Agency (2018), Surface water pollution risk assessment environmental quality standards. (online).

Ref 11.13: CEFAS (online), Centre for Environment Fisheries and Aquaculture Science, Use of Action Levels in Dredged Material Assessments.

Ref 11.14: Canadian Council of Ministers for the Environment (2002), Canadian Sediment Quality Guidelines for the Protection of Aquatic Life.

Ref 11.15: Design Manual for Roads and Bridges (2009), Volume 11, Section 3, Part 10 (HD 45/09) Road Drainage and the Water Environment, former Highways Agency, November 2009.

Ref 11.16: Environment Agency (2017), Water Framework Directive assessment: estuarine and coastal waters and Environment Agency (2016), Water Framework Directive risk assessment: how to assess the risk of your activity.

Ref 11.17: Department for Environment Food and Rural Affairs and Environment Agency (2015), UK Estuaries Database.

Ref 11.18: Department for Environment Food and Rural Affairs and Environment Agency (2008), Guidance on Tidal Asymmetry Analysis.

Ref 11.19: Official Journal of the European Communities (2000), The EU Water Framework Directive - integrated river basin management for Europe. Directive 2000/60/EC.

Ref 11.20: Official Journal of the European Communities (2006), The Groundwater Directive – on the protection of groundwater against pollution and deterioration. Directive 2006/118/EC.

Ref 11.21: Ministry of Housing, Communities & Local Government (2019), National Planning Policy Framework.

Ref 11.22: Department for Transport (2014), National Policy Statement for National Networks. (online) (Accessed June 2018).

Ref 11.23: Department for Transport (2014), National Policy Statement for Ports. (online) (Accessed June 2018).

Ref 11.24: Environment Agency (2018), Approach to groundwater protection.

Ref 11.25: The Planning Inspectorate (2017), Advice note eighteen. The Water Framework Directive. Version 1.

Ref 11.26: CIRIA (2015), Guidance on the construction of SuDS (C768).

Ref 11.27: Environment Agency (2018), Consented Discharges to Controlled Waters with Conditions. (online).

Ref 11.28: Met Office (2018), UK Climate Projection 2018 (UKCP18) Marine Report.

12 Flood Risk

12.1 Introduction

12.1.1 This Chapter reports the outcome of the assessment of likely significant effects arising from the Scheme on flood risk and is supported by Appendix 12A (Legislation, Policy and Guidance), Appendix 12B (Flood Risk Assessment (FRA)) and Appendix 12C (Drainage Strategy). All appendices are presented in document reference 6.2.

12.1.2 The assessment has focused on identifying the risk of flooding to the Scheme and the impact of the Scheme on flood risk to the surrounding area. Full details of the assessment undertaken can be found in the FRA (Appendix 12B, document reference 6.2).

12.1.3 The general approach adopted for the assessment of flood risk has been to:

- Assess the risk to the Scheme from all potential sources of flooding (both during construction and operation);
- Establish the existing and future flood risk to the Scheme;
- Assess the potential impacts of the Scheme on flood risk elsewhere (both during construction and operation); and
- Determine appropriate mitigation measures to manage flooding issues during operation in a sustainable way.

12.1.4 The Chapter describes the assessment methodology, the baseline conditions at the Site and in the surrounding area, any embedded mitigation adopted for the purposes of the assessment, a summary of the likely significant effects taking into account national legislation, the additional mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

12.2 Competent Expert

12.2.1 The flood risk lead, Julia Hunt, is a Chartered Principal Environmental Consultant who holds a BSc (Hons) degree in Geography from University College London (2007) and is a Chartered Water and Environmental Manager, Chartered Scientist and Chartered Environmentalist through the Chartered Institution of Water and Environmental Management (CIWEM). The flood risk lead has significant experience in undertaking flood risk assessments for planning applications and Development Consent Orders

and also extensive technical experience in flood hydrology and hydraulic modelling.

12.3 Legislative, Policy and Guidance Summary

12.3.1 Table 12.1 provides a summary of the key legislation, policy and guidance for this assessment.

12.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 12A (document reference 6.2).

Table 12.1: Summary of Key Legislation, Policy and Guidance

Legislation/ Policy/ Guidance	Summary	Chapter Reference
Floods Directive (2007/60/EC) (Ref 12.1)	The Floods Directive makes provision for the assessment of flood risk, mapping its potential impact and planning measures to reduce potential and significant flood risk.	The objectives of the Floods Directive that are relevant to this assessment are met through the legislation and policy documented in Appendix 12A (document reference 6.2).
National Policy Statement for National Networks (NPS NN) (Ref 12.2)	Sets out the government policies for nationally significant infrastructure projects on the road and rail networks in England and provides planning guidance for promoters of NSIPs. The NPS NN recognises that as a result of climate change, the risk of flooding will increase within the lifetime of NSIPs. Section 4.41 of the NPSNN states that if transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the	The UKCP09 were considered as part of this assessment but updated climate projections, the UK Climate Projections 2018 (UKCP18) were released in November 2018. The EA stated in its consultation response in October 2018 that if the UKCP18 guidance was published before the FRA was finalised, the assessment must consider the new guidance. The UKCP18 guidance has been used to inform the climate change sea level rise scenarios included in the FRA (Appendix 12B, document reference 6.2). It should be noted that the

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	UK Climate Projections 2009 (UKCP09) high emissions scenario against the 2080's projections at the 50% probability level. The NPS NN (paragraph 5.95) states that the FRA should be carried out with reference to the guidance from the NPPF and accompanying Planning Practice Guidance (PPG).	UKCP18 climate change sea level rise estimates are recommended for use over the UKCP09 estimates but UKCP09 has not been wholly superseded by UKCP18 yet and parts of UKCP09 are still valid. This is discussed further in Section 12.5 of the Chapter. This FRA has been carried out in accordance with the NPPF and the accompanying PPG.
National Policy Statement for Ports (NPSP) (Ref 12.3)	Provides guidance for assessing flood risk associated with developments in ports. The NPS for Ports acknowledges that whilst development within ports is 'water-compatible' and therefore is permitted in high flood risk areas (paragraph 5.2.3), it is still necessary to undertake a FRA in line with the NPPF (paragraph 5.2.4).	The FRA (Appendix 12A, document reference 6.2) has been carried out in accordance with the NPPF and the accompanying PPG.
National Planning Policy Framework (NPPF) (Ref 12.4)	The NPPF sets out the government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for developments can be produced. Paragraphs 155 to 165 of the NPPF outline the	The majority of the Scheme site lies in Flood Zone 3 (3a) (Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding), therefore an FRA has been carried out in accordance with the requirements of the NPPF and associated PPG.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	development requirements in terms of flood risk and the impact of climate change. The NPPF requires developments to be 'safe for its lifetime, without increasing flood risk elsewhere' (NPPF, paragraph 155) and, where possible to 'reduce flood risk overall' (NPPF, paragraph 160). Priority is given to the use of Sustainable Drainage Systems (SuDS) within the NPPF. The NPPF advises that FRAs are required for all developments in Flood Zones 2, 3a and 3b and for all development sites in Flood Zone 1 that are 1 hectare (ha) or greater. The definitions of these zones are provided in Section 4 of the FRA (Appendix 12B, document reference 6.2).	The FRA (Appendix 12B) has assessed the risk of flooding to the Scheme over its lifetime and the impact of the Scheme on flood risk elsewhere, taking into account the future implications of climate change.
Great Yarmouth Local Plan – Core Strategy 2013 – 2030 (Ref 12.5)	The Great Yarmouth Local Plan includes a policy (Policy CS13) – Protection areas at risk of flooding or coastal change. The policy (page 90) sets out that new development proposals should be directed away from the areas of highest risk of flooding (Flood Zones 2, 3a and 3b) unless it can be	The Sequential Test is discussed in Section 12.4 and the FRA (Appendix 12B, document reference 6.2). Chapter 3 of the ES (document reference 6.1) explains the reasons for the choice of location for the Scheme. The Exception test is discussed in Section 12.4, Appendix 12B (document reference 6.2) and

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	demonstrated that: • The requirements of the Sequential Test are met • Where applicable the requirements of the Exception Test are met • A satisfactory Flood Response Plan has been prepared The plan also recommends using SuDS in all new developments	Appendix A of the Case for the Scheme (document reference 7.1). Appendix 12C (document reference 6.2) is the Drainage Strategy for the Scheme and discusses the use of SuDS.

12.3.3 The Applicant's draft DCO seeks the disapplication of some legislation relating to consents relevant to this chapter. The Applicant's approach is discussed further in the Consents and Agreements Position Statement (document reference 7.3).

12.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

12.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document reference 5.2)).

Consultation

12.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

12.4.3 Table 12.2 and 12.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 12.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
4.6 Water Environment: ID 7: Ref 6.7.28 Where relevant, the Applicant should make use of Anglian Water's sewer flooding register to inform the assessment of baseline conditions, and note the records of incidences of internal flooding provided by NCC in their consultation response.	PINS	Anglian Water's sewer flooding register has been used in the FRA (Appendix 12B, document reference 6.2).
4.6 Water Environment: ID 12: Ref 6.7.65 The Inspectorate acknowledges the Applicant's proposal to include a standalone aspect chapter on Flooding within the ES, supported by a Flood Risk Assessment (FRA), and is content with this approach. The complete FRA must be included with the DCO application.	PINS	The FRA is presented in Appendix 12B (document reference 6.2).
4.6 Water Environment: ID 13: Ref 6.7.67 Paragraph 6.7.67 of the Scoping Report states that the 2D model developed for the FRA 'will focus on the River Yare through Great Yarmouth'. The Applicant must ensure that the hydraulic model is representative of the flood risk in the area and covers a sufficient area of the Main Rivers (Yare and Bure) in Great Yarmouth. Consultation bodies have identified that a new Essex, Norfolk and Suffolk 2D tidal coastal model (2017) is being developed. The Applicant should make effort to agree the model for the assessment in the ES with the consultation bodies and clearly	PINS	The model developed for use in this assessment is detailed in the hydraulic modelling report, which is Annex A of the FRA (Appendix 12B, document reference 6.2). The model has been submitted for review by the EA in advance of the DCO application but comments may not be received in time to incorporate into the application. The Essex, Norfolk and Suffolk 2D tidal coastal model (2017) was supplied by the EA for use in this assessment. The 2017 EA model was not adopted for this assessment but the defence levels used in the 2017 model were applied within the model

Scoping Opinion Item	Consultee	Response
describe and justify the model used.		developed for this assessment. An overview of the modelling undertaken for this assessment is provided in Section 12.8 and a detailed description of the modelling methodology and outputs is provided in Appendix 12B: Annex A (document reference 6.2).
4.6 Water Environment: ID 14: Ref 6.7.72 The Inspectorate notes that Table 28 of the Scoping Report presents the approach that is to be applied to determine the 'significance of flood impact'. This determines whether mitigation is required or not. It is not clear from this table what residual impacts are deemed to be significant in terms of the EIA Regulations. The ES should clearly state whether any impacts are significant or not significant as a result of the assessment.	PINS	Section 12.8 of this Chapter addresses how the significance of flood impacts has been determined.
4.6 Water Environment: ID 15: Ref Table 28 Table 28 of the Scoping Report classes 'More vulnerable' and 'Less vulnerable' development at negligible increased flood risk (up to 0.02m) as requiring no mitigation. The Inspectorate considers that the ES should provide further justification to explain why no mitigation is required in these instances with reference to the specifics of the receptors, and changes in flood depth, extent, frequency and hazard. Table 28 of the Scoping Report	PINS	Residual flood risk and mitigation are discussed for specific receptors in Section 12.8, the approach has been revised following the Scoping Opinion.

Scoping Opinion Item	Consultee	Response
also states that if there is a moderate or major magnitude of impact to 'water compatible development' mitigation is not required. The Inspectorate considers that given the variety of developments which constitute 'water compatible development', the basic framework provided by the impact assessment criteria should be supplemented with further justification to explain why a moderate and major magnitude of impact is acceptable for the particular water compatible uses. The Applicant should seek to agree flood risk mitigation requirements with relevant consultation bodies, including the EA, NCC and Anglian Water.		This comment refers to the previous assessment methodology. The methodology has been updated following the Scoping Opinion and is described in Section 12.4. Mitigation has been determined through consultation with the EA, NCC and Anglian Water as discussed in Section 12.8.
Appendix 2: Environment Agency response To comply with national policy the application is required to pass the Sequential and Exception Tests and be supported by a site-specific Flood Risk Assessment (FRA). If this proposal is considered an NSIP the National Policy Statement for National Networks should be referred to as well as the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) discussed above. (Environment Agency Scoping Response, Appendix 2 of Scoping Report).	Environment Agency	The Sequential Test is discussed in Section 12.4 and the FRA (Appendix 12B, document reference 6.2). Chapter 3 of the ES (document reference 6.1) explains the reasons for the choice of location for the Scheme. The Exception test is discussed in Section 12.4, Appendix 12B (document reference 6.2) and Appendix A of the Case for the Scheme (document reference 7.1). NPS NN and NPPF have been referred to.
Appendix 2: Environment Agency response Please note that we are currently investigating options to undertake works to the flood defences in	Environment Agency	The Applicant is working with the EA to ensure a co-ordinated approach to Scheme works and EA defence works. Section 12.5 of this Chapter discusses the

Scoping Opinion Item	Consultee	Response
Great Yarmouth including the area of the proposed bridge on the west bank. We therefore want to ensure that the proposed development and our works are co-ordinated where possible. This is to ensure that we avoid abortive works and deliver efficiencies where possible. The applicant has engaged in early pre-application discussions with us and we look forward to further consultation as the project progresses.		approach used in the assessment with regards to EA defences.
Appendix 2: Environment Agency response The return periods that the applicant intends to run as part of this modelling are detailed in section 6.7.68. We are satisfied that the following return periods are needed to understand the offsite impacts of this development: 5% (1 in 20), 0.5% (1 in 200) & 0.1% (1 in 1000) in current day and with climate change for the baseline and post development scenarios. The climate change approach that will be used for modelling these return periods is stated in section 6.7.69. This approach of calculating climate change using the five relevant guidance / datasets that are applicable to the development and using the calculation that provides the maximum increase in sea level rise, is acceptable.	Environment Agency	Details of the flood scenarios tested in the assessment are provided in Section 12.4 of this Chapter.

Table 12.3: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
The EA is seeking funding for capital works to upgrade the flood defences on the River Yare.	Environment Agency	The Applicant is working with the EA to ensure a co-ordinated approach to Scheme works and EA defence works. Section 12.5 of this Chapter discusses the approach used in the assessment with regards to EA defences.
The EA would welcome the opportunity to comment or review the FRA and any modelling prior to submission of the DCO.	Environment Agency	The model has been submitted for review by the EA in advance of the DCO application but comments may not be received in time to incorporate into the application.
The EA stated that if the updated UK Climate Projections (UKCP18) were published before submission of the DCO, the assessment would have to take these into account.	Environment Agency	The UKCP18 climate projections were released in November 2018 and have been considered in this assessment as documented in Section 12.4 of this Chapter.

12.4.4 Table 12.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

12.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 12.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
Environment Agency	Sustainable Places Planning Specialist	Pre-application meeting, 19th October 2018	EA confirmed that the defence heights in the JBA 2018 Great Yarmouth model should be used in any modelling of flood risk in the area. EA agreed to supply JBA model to WSP.

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			EA confirmed that Haven Bridge gauge is on the southern side of Haven bridge.
Environment Agency	Sustainable Places Planning Specialist	Pre-application meeting, 16th January 2019	EA recommended that a case by case approach should be adopted where each flooded area is considered independently and mitigation / actions should be considered and explanation / argument provided with reasons for / against recommended actions. EA suggested that for the DCO application, all cases of flood increase should be made clear in the FRA to enable the Inspector to make an informed decision. WSP confirmed that only existing defence levels would be included in the assessment representing an 'as now' scenario.
Environment Agency	Sustainable Places Planning Specialist	Stage 2 Consultation Response	As the bridge is considered safety critical the high emissions scenario and H++ scenario needs to be assessed. The EA stated that safety critical elements of the design should be assessed against the H++ estimates for sea level rise to assess a credible maximum scenario. The EA would not normally expect the design or mitigation to be provided to this level.

Insignificant Effects

12.4.6 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would

be insignificant and have therefore not been considered further in the assessment:

- The confluence between the River Waveney and the River Yare is located approximately 8 km upstream of the Principal Application Site. The distance to the River Waveney is considered sufficient such that no impact is likely to result from the Scheme, hence the River Waveney has not been considered further within the ES.
- No surface water features are found within the Satellite Application Sites, and the works associated with these will be minimal, their effects on the water environment have not been assessed further within the ES.

Likely Significant Effects

Construction Phase

12.4.7 Increase in water levels in the River Yare close to the Principal Application Site due to constriction of flows caused by cofferdams used to build bridge knuckles.

12.4.8 Increase in water depths on floodplain and receptors due to constriction of flows caused by cofferdams used to build bridge knuckles. This will only be an effect should a tidal flood event occur during the construction phase.

12.4.9 Potential for groundwater flooding during construction due to excavation and high groundwater levels at the Principal Application Site.

Operation Phase

12.4.10 Increase in water levels in River Yare close to the Principal Application Site due to the constriction of flows caused by the bridge knuckles.

12.4.11 Increase in water depths on the floodplain and receptors during a flood event due to constriction of flows caused by the bridge knuckles.

12.4.12 Increase in surface water runoff from the Principal Application Site as a result of the Scheme potentially leading to increased surface water flood risk elsewhere.

Extent of Study Area

12.4.13 The study area for the assessment incorporates a large part of Great Yarmouth as shown in Figure 12.1.

12.4.14 The Study Area for the assessment of impacts has incorporated the Principal Application Site as well as the Satellite Application Sites but given no surface water features are found within the Satellite Application Sites, and that works

associated with these will be minimal, their effects on the water environment have not been assessed further within the ES.

Method of Baseline Data Collation

Desk Study

12.4.15 The desk study involved the collation and analysis of available data on flood risk and the production of the FRA for the Scheme, contained within Appendix 12B (document reference 6.2).

Flood Risk Assessment

12.4.16 The FRA, contained with Appendix 12B (document reference 6.2), has been carried out by WSP in accordance with the NPSNN, NPSP, NPPF and the associated PPG.

12.4.17 The objectives of the FRA were to:

- Assess the risk to the Scheme from all potential sources of flooding (both during construction and operation);
- Establish the existing and future flood risk to the Scheme;
- Assess the potential impacts of the Scheme on flood risk elsewhere (both during construction and operation); and
- Determine appropriate mitigation measures to manage flooding issues during operation in a sustainable way.

12.4.18 The following data has been used to undertake the FRA:

- General Arrangement Plans (document reference 2.2);
- Engineering Plans, Drawings and Sections (document reference 2.10);
- OS Mastermap (provided by NCC);
- As-built construction drawings for Haven Bridge (provided by NCC);
- Bathymetric survey data for the River Yare through Great Yarmouth (collected by Peel Ports Great Yarmouth in 2017;
- 0.5 m LiDAR covering Great Yarmouth (flown in 2105 by the EA);
- 1 m LiDAR covering Great Yarmouth (flown in 2009 by the EA);
- Extreme Sea Level (ESL) data (provided by the EA);

- 15-minute resolution recorded water level data from gauges at Haven Bridge, Gorleston, Three Mile House and Burgh Castle (provided by the EA);
- Existing 1D/2D hydraulic model covering Great Yarmouth developed for the Great Yarmouth Reporting and Mapping Study, 2011 (provided by the EA);
- Existing 1D/2D hydraulic model covering Great Yarmouth developed for Great Yarmouth Flood Defence – Epoch 2 – 2016 to 2021, (Outline Business Case), 2018 (provided by EA); and
- Existing 1D/2D hydraulic model representing baseline scenario in Great Yarmouth, JBA 2018 with latest defence crest levels included (provided by EA).

12.4.19 The following documents have been used to gather information for the FRA:

- Great Yarmouth Strategic Flood Risk Assessment (SFRA), November 2017 (Ref 12.6);
- Broadlands Rivers Catchment Flood Management Plan (CFMP), December 2009 (Ref 12.7);
- Kelling to Lowestoft Ness Shoreline Management Plan 6 (SMP), August 2012 (Ref 12.8);
- NCC Preliminary Flood Risk Assessment Report (PFRA); July 2011 (Ref 12.9);
- Norfolk Local Flood Risk Management Strategy (LFRMS), July 2015 (Ref 12.10);
- EA data and web based mapping; and
- Broads Authority web based mapping.

Sequential and Exception Tests

12.4.20 The Scheme was initially subject to the Sequential Test. Drawing on previous optioneering work undertaken, Chapter 3 of the ES (document reference 6.1) explains the reasons for the choice of location for the Scheme, concluding that it is the most appropriate location.

12.4.21 As the Scheme is classified as ‘Essential Infrastructure’ and is predominantly located within Flood Zone 3, in accordance with the PPG the Exception Test is required for the Scheme in this location. The NPS NN also states that both elements of the test will have to be passed for the development to be

consented. For the Exception Test to be passed the following must be met (paragraph 5.108):

- *It must be demonstrated that the scheme development provides wider sustainability benefits to the community that outweigh flood risk; and*
- *A flood risk assessment must demonstrate that the scheme development will be safe for its lifetime, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.*

12.4.22 Part one of the Exception Test is addressed in Appendix A of the Case for the Scheme (document reference 7.1), which details how the wider sustainability benefits of the Scheme outweigh flood risk. The wider benefits of the Scheme include improving connectivity and resilience for port activities, supporting the delivery of existing and potential renewable energy NSIPs and supporting the port's role as an international gateway. The FRA (Appendix 12B, document reference 6.2) has been prepared to address part two of the Exception Test only.

Tidal Flood Risk Modelling

12.4.23 The main source of flooding to the Scheme is tidal. A 1D/2D Flood Modeller-TUFLOW model of the River Yare and its surrounding floodplain in Great Yarmouth has been developed for this assessment. Following review of the existing hydraulic model of Great Yarmouth (2011) provided by the EA, it was concluded that a new model should be developed for this assessment using the latest topographic and hydrological data. The impact of fluvial flows on flood risk to the Scheme was considered as part of the hydraulic assessment but these were found to have a negligible impact on flooding. Therefore, only tidal flooding has been modelled as part of this assessment as agreed with the EA. The model developed for this assessment has been submitted to the EA for review.

12.4.24 The model domain extends from the western edge of Breydon Water to the mouth of the River Yare where the river discharges into the sea. The River Yare through Great Yarmouth itself has been included in the 2D model domain in order to model flow routes through the town. It was not considered necessary to include the upper reaches of the River Yare within the 2D domain but the storage potential of Breydon Water and the northern floodplain has been included in a 1D domain linked to the 2D domain. It should be noted that the 1D domain is not an accurate physical representation of Breydon Water. Using this method, the model represents the function of the storage area without significantly increasing model runtimes as would happen if Breydon Water and the northern floodplain were included in the 2D model domain. The modelling is discussed in detail in the FRA (Appendix 12B, document reference 6.2).

12.4.25 A suite of sensitivity tests has been undertaken to determine the impact of a variety of parameters on the model results, including the roughness values representing land use within the model, fluvial inflows and tidal levels.

12.4.26 The model has been used to assess the following scenarios:

- Present Day Baseline – to establish the existing flood risk to the Scheme site;
- Future Baseline Climate Change – to establish the risk of flooding to the Principal Application Site with future climate change;
- Future Baseline H++ - to establish the risk of flooding to the Principal Application Site for a credible maximum flood scenario (high risk, low probability);
- Present Day Scheme – to establish flood risk to the Principal Application Site and the impact of the Scheme on flooding elsewhere in the present day conditions;
- Future Scheme Climate Change – to establish flood risk to the Principal Application Site and the impact of the Scheme on flooding elsewhere with future climate change;
- Future Scheme H++ - to establish flood risk to the Principal Application Site and the impact of the Scheme on flooding elsewhere for a credible maximum flood scenario.

12.4.27 Three flood return periods have been assessed using the flood model developed for this assessment; these are:

- 5% Annual Exceedance Probability (AEP) event (there is a 5% chance in any given year that a flood event of this magnitude will occur);
- 0.5% AEP event (tidal Flood Zone 3) (there is a 0.5% chance in any given year that a flood event of this magnitude will occur); and
- 0.1% AEP event (tidal Flood Zone 2) (there is a 0.1% chance in any given year that a flood event of this magnitude will occur).

12.4.28 Model runs have been undertaken for each return period with and without climate change allowances applied to determine the present day (2019) flood risk in Great Yarmouth and predicted future flood risk (climate change and H++). The impact of, and resilience to, future flooding will be considered and mitigation against future flood risk elsewhere will be recommended as necessary. Climate change allowances have been applied based on the NNNPS. As the development is a NSIP and safety-critical, it was agreed with the EA that a range of methods for estimating future sea level rise would be

considered and the method that produced the maximum increase in sea level would be used to represent the impact of future climate change in the model. The UK Climate Projections (UKCP18) Representative Concentration Pathways (RCP) 8.5 scenario gave the highest sea level rise (1.83m by 2140) and this has been used to define the climate change sea levels in this assessment.

12.4.29 To develop tidal curves representing the future H++ scenario, the H++ sea level rise estimates from UKCP09 were added to the present day tidal curves for each flood design event. Updates to the H++ estimates have not been made in UKCP18, the current guidance is to continue using the UKCP09 H++ estimates for assessments (Ref 12.8).

12.4.30 The effect of wave overtopping from the open coast has been considered but it was judged not to be critical in this assessment as the main flood risk to Great Yarmouth is tidal inundation. The Scheme is approximately 2.5km from the coastal boundary. Therefore, wave overtopping will not have an impact on the development because at water levels below the coastal defences, the arrangement of the harbour entrance prevents significant transmission of waves upstream on the River Yare. Should the defences be overtopped, wave action would have less of an impact and wave overtopping has been judged as a small residual uncertainty. Sensitivity testing of the tidal boundary has shown that the peak tidal level has the greatest impact on the maximum flood levels predicted for each return period event further justifying the decision to not consider wave overtopping in this assessment.

Methodology for Assessing Results

Tidal Flooding

12.4.31 The results of the model runs representing the Scheme scenario have been compared to the baseline model results for each simulation. Changes in water level between the baseline and Scheme scenarios within the River Yare channel and on the floodplain have been assessed.

12.4.32 In order to understand the significance of any change in flood risk between the baseline and Scheme scenarios, the approach has been based on that published in Volume 11, Section 2, Part 5 of the Design Manual for Roads and Bridges (DMRB) (HA 205/08), updated as necessary to take account of the 2017 EIA Regulations and the NPPF (PPG). The sensitivity of receptors to changes in flood risk has been classified as shown in Table 12.5, this is based on Table 2 of the Flood Risk and Coastal Change PPG (Ref 12.9).

Table 12.5: Receptor Sensitivity Classification

Sensitivity	Description
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly vulnerable	• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').
More vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and

Sensitivity	Description
	educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water-compatible development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities.

Sensitivity	Description
	• Ministry of Defence defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

12.4.33 The magnitude of impact in terms of flooding has been classified as shown in Table 12.6. The magnitude of change is a deviation from the baseline flood depth predicted for a given location.

Table 12.6: Magnitude of Impact

Magnitude of Impact	Change in Flood Depth
Major	0.3+ or flooding in areas that were previously not flooded
Moderate	>0.1 to ≤.3
Minor	>0.02 to ≤0.1
Negligible	0 to ≤0.02

12.4.34 Using the level of sensitivity and the magnitude of impact, the significance of a change in flood risk can be determined using the Significance Matrix shown in Table 12.7: Significance of a Change in Flood Risk. The significance categories are described in Table 12.8.

Table 12.7: Significance of a Change in Flood Risk

		Magnitude of Impact				
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
Sensitivity	**Highly Vulnerable**	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	More Vulnerable	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Less Vulnerable	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
	Water Compatible	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate

Table 12.8: Description of Significance Categories

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

12.4.35 In order to understand the impact of the Scheme on flood risk to people, flood hazard has been analysed. Flood hazard is calculated by the hydraulic model (TUFLOW) directly, the model has been configured to record the UK hazard rating as proposed in the Flood Risks to People Guidance (Ref 12.10). The formula used to calculate flood hazard rating is:

$$D(V + 0.5) + DF$$

D = Depth

V = Velocity

DF = Debris Factor

12.4.36 The debris factor can be set in a number of ways but the most recent guidance (Ref 12.11) is to use a depth varying debris factor with a non-zero value at low flood depths. Following the guidance, the debris factors (conservative method) that have been used in this assessment are provided in Table 12.9.

Table 12.9: Debris Factors Applied in the Model to Calculate Flood Hazard

Depth	Debris Factor
0 to 0.25m	0.5
0.25 to 0.75m	1
d>0.75m and/or v>2m/s	1

12.4.37 Values of the flood hazard rating are calculated for each grid cell within the model using the formula shown above, the values for flood hazard rating are then classified as shown in Table 12.10 to show the risk to people for a particular flood event across the modelled area.

Table 12.10: Flood Hazard Rating

Flood Hazard Rating	Hazard to People Classification
0	No hazard
<0.75	Very low hazard
0.75 – 1.25	Danger for some
1.25 – 2.0	Danger for most
>2.0	Danger for all

12.4.38 The flood hazard rating has been calculated for each of the events modelled in this assessment and a comparison of the hazard ratings across the study

area between the Baseline and Scheme scenarios for each flood event has been made to identify whether the Scheme acts to increase flood hazard within Great Yarmouth.

Surface Water Flooding

12.4.39 Surface water flooding to the Principal Application Site has been assessed by consulting the EA Risk of Flooding from Surface Water Map. The impact of the Scheme on surface water flooding has been assessed by calculating the surface water runoff rates from the Principal Application Site and the volume of storage required to manage runoff from the Principal Application Site to avoid increasing surface water flooding elsewhere.

12.4.40 The standard calculations to assess surface water runoff rates from a development assume the proposed development site is wholly greenfield pre-development and the difference in pre- and post-development runoff rates provides the volume of water storage required to limit runoff from the development site to greenfield rates. As the Principal Application Site is not wholly greenfield and is in fact made up of largely impermeable surfaces, it is acknowledged that surface water runoff from the Principal Application Site may not be limited to the greenfield runoff rates calculated. The surface water Drainage Strategy (Appendix 12C, document reference 6.2) and design will refine the initial runoff and volume values calculated as part of this assessment as the calculations presented within this document and the FRA (Appendix 12B, document reference 6.2) are conservative to understand the worst case in terms of surface water runoff from the Principal Application Site.

Sewer Flooding

12.4.41 Flood risk to the Principal Application Site from sewers has been assessed by reviewing the Anglian Water DG5 register for Great Yarmouth and identifying whether any sewer flooding incidents have occurred at the Principal Application Site. It is proposed that some water will be drained from the Principal Application Site via existing Anglian Water sewers, the Drainage Strategy (Appendix 12C, document reference 6.2) discusses how appropriate discharge rates to sewers have been agreed with Anglian Water to prevent an adverse impact on their network.

Groundwater Flooding

12.4.42 In order to assess groundwater flooding to the Principal Application Site and the impact of the Scheme on groundwater flooding, the British Geological Society (BGS) online maps and the SFRA have been consulted. There are no historical records of groundwater flooding in Great Yarmouth. Monitoring of groundwater levels was undertaken for this assessment to better understand the likelihood of flooding from this source. A number of

boreholes within and surrounding the Principal Application Site were monitored from June – December 2018.

Flood Risk from Artificial Sources

12.4.43 Flood risk from artificial sources includes reservoirs, canals and pumping stations. The closest reservoirs to the Principal Application Site and the risk of flooding to the Scheme from these were identified based on the EA reservoir flood mapping online. The study area was checked for the presence of canals to understand any flood risk from this source and any impact of the Scheme on flood risk from canals. The locations of pumping stations within the study area for this assessment were identified and risk to the Principal Application Site plus the impact of the Scheme on flood risk from them was assessed based on their distance from the Principal Application Site and the areas that they drain.

12.5 Baseline Environment

12.5.1 The Principal Application Site lies predominantly within floodplain cited as Flood Zone 3 (defined as land having a 1 in 100 or greater annual probability of river flooding (1%) or land having a 1 in 200 or greater annual probability of sea flooding (0.5%)). Flood Zone 3 is the highest risk zone defined by the EA.

12.5.2 Additional areas of land classified as being within Flood Zone 2 are also within the study area (defined as land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%) or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%)).

12.5.3 Figure 12.2 shows the areas of Flood Zone 3 and 2 relative to the Scheme location.

12.5.4 The EA Flood Map for planning does not show any defences in Great Yarmouth. However, there are a number of EA defence assets throughout Great Yarmouth, which consist of a mixture of embankments, quays, bridge abutments, demountable defences, flood gates and walls. The condition of these assets varies. Much of the town is dependent on flood defences to protect it from tidal flooding.

12.5.5 The likely evolution of the baseline environment has been considered in this assessment by assessing the influence of climate change on flood risk within Great Yarmouth.

Future Baseline

12.5.6 The effects of climate change are expected to lead to increased sea levels and more extreme storm events, which has the potential to increase the risk of flooding (particularly tidal and surface water flooding).

12.5.7 The future baseline in terms of flood risk has been assessed by considering the impact of climate change on sea level rise in Great Yarmouth. As tidal flooding is the predominant source of flooding to Great Yarmouth, the future baseline for this has been considered in detail through hydraulic modelling of tidal climate change scenarios as discussed in Section 12.8.

12.5.8 The impact of climate change on surface water runoff from the site has been assessed to determine storage required at the Principal Application Site to prevent any increases to surface water flood risk elsewhere as a result of the Scheme in the future as discussed in Section 12.8.

12.5.9 The effects of sea level rise are also expected to lead to higher groundwater levels in the study area, due to hydraulic connectivity and tidal influence on the local groundwater levels. This is discussed in Section 12.8.

12.5.10 The EA is currently in the process of designing upgrades to the flood defences throughout Great Yarmouth. Works to upgrade the defences are programmed to start in December 2019 with completion programmed for September 2020. The design of the defence upgrades is not finalised and as such this assessment adopts a conservative approach and assumes the defence levels and alignment through Great Yarmouth remain as existing for the future baseline scenario.

12.6 Sensitive Receptors

12.6.1 Receptors within Great Yarmouth have been classified using Ordnance Survey (OS) Address Base Data (Ref 12.12), which classifies all properties based on the Local Land and Property Gazetteers and OS large-scale data. A summary of the receptors identified within the study area for this assessment is provided in Table 12.11 with particularly sensitive receptors listed individually. The impact of the Scheme on flooding at the receptors listed in Table 12.11 has been assessed by calculating the change in flood level to each of the receptors between the Baseline and Scheme scenarios for each flood event assessed in this assessment, the significance of change at each receptor has then been classified using Table 12.7.

Table 12.11: Flood Risk Receptors Identified within Assessment Study Area

Receptor	Sensitivity (from Table 12.5)	Location
Residential (including residential care homes)	More Vulnerable	Throughout majority of study area except on agricultural land immediately south of Breydon Water and to south of Scheme on east bank of River Yare
Commercial	Less Vulnerable	Throughout majority of study area
Commercial water compatible	Water Compatible	Along west and east banks of River Yare through Great Yarmouth (port infrastructure)
Great Yarmouth Fire Station	Highly Vulnerable	NGR: 652593, 306812
Police Investigation Centre	Highly Vulnerable (assumed required to be operational during flooding)	NGR: 651805, 306445
A47	Essential Infrastructure	Crosses River Yare at eastern end of Breydon Water and runs north-south to the west of the River Yare through Great Yarmouth

12.7 Establishing the Scenario for Assessment

Construction Phase

12.7.1 During construction, sheet piles will be used in the river channel to create a cofferdam on either side of the channel, which will form the footprint of the bridge supporting knuckles. The cofferdams will be dewatered as necessary and backfilled to create the knuckles.

12.7.2 The cofferdams will reduce the width of the River Yare channel by approximately 50% to no less than 50m (allowable limit of deviation for navigable channel width). However, this is the same reduction as during the operational phase i.e. there will be no greater constriction in the channel during the construction phase.

Operational Phase

12.7.3 The Scheme includes a bridge deck spanning the watercourse, for this assessment an invert level of 4.5mAOD and a deck height of 9.6mAOD in the centre of the bridge have been assumed and are within the Limits of Deviation for the Scheme. These values have been included in the assessment and a Rochdale Envelope approach has been used to consider a feasible worst-case Scheme design in terms of flood risk. The soffit level of the bridge is not likely to be less than 5.36mAOD but the 4.5mAOD level has been used in the modelling in order to be conservative as this will cause a greater constriction in the channel. The bridge deck level will potentially be higher than 9.6mAOD but a higher deck level would not have an impact on the findings of this assessment as the 9.6mAOD level is above the highest tidal flood level considered in this assessment. Knuckles span approximately a quarter of the way across the channel from both banks and their combined impact restricts the channel width by up to approximately 50%. It has been assumed for this assessment that each knuckle ties into the bridge deck and therefore both knuckles have a deck height of 9mAOD.

12.7.4 Each side of the bridge has an approach road sloping from the bridge deck to the existing ground level on either side of the river. The approach roads have been represented on embankments but there is an opening in them on either side of the river to allow roads to run alongside the river underneath the approach roads to the bridge. The openings in the embankments have been included in the representation of the Scheme in the hydraulic model.

12.8 Assessment of Effects, Mitigation and Residual Effects

12.8.1 All sources of flooding are considered in the FRA (Appendix 12B, document reference 6.2). Tidal flooding is the most significant flood risk to Great Yarmouth and as such is discussed in detail in this Chapter. The FRA found that the Scheme will have an impact on tidal flood risk within Great Yarmouth. The FRA also found that groundwater flooding may pose a risk to the Scheme during construction and that the Scheme could increase surface water runoff and potentially lead to increased surface water flooding in the vicinity of the Scheme.

12.8.2 During the operation phase, flood risk from sewers, groundwater, reservoirs, canals and pumping stations was found to be negligible meaning that the significance of each of these sources of flood risk during operation to the Principal Application Site is neutral. During the construction phase, flood risk from sewers, reservoirs, canals and pumping stations was found to be negligible and therefore the significance of each of these sources of flood risk during construction to the Principal Application Site is neutral.

Operation Phase

Tidal Flooding – Present Day Scenario

12.8.3 This section details the impact of the Scheme on flooding for the Present Day scenario.

12.8.4 Figure 12.3 shows the flood extents predicted by the model for the Baseline Present Day event. The results show that there is no risk during a 5% AEP Present Day event to Great Yarmouth in the Baseline scenario. The modelling has shown that the urban area of Great Yarmouth floods during the 0.5% AEP and larger events. The 0.5% Baseline Present Day event shows a significant flood extent caused due to water levels overtopping the raised defences through the town. As expected the 0.1% AEP Baseline Present Day event shows extensive flooding throughout the catchment. In addition to the significant flooding in the town centre, the water levels are sufficient to overtop the defences along the southern edge of Breydon Water in the 0.1% AEP Baseline Present Day event.

12.8.5 Figure 12.4 shows comparison points within the River Yare channel at which the Baseline and Scheme modelling results have been compared. Table 12.12 shows the Baseline and Scheme water levels predicted by the model in channel for the Present Day scenario for different return periods at each of the comparison points on Figure 12.4. Table 12.12 shows that in the channel during the 5% AEP Present Day event, to the south of the Scheme there is a negligible adverse impact as water levels increase by up to 0.02 m. To the north of the Scheme during the same event, there is a minor beneficial impact as water levels in the channel are reduced by up to 0.09 m. The negligible increase in water levels in the channel can be attributed to the narrowing of the channel by the bridge knuckles, which reduce the width of the channel under the bridge by approximately 50% compared to its current width.

12.8.6 Within the channel, the differences between the Baseline and Scheme scenarios for the 0.5% AEP and 0.1% AEP Present Day events show the same pattern as the 5% AEP event. For the 0.5% AEP Present Day event there is a negligible adverse impact in water levels south of the Scheme of up to 0.02 m. However, there is a minor beneficial reduction in water levels north of the Scheme of up to 0.08 m. During the 0.1% AEP Present Day event, there is a minor adverse impact south of the Scheme with increases in water level predicted up to 0.06m and to the north of the Scheme there is a minor beneficial impact with reductions in water level of up to 0.05 m. These results show that the general effect of the Scheme in the channel is to increase water levels south of the site and decrease north of the site. This is because of the constriction in the channel caused by the knuckles used to support the Scheme. This reduces the overall capacity of the channel

between the supports slowing the flow rate through the area reducing the amount of water that can transit up the channel from the tidal boundary.

Table 12.12: Present Day Hydraulic Modelling Results

Present Day	Baseline (m AOD)			Scheme (m AOD)			Difference (Scheme – Baseline (m)		
Point (Figure 12.4)	**5%**	**0.5%**	**0.1%**	**5%**	**0.5%**	**0.1%**	**5%**	**0.5%**	**0.1%**
US1	2.38	2.99	3.16	2.33	2.96	3.15	-0.05	-0.04	-0.01
US2	2.40	3.01	3.27	2.34	2.97	3.25	-0.06	-0.05	-0.02
US3	2.44	3.04	3.31	2.37	2.99	3.28	-0.07	-0.06	-0.03
US4	2.48	3.07	3.35	2.40	3.01	3.32	-0.08	-0.06	-0.03
US5	2.52	3.12	3.41	2.44	3.05	3.37	-0.08	-0.07	-0.04
USW	2.55	3.15	3.44	2.46	3.07	3.40	-0.09	-0.07	-0.04
USE	2.55	3.14	3.44	2.46	3.07	3.40	-0.09	-0.07	-0.04
C1	2.57	3.17	3.46	2.48	3.08	3.42	-0.09	-0.08	-0.05
C2	2.58	3.18	3.48	2.59	3.20	3.54	0.02	0.02	0.06
C3	2.59	3.20	3.50	2.61	3.22	3.56	0.02	0.02	0.06
DSW	2.61	3.22	3.53	2.63	3.24	3.58	0.02	0.02	0.05
DSE	2.61	3.22	3.53	2.62	3.24	3.58	0.02	0.02	0.05
DS5	2.64	3.26	3.60	2.65	3.28	3.65	0.02	0.02	0.04
DS4	2.67	3.30	3.68	2.69	3.32	3.72	0.01	0.01	0.04
DS3	2.72	3.36	3.79	2.73	3.37	3.82	0.01	0.01	0.02
DS2	2.78	3.43	3.91	2.78	3.43	3.92	0.01	0.00	0.01
DS1	2.82	3.48	4.00	2.83	3.48	4.01	0.00	0.00	0.00

12.8.7 It is also necessary to assess the impact of the Scheme on water levels on the floodplain and the different receptors within Great Yarmouth. For the 5% AEP Present Day event, there is no change in flood levels on the floodplain between the Baseline and Scheme scenarios as all the water is retained in the channel for this event and no out of bank flooding occurs.

12.8.8 Figure 12.5 shows a comparison of the predicted water levels for the Baseline and Scheme Present Day scenarios for the 0.5% AEP event showing the magnitude of impact with the Scheme in place. A negligible increase in flood extent on an area of grassland between South Denes Road and Great Yarmouth Power Station is predicted with the Scheme in place

because the Scheme water levels are 0.02m higher than the Baseline water levels in this area. There is also a minor increase in flood extent at Southtown Common with the Scheme in place due to a minor increase in water levels of up to 0.1m compared to the Baseline scenario affecting the Common itself and a section of the open channel of the watercourse that flows through the Common. To the south of the Scheme, on the eastern bank of the River Yare water levels are increased by up to 0.08m (minor adverse impact) in the Scheme Present Day scenario compared to the Baseline Present Day scenario. On the west bank of the River Yare to the south of the Scheme, water levels are increased by up to 0.1m (minor adverse impact) at Southtown Common.

12.8.9 Table 12.13 lists the receptors within the study area (shown on Figure 12B.1) predicted by the hydraulic model to be flooded for the 0.5% AEP Present Day event and details the change in flood depth between the Baseline and Scheme scenarios for this event. A receptor is assumed to be flooded if the modelled flood extent covers any part of the building footprint, it has been assumed in the model that all buildings within the study area have a threshold level of 0.2m (in the absence of detailed survey information), therefore buildings are shown to be internally flooded where the modelled flood depths are greater than 0.2m. Based on the sensitivity of each receptor and the change in flood depth between the Baseline and Scheme scenarios predicted by the hydraulic model, the significance of the change in flood risk for each receptor has been classified based on Table 12.7.

Table 12.13: Impact of Scheme on Flooding to Receptors during 0.5% AEP Present Day Scenario

Receptor	Sensitivity	Baseline Flood Depth	Change in Flood Depth Scheme – Baseline	Significance of Change in Flood Risk
Police Investigation Centre, Thamesfield Way (Emergency/Rescue Service shown on Figure 12B.1)	**Highly Vulnerable** (assumed required to be operational during flooding)	0.22m	-0.22m (flooded in Baseline scenario, not flooded in Scheme scenario)	Large Beneficial
Great Yarmouth Fire Station (northern fire station	**Highly Vulnerable**	1.1m	-0.14m (flooded in both Baseline and Scheme	Large Beneficial

Receptor	Sensitivity	Baseline Flood Depth	Change in Flood Depth Scheme – Baseline	Significance of Change in Flood Risk
shown on Figure 12B.1)			scenario)	
Residential properties on west bank of River Yare to south of Scheme (Queen Anne's Road)	**More Vulnerable**	0.3m	Up to +0.13m (flooded in both Baseline and Scheme scenario)	Moderate Adverse
Residential properties to north of Scheme (Southtown area on west bank and between Sutton Road and Alma Road on east bank of River Yare)	**More Vulnerable**	West bank: between 0.2m and 0.56m East bank: between 0.4m and 0.9m	Up to -0.3m (flooded in both Baseline and Scheme scenario)	Moderate Beneficial
Commercial properties on west bank of River Yare to south of Scheme	**Less Vulnerable**	0.3m	Up to +0.03m (flooded in both Baseline and Scheme scenario)	Slight Adverse
Commercial properties to north of Scheme (Southtown area on west bank and between Sutton Road and Alma Road on east bank of River Yare)	**Less Vulnerable**	West bank: between 0.2m and 0.56m East bank: between 0.4m and 0.9m	Up to -0.3m (majority flooded in both Baseline and Scheme scenario but a number of commercial properties are removed from flooding with the Scheme in place)	Moderate Beneficial

Receptor	Sensitivity	Baseline Flood Depth	Change in Flood Depth Scheme – Baseline	Significance of Change in Flood Risk
Water compatible commercial properties to south of Scheme on east bank of River Yare (within port area)	**Water compatible**	Between 0.2m and 0.6m	Up to +0.08m (flooded in both Baseline and Scheme scenario)	Slight Adverse
Water compatible commercial properties to south of Scheme on west bank of River Yare (within port area)	**Water compatible**	1.3m	Up to +0.02m (flooded in both Baseline and Scheme scenario)	Slight Adverse

12.8.10 The impact of the Scheme on flood hazard in the 0.5% AEP Present Day event has also been assessed to understand whether any receptors move to a higher flood hazard category compared to the Baseline scenario. For this event, the changes in flood hazard predicted by the model are small and the pattern of change is in line with the change in water levels seen between the Baseline and Scheme scenarios. The flood hazard ratings across the study area for the Baseline 0.5% AEP Present Day event and Scheme 0.5% AEP Present Day Event are shown in Figure 12.6 and Figure 12.7, respectively. To the south of the Scheme on the east bank of the River Yare (where water levels are increased with the Scheme in place), the extent of the 'Danger for most' hazard rating category increases slightly with the Scheme in place compared to the Baseline but no properties in this area move into a higher hazard category as a result. To the south of the Scheme on the west bank of the River Yare, where water levels increased moderately with the Scheme in place, the areas shown as 'Danger for some' and Danger for most' increase slightly but no properties are impacted by this. There are no areas on the floodplain in the 0.5% AEP Present Day event in either the Baseline or Scheme scenario that are classified as 'Danger for all', the channel is classified in this category due to its depth.

12.8.11 To the north of the Scheme on both sides of the river, as the water levels are predicted to reduce for the 0.5% AEP Present Day event with the Scheme in place compared to the Baseline scenario, the flood hazard rating improves for a number of properties with some being moved to a lower hazard category with the Scheme in place.

12.8.12 In terms of flood risk to the Scheme itself and its operability and safety requirements, the level of the bridge deck assumed for this assessment (9.6mAOD) is above the maximum flood level considered in this assessment, as the 0.1% AEP H++ event peak tidal level is 7.13mAOD. However, the approach roads to the bridge are impacted by flooding.

12.8.13 The approach road on embankment on the western side of river is not predicted to flood during the 0.5% AEP Present Day Scheme scenario, however there is ponding of flood water on the southern side of the embankment leading to increased flooding to houses with the Scheme in place. The approach road on eastern side of the river is predicted to flood during 0.5% AEP Present Day event with the Scheme in place but the flood depths in this area are up to 0.13m lower than in the Baseline scenario for the same event. Ideally, the approach road would be raised above the 0.5% AEP Climate Change flood level but given the location of the approach road adjacent to the river and the fact that it is essential infrastructure that has to cross the area of risk, it would be impractical to raise the road above the flood level in this area. In the 0.5% AEP Present Day Baseline scenario, the whole area surrounding the approach road on the eastern side of the river is flooded to a depth of approximately 2.9m.

Tidal Flooding – Climate Change Scenario

12.8.14 Figure 12.8 shows the flood extents predicted by the model for the Baseline Climate Change event. The results show that all three climate change events modelled predict flooding to a large part of the study area with a large part of the urban area flooded in each event.

12.8.15 Table 12.14 shows the Baseline and Scheme water levels predicted by the model in channel for the Climate Change scenario for different return periods at each of the comparison points on Figure 12.4.Table 12.14 shows that in the channel during the 5% AEP Climate Change event, to the south of the Scheme, water levels are raised by up to 0.12m with the largest increase at the location of the bridge (moderate adverse impact). The impact of the Scheme in the Climate Change scenario is actually less during the 0.5% AEP and 0.1% AEP as the peak tidal level for each of these events is above all of the current defence heights through the town. Therefore, the increases seen in the channel are less than for the 5% AEP event, for which some of the defence heights are higher than the peak water level. There is a minor adverse impact in the channel for the 0.5% AEP event with water levels increased by up to 0.1m in the Scheme scenario compared to the Baseline. The increases in the channel with the Scheme in place for the 0.1% AEP event are negligible (up to 0.02m).

12.8.16 As for the Present-Day scenario, each of the climate change scenarios show a beneficial impact in terms of flood risk to the north of the Scheme with

reductions predicted within the channel. For each flood event, the reduction in water levels has a minor beneficial impact.

Table 12.14: Climate Change Hydraulic Modelling Results

Climate Change Point (see Figure 12.4)	Baseline (m AOD)			Scheme (m AOD)			Difference (Scheme – Baseline (m))		
	5%	0.5%	0.1%	5%	0.5%	0.1%	5%	0.5%	0.1%
US1	3.34	4.09	4.93	3.33	4.04	4.87	-0.01	-0.05	-0.05
US2	3.42	4.11	4.93	3.41	4.06	4.87	-0.01	-0.05	-0.06
US3	3.47	4.12	4.93	3.46	4.07	4.87	-0.01	-0.05	-0.06
US4	3.54	4.13	4.92	3.52	4.08	4.87	-0.02	-0.05	-0.06
US5	3.62	4.15	4.92	3.60	4.09	4.88	-0.02	-0.06	-0.04
USW	3.68	4.17	4.95	3.64	4.11	4.90	-0.03	-0.06	-0.04
USE	3.67	4.17	4.94	3.64	4.11	4.90	-0.03	-0.06	-0.04
C1	3.71	4.18	4.96	3.66	4.12	4.91	-0.04	-0.06	-0.05
C2	3.73	4.19	4.97	3.85	4.22	5.00	0.12	0.04	0.02
C3	3.76	4.20	4.99	3.87	4.25	5.01	0.11	0.05	0.02
DSW	3.81	4.23	5.02	3.91	4.30	5.03	0.09	0.07	0.01
DSE	3.81	4.23	5.02	3.91	4.30	5.03	0.09	0.07	0.01
DS5	3.96	4.38	5.14	4.03	4.48	5.16	0.07	0.10	0.02
DS4	4.12	4.63	5.33	4.18	4.70	5.34	0.05	0.07	0.02
DS3	4.31	4.89	5.52	4.35	4.93	5.54	0.04	0.04	0.01
DS2	4.51	5.16	5.74	4.52	5.18	5.75	0.02	0.02	0.01
DS1	4.66	5.36	5.88	4.66	5.36	5.88	0.00	0.00	0.00

12.8.17 The impact of the Scheme on water levels on the floodplain and receptors within Great Yarmouth has been assessed for the Climate Change scenario. The impact of the Scheme in the Climate Change scenarios is less than for the Present Day scenario as the water levels for each event are higher in the Climate Change scenario and flooding on the floodplain is more extensive during the Climate Change Baseline scenario meaning that the Scheme has less of an impact overall. Figure 12.9 shows a comparison of the predicted water levels for the Baseline and Scheme Climate Change scenarios for the 0.5% AEP event showing the magnitude of impact with the Scheme in place. The difference in extent of flooding between the Baseline and Scheme scenarios for the 0.5% AEP Climate Change event is negligible. As for the Present Day scenario, there is an increase in water levels to the south of the

Scheme and a reduction in water levels to the north. On the floodplain to the south of the Scheme, the maximum increase in water level with the Scheme in place is 0.1 m, a moderate adverse impact. Near to the harbour at the end of the River Yare, there is a negligible adverse impact with increases in water level of up to 0.02 m with the Scheme in place.

12.8.18 Table 12.15 lists the receptors within the study area predicted to be flooded by the hydraulic model for the 0.5% AEP Climate Change event and details the change in flood depth between the Baseline and Scheme scenarios for this event. A receptor is assumed to be flooded if the modelled flood extent covers any part of the building footprint, it has been assumed in the model that all buildings within the study area have a threshold level of 0.2m (in the absence of detailed survey information), therefore buildings are shown to be internally flooded where the modelled flood depths are greater than 0.2m. Based on the sensitivity of each receptor and the change in flood depth between the Baseline and Scheme scenarios predicted by the hydraulic model, the significance of the change in flood risk for each receptor has been classified based on Table 12.7.

Table 12.15: Impact of Scheme on Flooding to Receptors during 0.5% AEP Climate Change Scenario

Receptor	Sensitivity	Baseline Flood Depth	Change in Flood Depth Scheme – Baseline	Significance of Change in Flood Risk
Police Investigation Centre, Thamesfield Way (Emergency/Rescue Service shown on Figure 12B.1)	**Highly Vulnerable** (assumed required to be operational during flooding)	3.7m	-0.05m (flooded in both Baseline and Scheme scenario)	Moderate Beneficial
Great Yarmouth Fire Station (northern fire station shown on Figure 12B.1)	**Highly Vulnerable**	1.2m	-0.01m (flooded in both Baseline and Scheme scenario)	Slight Beneficial
Residential properties on west bank of River Yare to south of Scheme (Queen Anne's Road)	**More Vulnerable**	3m	Up to +0.07m (flooded in both Baseline and Scheme scenario)	Slight Adverse

Receptor	Sensitivity	Baseline Flood Depth	Change in Flood Depth Scheme – Baseline	Significance of Change in Flood Risk
Residential properties to north of Scheme (Southtown area on west bank and between Sutton Road and Alma Road on east bank of River Yare)	**More Vulnerable**	West bank: 3.8m East bank: between 2m and 3m	Up to -0.05m (flooded in both Baseline and Scheme scenario)	Slight Beneficial
Commercial properties on west bank of River Yare to south of Scheme	**Less Vulnerable**	3m	Up to +0.05m (flooded in both Baseline and Scheme scenario)	Slight Adverse
Commercial properties to north of Scheme (Southtown area on west bank and between Sutton Road and Alma Road on east bank of River Yare)	**Less Vulnerable**	West bank: 3.8m East bank: between 2m and 3m	Up to -0.05m (majority flooded in both Baseline and Scheme scenario, but a number of commercial properties are removed from flooding with the Scheme in place)	Slight Beneficial
Water compatible commercial properties to south of Scheme on east bank of River Yare (within port area)	**Water compatible**	Between 1.6m and 2.4m	<+0.01m (flooded in both Baseline and Scheme scenario)	Neutral
Water compatible commercial properties to south of Scheme on west bank of River Yare (within port area)	**Water compatible**	Between 2m and 3.2m	Up to +0.07m (flooded in both Baseline and Scheme scenario)	Slight Adverse

12.8.19 The impact of the Scheme on flood hazard in the 0.5% AEP Climate Change event has also been assessed to understand whether any receptors move to a higher flood hazard category compared to the Baseline scenario. For this event, there is a negligible change in flood hazard predicted between the Baseline and Scheme scenarios. The flood hazard ratings across the study area for the Baseline 0.5% AEP Climate Change event and Scheme 0.5% AEP Climate Change Event are shown in Figure 12.10 and Figure 12.11 respectively. For both the Baseline and Scheme scenario, a large proportion of the study area is classified as 'danger to all' incorporating a large number of properties.

12.8.20 Whilst the bridge deck is above the 0.1% AEP Climate Change flood level, the approach roads to the bridge are predicted to flood during each of the Climate Change events modelled. On the western side of the river, the new roundabout that the approach road leads to is predicted to flood to a depth of up to 3m in the 0.5% AEP Climate Change event. However, this is not as a result of the Scheme as the Baseline flood depth in this area is approximately 3m as well (there is actually a slight reduction in flood levels predicted in the Scheme scenario compared to the Baseline in the 0.5% AEP Climate Change event). The eastern approach road to the bridge is predicted to flood up to a depth of approximately 2.5m in the 0.5% AEP Climate Change event but flood levels in this location even in the Baseline scenario are up to 2.5m in this event.

Tidal Flooding – H++ Scenario

12.8.21 Figure 12.12 shows the flood extents predicted by the model for the Baseline and Scheme 0.5% AEP H++ events. The results show that for both scenarios a large part of the study area and urban area of Great Yarmouth is predicted to flood.

12.8.22 Table 12.16 shows the Baseline and Scheme water levels predicted by the model in channel for the 0.5% AEP H++ scenario at each of the comparison points on Figure 12.4. Table 12.14 shows that in the channel during the 0.5% AEP H++ event, the Baseline and Scheme scenarios predict similar water levels with only negligible differences between them at each comparison point. The impact of the Scheme on water levels is less in the H++ event than it is for the Present Day and Climate Change events. This is because the water levels are much higher for the extreme H++ event than for the Present Day and Climate Change events meaning that the constriction caused by the bridge in channel has less of an impact.

Table 12.16: H++ 0.5% AEP Event Hydraulic Modelling Results

Climate Change Point (see Figure 12.4)	Baseline (mAOD)	Scheme (mAOD)	Difference Scheme – Baseline (m)
US1	6.54	6.53	-0.01
US2	6.52	6.51	-0.01
US3	6.52	6.51	-0.01
US4	6.51	6.50	-0.01
US5	6.51	6.50	-0.01
USW	6.51	6.50	-0.01
USE	6.51	6.50	-0.01
C1	6.51	6.50	-0.01
C2	6.51	6.51	0.00
C3	6.51	6.50	-0.01
DSW	6.51	6.50	-0.01
DSE	6.51	6.50	-0.01
DS5	6.52	6.51	-0.01
DS4	6.54	6.53	-0.01
DS3	6.56	6.56	0.00
DS2	6.60	6.60	0.00
DS1	6.60	6.60	0.00

12.8.23 The impact of the Scheme on water levels on the floodplain within Great Yarmouth has been assessed for the H++ scenario. The impact of the Scheme in the H++ scenario is less than for the Present Day and Climate Change scenarios as the water levels for each event are higher in the H++ scenario and flooding on the floodplain is extensive during the Baseline scenario meaning that the Scheme has less of an impact overall. Figure 12.12 shows a comparison of the predicted water levels for the Baseline and Scheme H++ scenarios for the 0.5% AEP event showing the magnitude of impact with the Scheme in place. The difference in depth and extent of flooding between the Baseline and Scheme scenarios for the 0.5% AEP H++ event is negligible.

12.8.24 In terms of flood risk to the Scheme itself, the bridge deck assumed for this assessment (9.6mAOD) is above the peak water level for even the 0.1% AEP H++ event (7.13mAOD). However, for the 0.5% AEP H++ event, significant flooding is predicted across Great Yarmouth including in the

location of the proposed approach roads to the bridge in both the Baseline and Scheme scenarios.

Tidal Flooding – Mitigation and Residual Flood Risk

12.8.25 It has been agreed with the EA that mitigation is not required for the H++ event modelled (Table 12.4). This provides a credible maximum scenario against which the Scheme can be assessed. Therefore, mitigation for increases in flood risk during the Present Day and Climate Change tidal flood events has been considered as part of this assessment. Similarly, the 0.1% AEP flood event is an extreme, low probability event and mitigation for this event in the Present Day or Climate Change scenario has not been considered. Therefore, the largest flood event considered in this assessment for mitigation is the 0.5% AEP Climate Change event.

12.8.26 Table 12.10 shows that the largest impact of the Scheme is a moderate adverse impact on residential properties to the south of the Scheme to the west of the River Yare, with increases in water level of up to 0.13m in the Scheme scenario compared to the Baseline scenario for the 0.5% AEP Present Day event. However, this impact is over a very small area and affects two properties. For the 0.5% AEP Climate Change event, the predicted increase is up to 0.07m in the Scheme scenario compared to the Baseline in the same location affecting the same two properties. This is classified as a slight adverse impact. In the 0.5% AEP Climate Change event, all of the adverse impacts to receptors are slight and there is a moderate beneficial impact to the Police Investigation Centre.

12.8.27 Given that there are only two properties within the area where the Scheme was found to have a moderate adverse impact in the Present Day scenario and for other receptors in Great Yarmouth there is only a slight adverse impact in the Present Day and Climate Change scenarios. Using professional judgement, it is deemed impractical to provide specific mitigation for the two properties to reduce the level of flooding in these circumstances. The Scheme is essential infrastructure that has to be located in Flood Zone 3 as it has to cross the river, therefore the impact on water levels in Great Yarmouth is unavoidable and the wider sustainability benefits of the Scheme have been shown to outweigh minor increases in flood risk (Appendix A, Case for the Scheme). To the south of the Scheme on the west side of the River Yare, the Baseline flood depths in the Present Day scenario are already up to 0.5m, which would almost certainly be above property threshold levels. The modelled hazard outputs show that the Scheme does not increase flood hazard to any properties. However, mitigation in the form of an emergency preparedness and response plan can be provided to reduce the risk to life and to property, which if implemented appropriately would mean that the significance of flooding to the two properties in question would be reduced from moderate adverse to slight adverse. The use of an emergency preparedness and response plan as mitigation is discussed

further in 12.8.31 as mitigation for any increases in flood risk across Great Yarmouth as a result of the Scheme.

12.8.28 In terms of the safety and operability of the Scheme, the bridge deck itself is not predicted to flood in any of the scenarios modelled for this assessment (including the H++ events). However, parts of the approach roads on either side of the bridge are predicted to flood. On the western side of the river, the new roundabout that the approach road leads to is predicted to flood to a depth of up to 3m in the 0.5% AEP Climate Change event. However, this is not as a result of the Scheme as the Baseline flood depth in this area is approximately 3m as well (there is actually a slight reduction in flood levels predicted in the Scheme scenario compared to the Baseline in the 0.5% AEP Climate Change event). The eastern approach road to the bridge is predicted to flood up to a depth of approximately 2.5m in the 0.5% AEP Climate Change event but flood levels in this location even in the Baseline scenario are up to 2.5 m in this event.

12.8.29 As the impacts of the Scheme on flood risk are negligible in the location of the approach roads on either side of the river, the relative level of flood risk during flood events in these areas remains the same as for the Baseline scenario and the figures showing flood hazard for the Present Day and Climate Change scenarios show this (Figures 12.6, 12.7, 12.10 and 12.11). As stated in paragraph 5.109 of the NPS NN (Ref 12.2), essential infrastructure proposed within Flood Zone 3 should be designed and constructed to remain operational and safe for users in times of flood. The bridge itself remains operational and safe during all flood events modelled but the access roads leading to the bridge do not. Given the Baseline level of flood risk within Great Yarmouth, it is not possible to completely remove the risk of flooding to the access roads during tidal flood events. Ideally, all elements of the Scheme would be raised above the 0.5% AEP Climate Change tidal flood level but this would involve significant raising of the approach roads to the bridge and would likely render the design impractical.

12.8.30 The Scheme does have a safety critical element, being the bridge deck. Although the bridge deck itself is not predicted to flood in any of the scenarios modelled (including the extreme 0.1% H++ scenario), the approach roads to the bridge are predicted to flood and would be impassable in the Baseline 0.5% Present Day event where flood depths up to 0.6 m are predicted at the location of the new roundabout on the western side of the river and flood depths of up 1.2 m are predicted where the approach road is planned on the eastern side of the river. Due to the negligible changes in water levels predicted at the location of the approach roads during the operational phase of the Scheme, the risk to safety during a flood event is the same as for the Present Day Baseline scenario.

12.8.31 Given the Baseline level of flood risk within Great Yarmouth, it is not possible to completely remove the risk of flooding to the access roads during a tidal

flood event. As safe access/egress cannot be achieved, it is proposed that no part of the Scheme is to be opened to the public until an emergency preparedness and response plan has been developed in consultation with GYBC, NCC and the EA and this should be approved in writing by the county planning authority (NCC). Due to the existing significant flood hazard to Great Yarmouth, there are already emergency procedures in place to be implemented during times of flood including the Norfolk Strategic Flood Plan (Ref 12B.23) and the Norfolk Tactical Flood Plan (Ref 12B.24). The response to significant flood events is coordinated by the Norfolk Resilience Forum (made up of the emergency services, local authorities, volunteer organisations and PPGY), any response is based on the predicted severity of the flood event. However, any existing emergency procedures will not address the issues specific to the Scheme and additional mitigation is recommended. It is recommended that the bridge deck of the Scheme is closed for public use during major flooding events in order to prevent vehicles or people becoming stranded. It should be noted that as the major risk of flooding in Great Yarmouth is from tidal sources, which can be predicted 24-48 hours in advance, there would be time for event specific appropriate action to be taken to reduce risk to life and property.

Surface Water Flooding

12.8.32 This section details the risk of surface water flooding to the Scheme and the impact of the Scheme on surface water runoff from the Principal Application Site area.

12.8.33 The EA web-based Risk of Flooding from Surface Water Map shows medium and high risk of surface water flooding within the Principal Application Site (refer to Appendix 12B (document reference 6.2) for details) and it is therefore considered that the overall flood risk to the Scheme from surface water is moderate. However, the management of surface water on the Principal Application Site is addressed in the Drainage Strategy (Appendix 12C, document reference 6.2) and the Scheme design will incorporate embedded mitigation, which will reduce the residual risk of surface water flooding to the Scheme to negligible.

12.8.34 An initial high-level assessment of the impact of the Scheme on surface water flood risk has been assessed by calculating surface water runoff from the Principal Application Site for both the greenfield and post-scheme scenario, this is detailed in the FRA (Appendix 12B, document reference 6.2). The surface water Drainage Strategy (Appendix 12C, document reference 6.2) and design will refine these initial runoff and volume values as the assessment in the FRA is conservative to understand the worst case in terms of surface water runoff from the Principal Application Site. The Scheme drainage will be as set out in the Drainage Strategy and this will include embedded mitigation to manage surface water runoff from the Principal Application Site and limit runoff to agreed discharge rates. The

installation of VMS at the Satellite Application Sites will not impact on surface water runoff; therefore the assessment is for the Principal Application Site only.

12.8.35 Surface water runoff accounting for climate change was assessed to ensure that an increased risk of flooding and the consequences of climate change are anticipated and mitigated. The impacts of climate change need to be taken into account when designing the drainage infrastructure. Surface water needs to be managed in a way that does not increase flood risk offsite, whether through attenuation or infiltration.

12.8.36 Although the existing land use at the Principal Application Site is not wholly greenfield, there will be an increase in impermeable surface area at the Principal Application Site as a result of the Scheme. The Scheme will increase the impermeable surface area at the Principal Application Site by 1.78ha compared to the existing surfaces within this area.

12.8.37 For the purposes of this assessment, it has been assumed that the Principal Application Site is wholly greenfield currently to identify the worst-case scenario in terms of storage required on site in order to limit runoff from the Principal Application Site to the greenfield rates. In reality, a large proportion of the Principal Application Site is currently impermeable, however the Scheme will still increase the impermeable area and therefore there is a need to manage surface water runoff on site to prevent an increase in flood risk elsewhere. Table 12.17 provides a comparison of the assumed greenfield surface water runoff rates with the post-Scheme runoff rates.

Table 12.17*: Greenfield and Post-Scheme Runoff Rates Comparison*

Area	Rainfall Event (AEP)	Greenfield Runoff (l/s)	Post-Scheme Runoff (l/s)	Difference between Greenfield and Post-Scheme Runoff (l/s)
Principal Application Site	3.33%	64.27	329.97	265.70
	1%	89.73	464.53	374.80
	1% + CC Central	112.16	558.74	446.58
	1% + CC Upper End	148.05	656.83	508.78

Surface Water Flooding – Mitigation and Residual Flood Risk

12.8.38 There is potential for surface water flooding to affect the Principal Application Site and the Scheme will result in an increase in impermeable area (of 1.78ha) compared to the existing site, which would lead to an increase in the surface water runoff at the Principal Application Site post-development (see Appendix 12B (document reference 6.2) for details). The Drainage Strategy

(Appendix 12C, document reference 6.2) explains how surface water on the Principal Application Site will be managed, embedded mitigation is included in the design for the Scheme to reduce the risk of surface water flooding to the Scheme and prevent an increase in surface water runoff as a result of the Scheme. The surface water runoff calculations above assume that the Principal Application Site is wholly permeable pre-development to understand the surface water storage required should discharge from the Principal Application Site need to be limited to the greenfield runoff rate. However, the Principal Application Site is not currently wholly greenfield, as 10.44ha of the total 17.33ha Application Site area is currently impermeable.

12.8.39 Where limiting runoff from the Application Site to greenfield runoff rates is not achievable, the post development runoff rates should not exceed the existing runoff rates from the area. The Drainage Strategy (Appendix 12C, document reference 6.2) explains how the preferred option to manage runoff from the site is to discharge to IDB watercourses and Anglian Water sewers. However, discharging to the River Yare has not been ruled out to allow flexibility in the drainage design for the Scheme. Where it is proposed to discharge into Anglian Water sewers, the runoff rates will be restricted to Anglian Water requirements to ensure the Scheme does not cause any sewer flooding. As the post-development runoff is increased compared to the pre-development scenario, it is necessary to provide storage within the Application Site area to limit runoff. Storage will be included in the design of the Scheme as embedded mitigation as discussed in the Drainage Strategy.

12.8.40 The Great Yarmouth Local Plan (Ref 12.5) strongly recommends the use of sustainable drainage systems (SuDS) to manage surface water. There are a range of SuDS options available that could be considered and implemented where appropriate including swales and attenuation ponds. The use of any SuDS features within the Scheme is dependent on the site constraints and underlying ground conditions. The Drainage Strategy document considers this in detail and discusses the proposed embedded mitigation for additional surface water runoff. The proposed SuDS features to be used as part of the Scheme are detailed in the Drainage Strategy (Appendix 12C, document reference 6.2).

12.8.41 The embedded mitigation in the Scheme for surface water means that the residual risk of flooding to the Scheme from surface water and risk of the Scheme increasing surface water flood risk elsewhere is reduced to negligible.

Other Sources of Flood Risk

The FRA (Appendix 12B, document reference 6.2) has shown that there is negligible flood risk to the Scheme from fluvial, groundwater, sewer and artificial sources of flooding during the operational phase. Similarly, the Scheme was not shown to impact on these sources of flood risk during the

operational phase. Therefore, mitigation is not required for fluvial, groundwater, sewer and artificial sources of flooding for the operational phase of the Scheme.

Construction Phase

12.8.42 Tidal and groundwater flood risk are considered to have the potential to impact the Scheme during construction and without mitigation could be significant. The FRA (Appendix 12B, document reference 6.2) shows that the Principal Application Site is not at risk of flooding from fluvial sources, sewers, reservoirs, canals and pumping stations, therefore these sources of flood risk will not be an issue during construction and their significance based on Table 12.7 is neutral due to their negligible impact at the Principal Application Site.

Tidal Flooding

12.8.43 The construction phase does not have a different footprint in the River Yare channel or on the floodplain to the operational phase of the Scheme as cofferdams are to be constructed the same size as the knuckles in the channel and back filled to create the knuckles. Therefore, it has not been necessary to model a during-construction scenario using the hydraulic model developed for this study. However, as the FRA (Appendix 12B, document reference 6.2) has found that there is a risk of flooding to the Scheme in operation, there will also be a risk of flooding to the Scheme site during construction.

12.8.44 As the construction footprint of the Scheme within the River Yare will be the same as the operational phase footprint, the flood risk to the Application Site during construction will be the same as during the operational phase with potential for a minor (up to 0.1m) increase in water levels at the Principal Application Site in the 0.5% AEP Climate Change scenario. Without mitigation, the significance of tidal flooding to the Principal Application Site during construction is considered slight in line with Table 12.7 (the Scheme has been considered as ‘less vulnerable’). Given the low likelihood of a significant flood event occurring during the construction phase, the implementation of a flood management plan is sufficient mitigation to reduce the significance of tidal flood risk during construction to neutral or slight. The OCoCP (para 7.2.1) states that the contractor must prepare a flood management plan to form part of the full CoCP.

Groundwater Flooding

12.8.45 Due to the presence of groundwater at 1.1m below ground level, the potential for groundwater flooding during construction was considered. However, the potential for groundwater flooding is reduced due to the construction methods to be used meaning that the residual risk of flooding

from groundwater during construction is minor. Any residual groundwater flooding risk during construction should be managed using the flood management plan and anyone working on site should be made aware that there is potential for groundwater flooding to the Principal Application Site. With the flood management plan in place, the significance of the risk of groundwater flooding to the Scheme during construction is neutral or slight.

Surface Water Flooding

12.8.46 The FRA (Appendix 12B, document reference 6.2) found that the Principal Application Site is at risk of surface water flooding, however there will be embedded mitigation as part of the Scheme design to manage surface water at the Principal Application Site. Similarly, during construction surface water will be managed. As with tidal flooding, the probability of a surface water flood event occurring during construction is low and therefore mitigation in the form of the flood management plan is sufficient to ensure that the significance of risk from surface water flooding (Table 12.7) is neutral or slight.

Monitoring

12.8.47 No monitoring is considered to be required over and above that which is included in the Outline CoCP (document reference 6.16) and its subsequent development by the Contractor into a full CoCP. The full CoCP, once detailed, will provide a review, monitoring and audit mechanism to determine the effectiveness of and compliance with environmental control measures.

12.9 Limitations and Assumptions

12.9.1 The hydraulic model developed to assess tidal flooding for this assessment has used the latest data and information available. However, assumptions have been made within the modelling as detailed in Appendix 12B: Annex A (document reference 6.2). The model has been calibrated to the 2013 flood event in Great Yarmouth but as no data was available for previous out of bank flooding in the town, it has not been possible to calibrate the model to any other flood events.

12.9.2 The tidal calculations undertaken to derive the tidal boundary within the hydraulic model are based on the latest guidance and data but there is always uncertainty within such calculations. Sensitivity tests have been undertaken to understand the uncertainty associated with the hydrology in the model.

12.9.3 There are a variety of methods to estimate sea level rise as a result of climate change and five different methods have been considered in this assessment. The method that produced the highest sea level rise estimate was chosen for use in this assessment, in order to be conservative, but the

uncertainty associated with this should be acknowledged. The fact that there are at least five different methods using different scenarios of climate change to estimate future sea level rise shows the inherent uncertainty of trying to predict future climate change and its impacts.

12.9.4 In order to determine the permeable and impermeable areas of the Principal Application Site pre-and post-development, it has been assumed that existing gardens and grassed recreational areas are permeable and that the landscaping works proposed as part of the Scheme (shown in document reference 2.2) are permeable. All other surfaces have been assumed to be impermeable.

12.10 Summary

12.10.1 This Chapter reports the outcome of the assessment of likely significant effects arising from the Scheme on flood risk and is supported by Appendix 12A (Legislation, Policy and Guidance), Appendix 12B (Flood Risk Assessment) and Appendix 12C (Drainage Strategy) (document reference 6.2 for all of the above).

12.10.2 The assessment has focused upon identifying the risk of flooding to the Scheme and the impact of the Scheme on flood risk to the surrounding area. Full details of the assessment undertaken can be found in the FRA (Appendix 12B, document reference 6.2).

12.10.3 A summary of applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 12A (document reference 6.2).

12.10.4 An overview of consultation undertaken to date on the Scheme is provided in ES Chapter 5: Consultation. Specifically, to this assessment, PINS and the Environment Agency have provided consultation responses. The consultation responses have been taken into account within the Chapter and its supporting Appendices.

12.10.5 The following effects have been considered insignificant and have therefore not been assessed further:

- The confluence between the River Waveney and the River Yare is located approximately 8 km upstream of the Principal Application Site. The distance to the River Waveney is considered sufficient such that no impact is likely to result from the Scheme, hence the River Waveney has not been considered further within the ES.

- No surface water features are found within the Satellite Application Sites, and the works associated with these will be minimal, their effects on the water environment have not been assessed further within the ES.

12.10.6 The desk study involved the collation and analysis of available data on flood risk; and the production of the FRA for the Scheme, contained with Appendix 12B (document reference 6.2). The FRA has been carried out in accordance with the NPSNN, NPSP, NPPF and the associated PPG.

12.10.7 The main source of flooding to the Scheme is tidal. A 1D/2D Flood Modeller-TUFLOW model of the River Yare and its surrounding floodplain in Great Yarmouth has been developed for this assessment. The model has been used to assess the following scenarios:

- Present Day Baseline – to establish the existing flood risk to the Scheme site;
- Future Baseline Climate Change – to establish the risk of flooding to the Scheme site with future climate change;
- Future Baseline H++ - to establish the risk of flooding to the Scheme site for a credible maximum flood scenario (high risk, low probability);
- Present Day Scheme – to establish flood risk to the Scheme and the impact of the Scheme on flooding elsewhere in the present day conditions;
- Future Scheme Climate Change – to establish flood risk to the Scheme and the impact of the Scheme on flooding elsewhere with future climate change;
- Future Scheme H++ - to establish flood risk to the Scheme and the impact of the Scheme on flooding elsewhere for a credible maximum flood scenario.

12.10.8 Three flood return periods have been assessed using the flood model developed for this assessment; these are:

- 5% Annual Exceedance Probability (AEP) event (there is a 5% chance in any given year that a flood event of this magnitude will occur);
- 0.5% AEP event (tidal Flood Zone 3) (there is a 0.5% chance in any given year that a flood event of this magnitude will occur); and
- 0.1% AEP event (tidal Flood Zone 2) (there is a 0.1% chance in any given year that a flood event of this magnitude will occur).

12.10.9 The results of the model runs representing the Scheme scenario have been compared to the baseline model results for each simulation. Changes in water level between the baseline and Scheme scenarios within the River Yare channel and on the floodplain have been assessed. In order to understand the significance of any change in flood risk between the baseline

and Scheme scenarios, the approach has been based on that published in Volume 11, Section 2, Part 5 of the Design Manual for Roads and Bridges (DMRB) (HA 205/08), updated as necessary to take account of the 2017 EIA Regulations and the NPPF (PPG).

12.10.10 The EA is currently in the process of designing upgrades to the flood defences through Great Yarmouth. Works to upgrade the defences are programmed to start in December 2019 with completion programmed for September 2020. The design of the defence upgrades is not finalised and as such this assessment adopts a conservative approach and assumes the defence levels and alignment through Great Yarmouth remain as existing for the future baseline scenario.

12.10.11 All sources of flooding are considered in the FRA (Appendix 12B, document reference 6.2). Tidal flooding is the most significant flood risk to Great Yarmouth and as such is discussed in detail, here in the Chapter. The Scheme was found to have the greatest impact on tidal flooding within the FRA. The FRA also found that groundwater flooding may pose a risk to the Scheme during construction and that the Scheme could increase surface water runoff and potentially lead to increased surface water flooding in the vicinity of the Scheme.

12.10.12 During the operation phase, flood risk from sewers, groundwater, reservoirs, canals and pumping stations was found to be negligible meaning that the significance of each of these sources of flood risk during operation to the Principal Application Site is neutral. During the construction phase, flood risk from sewers, reservoirs, canals and pumping stations was found to be negligible and therefore the significance of each of these sources of flood risk during construction to the Principal Application Site is neutral.

12.10.13 The change in flood risk from the Baseline to Scheme scenario for the Present Day tidal events was found to be significant. The maximum increase in water level as a result of the Scheme in the 0.5% AEP Present Day event was 0.1m (minor adverse) at Southtown Common. A moderate adverse impact was also found to residential receptors within the study area for the same event. The change in flood hazard categorisation between the Baseline and Scheme scenarios for the Present Day tidal flood event is minimal and no receptors are moved to a higher flood hazard category as a result of the Scheme.

12.10.14 The impact of the Scheme on tidal flood risk for the Climate Change events is less than for the Present Day events with the only significant effect in the 0.5% AEP Climate Change event being moderate beneficial. All other impacts are not significant in the 0.5% AEP Climate Change scenario.

12.10.15 The H++ scenario has been assessed to understand the full picture of risk in Great Yarmouth but the Scheme does not need to be designed and

mitigated to this level. The impact of the Scheme in the H++ scenario is less than for the Climate Change scenario as the tidal water levels are much higher lessening the impact of the constriction posed by the bridge knuckles in the channel. The difference in depth and extent of flooding between the Baseline and Scheme scenarios for the 0.5% AEP H++ event is negligible.

12.10.16 There are increases in water level of up to 0.13m in the Scheme scenario compared to the Baseline scenario for the 0.5% AEP Present Day tidal flood event. However, this impact is over a very small area and affects two properties. For the 0.5% AEP Climate Change event, the predicted increase is up to 0.07m in the Scheme scenario compared to the Baseline in the same location. This is classified as a slight adverse impact. Given that there are only two properties within the area where the Scheme was found to have a moderate adverse impact in the Present Day scenario and for other receptors in Great Yarmouth there is only a slight adverse impact in the Present Day and Climate Change scenarios, using professional judgement it is deemed impracticable to provide specific mitigation for the two properties to reduce the level of flooding in these circumstances. The Scheme is essential infrastructure that has to be located in Flood Zone 3 as it has to cross the river, therefore the impact on water levels in Great Yarmouth is unavoidable. The modelled hazard outputs show that the Scheme does not increase flood hazard to any properties. However, mitigation in the form of an emergency preparedness and response plan can be provided to reduce the risk to life and to property, which if implemented appropriately would mean that the significance of flooding to the two properties in question would be reduced from moderate adverse to slight adverse.

12.10.17 In terms of the safety and operability of the Scheme, the bridge deck itself is not predicted to flood in any of the scenarios modelled for this assessment (including the H++ events). However, parts of the approach roads on either side of the bridge are predicted to flood. Given the Baseline level of flood risk within Great Yarmouth, it is not possible to completely remove the risk of flooding to the access roads during tidal flood events. Ideally, all elements of the Scheme would be raised above the 0.5% AEP Climate Change tidal flood level but this would involve significant raising of the approach roads to the bridge and would likely render the design impractical.

12.10.18 Given the Baseline level of flood risk within Great Yarmouth, it is not possible to completely remove the risk of flooding to the access roads during a tidal flood event. As safe access/egress cannot be achieved, an emergency flood plan must be considered. Due to the existing significant flood hazard to Great Yarmouth, there are already emergency procedures in place to be implemented during times of flood including the Norfolk Strategic Flood Plan (Ref 12.13) and the Norfolk Tactical Flood Plan (Ref 12.14). The response to significant flood events is coordinated by the Norfolk Resilience Forum (made up of the emergency services, local authorities, volunteer

organisations and PPGY), any response is based on the predicted severity of the flood event. However, any existing emergency procedures will not address the issues specific to the Scheme and additional mitigation is recommended. It is recommended that the bridge deck of the Scheme is closed for public use during major flooding events in order to prevent vehicles or people becoming stranded. It should be noted that as the major risk of flooding in Great Yarmouth is from tidal sources, which can be predicted 24-48 hours in advance, there would be time for event specific appropriate action to be taken to reduce risk to life and property.

12.10.19 An initial high-level assessment of the impact of the Scheme on surface water flood risk has been assessed by calculating surface water runoff from the seven discrete areas of the Principal Application Site for both the greenfield and post-Scheme scenario. The Scheme will result in an increase in impermeable area compared to the existing site and will in turn lead to an increase in the surface water runoff for the Principal Application Site post-development. The Drainage Strategy (Appendix 12C, document reference 6.2) should be referred to for details of how surface water runoff from the Principal Application Site will be managed. The Drainage Strategy includes details of the embedded mitigation for surface water flooding within the Scheme, which means that the significance of surface water flooding at the Principal Application Site is neutral.

12.10.20 Tidal and groundwater flooding were found to be potential risks during construction. Due to the relatively short lifespan of the construction phase, a flood management plan should be prepared for the site as part of the full Code of Construction Practice (CoCP). Given the low likelihood of a significant flood event occurring during the construction phase, the implementation of a flood management plan is sufficient mitigation to ensure that the significance of tidal and groundwater flooding during construction are neutral or slight. A flood management plan will be provided within the full CoCP.

Table 12.18: Summary of Effects Table for Flood Risk

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Tidal Flooding	Scheme	Neutral or slight adverse	n/a	Neutral or slight adverse
Groundwater Flooding	Scheme	Neutral or slight adverse	n/a	Neutral or slight adverse
Operational Phase				
Tidal Flooding	Police Investigation Centre, Thamesfield Way	Moderate beneficial	Reduction in risk of flooding with Scheme in place.	Moderate beneficial
Tidal Flooding	Great Yarmouth Fire Station	Slight beneficial	Reduction in risk of flooding with Scheme in place.	Slight beneficial
Tidal Flooding	Residential properties on west bank of River Yare to south of Scheme	Moderate adverse	Emergency Preparedness and Response Plan	Slight adverse
Tidal Flooding	Residential properties to north of Scheme (west and east banks	Slight beneficial	Reduction in risk of flooding with Scheme in	Slight beneficial

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	of River Yare)		place.	
Tidal Flooding	Commercial properties on west bank of River Yare to south of Scheme	Slight adverse	Emergency Preparedness and Response Plan	Neutral or slight adverse
Tidal Flooding	Commercial properties to north of Scheme (west and east banks of River Yare)	Slight beneficial	Reduction in risk of flooding with Scheme in place.	Slight beneficial
Tidal Flooding	Water compatible commercial properties to south of Scheme on east bank of River Yare	Neutral	Emergency Preparedness and Response Plan	Neutral
Tidal Flooding	Water compatible commercial properties to south of Scheme on west bank of River Yare	Slight adverse	Emergency Preparedness and Response Plan	Neutral or slight adverse

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Increase in surface water runoff from Application Site	Any receptors close to the Application Site	Neutral	n/a	Neutral

12.11 References

Ref 12.1: European Union (2007), Floods Directive (2007/60/EC).

Ref 12.2: Department for Transport (2014), National Policy Statement for National Networks.

Ref 12.3: Department for Transport (2012), National Policy Statement for Ports.

Ref 12.4: Ministry of Housing, Communities & Local Government (2018), National Planning Policy Framework.

Ref 12.5: Great Yarmouth Borough Council (2015), Great Yarmouth Local Plan – Core Strategy 2013 – 2030.

Ref 12.6: JBA Consulting (2017), Great Yarmouth Strategic Flood Risk Assessment.

Ref 12.7: Environment Agency (2009), Broadlands Rivers Catchment Flood Management Plan.

Re12.8: Met Office (2018), “UKCP18 for UKCP09 users”, UKCP18 Guidance.

Ref 12.9: Ministry of Housing, Communities & Local Government (2014), Flood Risk and Coastal Change Planning Practice Guidance.

Ref 12.10: Defra/Environment Agency Flood and Coastal Defence R&D Programme (2006), Flood Risks to People Phase 2 FD2321/TR2 Guidance Document.

13 Climate Change

13.1 Introduction

13.1.1 This chapter reports the outcome of the assessment of likely significant effects of the Scheme in relation to climate change, based on data currently available and gathered at this point of the assessment process. It considers the effects in terms of:

- The contribution of the Scheme to climate change: the greenhouse gas (GHG) emissions assessment under Section 13.5; and
- The assessment of the vulnerability of the Scheme to climate change (climate change resilience and adaptation) under Section 13.6.

13.1.2 The chapter describes the assessment methodology, baseline conditions, any embedded or additional mitigation measures adopted for the purposes of the assessment. It provides a summary of the likely significant effects taking into account national legislation and describes additional mitigation measures required to reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

13.1.3 This chapter (and its associated plates, figures and appendices) is intended to be read as part of the wider ES.

13.2 Competent Expert

13.2.1 The climate change lead, Caroline Jones, is a Senior Environmental Consultant who holds a BSc (Hons) degree in Geography from The University of Plymouth (1999). The climate change lead has significant experience regarding writing climate change chapters for road infrastructure schemes and sector specific experience in material and waste chapters, environmental audit and due diligence, and environmental management systems.

13.2.2 The GHG sections of this chapter have been reviewed by James Peet, a Principal Environmental Consultant who holds a MSc. James has over seven years of environmental and sustainability experience specialising in carbon management and EIA.

13.2.3 The climate change resilience and adaptation sections of the chapter have been reviewed by Nikki van Dijk, a Chartered Associate Environmental Consultant who holds an MSc in Climate Change. Nikki has significant experience in preparing and reviewing climate chapters and is a member of the IEMA working group to review and update EIA guidance regarding climate change resilience and adaptation.

13.3 Legislative, Policy and Guidance Summary

13.3.1 Table 13.1 provides a summary of the key policy and guidance for this assessment.

13.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 13A (document reference 6.2).

Table 13.1: Summary of Key Policy and Guidance

Policy / Guidance	Summary	Chapter Reference
National Policy Statement for National Networks (2014)	The NPS NN (Ref 13.2) sets out Government policy on national networks and identifies that the transport sector will play an important part in meeting the Government's carbon targets through technological innovation (paragraph 3.14) and sustainable modes of transport (paragraph 3.15 and 3.16). In relation to climate change adaptation, the policy states that *"New national networks infrastructure… will need to remain operational over many decades. Consequently, applicants must consider the impacts of climate change"* (paragraph 4.40), through the application of *"…the UK climate projections"* using the *"…high emissions scenarios…against the 2080 projections at the 50% probability level"* (paragraph 4.41). The policy states that it should be demonstrated *"…that there are no critical features of the design of new national networks infrastructure which may be seriously affected by more radical changes to the climate, beyond that projected in…UK climate projections. Any potential critical features should be assessed taking account of the latest credible scientific evidence…and on the*	This chapter has considered the impacts of carbon (GHG emissions) from the Scheme (see Section 13.5). Section 13.6 (and the accompanying appendices (Appendix 13B and 13C (document reference 6.2)) reviews the impacts of climate change and assesses climate resilience of the Scheme. The climate resilience assessment uses the UK Climate Projections 2018 (UKCP18) (Appendix 13B, document reference 6.2) as part of the vulnerability assessment. UKCP18 data is the most up-to-date projections and represents the best current understanding of how climate in the UK will change over the 21st century. The vulnerability assessment uses the

Policy / Guidance	Summary	Chapter Reference
	basis, that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime through potential further mitigation or adaptation" (paragraph 4.43). Chapter 5: Generic Impacts (Carbon emissions paragraph 5.16 to 5.19) sets out Government policy on climate change and outlines the importance of reducing carbon emissions, stating that the Government has a legally binding commitment to reduce greenhouse gas emissions by *"at least 80% by 2050"* and to conform to Carbon Budgets outlined in the *"Carbon Plan 2011"*. The policy states that *"Carbon impacts will be considered as part of the appraisal of scheme options (in the business case), prior to the submission of an application for DCO"* (paragraph 5.17) and that *"any Environmental Statement will need to describe an assessment of any likely significant climate factors in accordance with the requirements in the EIA Directive"*. However, it goes on to say that *"It is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets. However, road projects applicants should provide evidence of the carbon impact of the project and an assessment against the Government's Carbon Budgets"* (paragraph 5.17). The policy also states that *"an increase in carbon emissions is not a reason to refuse development*	high emissions scenarios (termed RCP8.5 in UKCP18) for the 2080s using the 50% percentile projections. The vulnerability assessment includes extreme climate change scenarios (Appendix 13B, document reference 6.2). The findings of the climate resilience assessment, summarised in Table 13.24, provides a resilience rating of the Scheme components to climate change and also present a significance assessment. The GHG emissions chapter, notably Section 13.5, considers the carbon impacts of the Scheme. Table 13.8, Table 13.9 and Table 13.12 compares the calculated GHG emissions from the Scheme with the UK Government Carbon Budgets.

Policy / Guidance	Summary	Chapter Reference
	consent, unless the increase in carbon emissions resulting from the proposed Project are so significant that it would have a material impact on the ability of Government to meet its carbon reduction targets". The Policy states that the Government's Carbon Plan 2011 *"…includes a range of non-planning policies which will…ensure that any carbon increases from road development do not compromise its overall carbon reduction commitments". "Therefore, any increase in carbon emissions is not a reason to refuse development consent, unless the increase…is so significant it would have a material impact on the ability of the Government to meet its carbon reduction targets"* (paragraph 5.18). Evidence of mitigation measures should be presented for the Secretary of State to consider the effectiveness of such mitigation to ensure that the carbon footprint is not unnecessarily high. In relation to climate resilience, Chapter 5 sets out key considerations for infrastructure projects that are proposed on or near the coast. Developments in these areas are required to *"undertake an assessment of the vulnerability of the proposed development to coastal change, taking account of climate change, during the project's operational life"* (paragraph 5.71). With regards to the decision-making process, the policy states that *"the applicant must demonstrate that a full account has been taken of the policy on*	Embedded mitigation measures are presented in paragraphs 13.5.25 and Table 13.23. The vulnerability assessment (presented in Appendix 13B, document reference 6.2) includes variables associated with coastal locations (sea level change, storm surge) and other climate change variables consistent with the Scheme and its operational life. Variables assessed as medium or high vulnerability are taken forward for further risk assessment (Appendix

Policy / Guidance	Summary	Chapter Reference
	assessment and mitigation…taking account of the potential effects of climate change on these risks" (paragraph 5.78). Chapter 5 also acknowledges the fact that climate change will likely lead to an *"increased flood risk in areas susceptible to flooding, and to an increased risk of flooding in some areas which are not currently thought of as being at risk"* (paragraph 5.93). It also states that an applicant's assessment should *"identify and assess the risks of all forms of flooding to and from the Scheme and demonstrate how these flood risks will be managed, taking climate change into account"* by taking *"the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made"* when preparing the Flood Risk Assessment (paragraph 5.94).	13B, document reference 6.2). The final steps of the climate resilience assessment has taken account of embedded mitigation measures (Table 13.23) to determine the resilience rating of the Scheme components. Climate change in relation to flood risk is considered further in the Chapter 12: Flood Risk (document reference 6.1).
National Policy Statement for Ports (2012)	The NPS for Ports (Ref 13.10), in relation to greenhouse gases, states that *"new port infrastructure should…minimise the emissions of greenhouse gases from port related development"* (paragraph 3.3.3). It is recognised that *"Port developments may have an effect on greenhouse gases, particularly through their impact on sea and road transport"* and that impact may be positive if there is a shift from road to shipping or rail transport (paragraph 4.12.1). The policy states that *"Given the international nature of shopping and the difficulties in estimating and attributing GHGs…measures to address emissions from ships on*	This chapter has considered the impacts of carbon (GHG emissions) from the Scheme in relation to inland transport needs (see Section 13.5). Section 13.6 (and the accompanying appendices (Appendix 13B and 13C, document reference 6.2) assesses climate resilience of the Scheme.

Policy / Guidance	Summary	Chapter Reference
	international journeys are…not included in the national targets recommended by the Committee on Climate Change" (paragraph 4.12.2). Paragraph 4.12.5 discusses inland transport and states that *"where the development will lead to significant increases in inland transport needs, the estimated impact on CO_2, and other greenhouse gases if significant, will need to be covered in the Environmental Statement"*. In reference to climate adaptation, the policy states that *"… applicants must consider the impacts of climate change when planning the location, design, build and operation of new port infrastructure"* (paragraph 4.13.6). The policy also states that "… *the decision-maker should satisfy itself that there are not critical features of the design…which may be seriously affected by more radical changes to the climate beyond that projected in the…UK Climate Projections"* (paragraph 4.13.11).	The GHG assessment (Section 13.5) includes an assessment from end -user traffic emissions (regional traffic flows). The vulnerability assessment (presented in Appendix 13B, document reference 6.2) includes variables associated with coastal locations (sea level change, storm surge) and other climate change variables consistent with the Scheme and its operational life. The vulnerability assessment includes extreme climate change scenarios (Appendix 13B, document reference 6.2). The findings of the climate resilience assessment (Table 13.24) present the significance of key components of the Scheme, including criterial features and provides a significance rating resilience to climate change.

Policy / Guidance	Summary	Chapter Reference
National Planning Policy Framework (2019)	Paragraph 8 of the NPPF (Ref 13.1) includes in the definition of the environmental objective *"mitigating and adapting to climate change, including moving to a low carbon economy"*. Chapter 9: Promoting Sustainable Transport, encourages the pursuit of *"…opportunities to promote walking, cycling and public transport…and offer a choice of genuine transportation modes"* (paragraphs 102 and 103). Chapter 14: Meeting the Challenge of Climate Change, Flooding and Coastal Change, establishes that Local Planning Authorities *"should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure"* (paragraph 149).	Not directly applicable to this chapter. Appendix 13A (document reference 6.2) provides a summary of applicable legislation in order to provide an overview of the UK commitment to climate change and requirements to consider climate change impacts on development and infrastructure. Climate change in relation to flood risk is considered further in the Chapter 12: Flood Risk.
IEMA (2017), Environmental Impact Assessment Guide to: Assessing GHG Emissions and Evaluating their	The guidance document has been produced to aid practitioners with addressing GHG emissions assessment and mitigation in statutory and non-statutory EIAs, in line with the 2014 amendment to the EIA Directive (2014/52/EU). The guidance document covers	The guidance has been used throughout the greenhouse gases part of the chapter see Section 13.5. Specific application of the IEMA guidance is presented in the Assessment

Policy / Guidance	Summary	Chapter Reference
Significance (Ref 13.3)	screening, scoping, baseline, assessment methodology, significance and mitigation.	Methodology and Significance Criteria section (from paragraph 13.5.8).
IEMA (2015), Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (Ref 13.8)	The guidance document provides a framework for the effective consideration of climate changes resilience and adaptation in EIA, in line with the 2014 amendment to the EU EIA Directive (2014/52/EU). The guidance document covers legislation and policy setting, identifying future climate, building climate resilience into the project, and integration climate change adaptation into the EIA.	This guidance has been used throughout the climate resilience part of this chapter, see Section 13.6.

13.4 Scope

Scope of the Assessment

13.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

13.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

13.4.3 Table 13.2 and 13.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 13.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
4.7 Climate Change: ID 1: Ref Table 31 Construction – land use, land use change and	PINS	This chapter has been produced in line with the Scoping Report. No

Scoping Opinion Item	Consultee	Response
forestry: *"The Inspectorate agrees that effects in relation to forestry can be scoped out of the ES on the basis that no forestry receptors will be affected by the Proposed Development.* *The SoS also agrees that climate change effects associated with the land take for the scheme can be scoped out of the assessment on the basis that climate change (and in particular GHG emissions) associated with construction activities and emissions associated with construction, such as materials used and transportation to and from site, are to be assessed in the ES".*		further action required.
4.7 Climate Change: ID 2: Ref Table 31 Operation – end-user emissions (regional traffic flows): *"Table 31 of the Scoping Report states that end-user emissions during operation will be included within the air quality assessment. The Applicant should avoid duplicating assessments in the ES; however, the ES should ensure that climate change impacts associated with the emissions of end users during operation is described and assessed.*	PINS	End user GHG emissions are presented in this chapter as part of the baseline and assessment, see Table 13.9 and from paragraph 13.5.36.

Scoping Opinion Item	Consultee	Response
It is not currently clear whether the Air Quality aspect chapter will present this assessment or whether it will be included in the Climate Change aspect chapter".		
4.7 Climate Change: ID 3: Ref Table 31 Operation – Operation and Maintenance activities: *"The Inspectorate agrees that greenhouse gas emissions associated with the lighting of the operational Proposed Development are unlikely to be significant on the basis that lighting is expected to be efficient LED units providing some reduction in emissions compared to the baseline. Therefore, operation and maintenance of lighting can be scoped out of the impact assessment"*.	PINS	This chapter has been produced in line with the Scoping Report. No further action required within this chapter. The lighting specification will be secured by DCO requirement through the Lighting Report (Appendix D of the Design Report) (document reference 7.4).
4.7 Climate Change: ID 3: Ref Table 31 Operation – Repair, Replacement and Refurbishment activities: *"The Scoping Report proposes to scope out repair, replacement and refurbishment activities on climate change. The Scoping Report states that the key source of greenhouse gas emissions during repair, replacement and*	PINS	This chapter has been produced in line with the Scoping Report. No further action required.

Scoping Opinion Item	Consultee	Response
refurbishment of the Scheme would be an increase in emissions proportional to the increase in the pavement area. *The Inspectorate agrees that GHG emissions associated with repair, replacement and refurbishment activities during operation can be scoped out of the assessment on the basis that these are likely to be small-scale replacement of components and occasional resurfacing and therefore significant effects are unlikely to occur".*		
4.7 Climate Change: ID 5: Ref Paragraph 6.8.19 Decommissioning: *"The Scoping Report proposes to scope out decommissioning of the Scheme. The justification given is that decommissioning would take place far into the future, and there is uncertainty regarding the decommissioning process and associated emissions.* *The Inspectorate agrees that decommissioning can be scoped out of the assessment on the basis that decommissioning of the Scheme is unlikely to occur in the foreseeable*	PINS	Information on the design life and decommissioning has been included in Chapter 2: Description of the Scheme. Decommissioning of the Scheme remains out of scope of this chapter as this is considered to be too far into the future for any certainty in the decommissioning process and associated GHG emissions.

Scoping Opinion Item	Consultee	Response
future. *The Applicant's attention is, however, directed to the comments in Section 2.3 (paragraph 2.3.9) of this Opinion and the need to provide more information with regards to the design life of the Proposed Development and any need to decommission elements of the Proposed Development, including timescales. Should further detail become available regarding decommissioning to enable an assessment of climate change at this life cycle stage, an assessment should be presented in the ES where significant effects are considered to be likely".*		
4.7 Climate Change: ID 6: Ref Paragraph 6.8.6; Table 29 Baseline data - UKCP09 Projections: *"The assessment of potential impacts of climate change should use the latest UK Climate Projections. This should include the anticipated UKCP18 projections, where available and appropriate".*	PINS	The baseline data (presented in Appendix 13B (document reference 6.2)), has been prepared using UKCP18 data (Ref 13.11). However, at the time of writing this chapter, UKCP18 projection data for snowfall and relative humidity is not available. Information on projected climate for these variables has therefore been taken from the previous projections, UKCP09 (ref 13.7). Refer to Appendix

Scoping Opinion Item	Consultee	Response
		13B (document reference 6.2) and the assessment methodology within this chapter (from paragraph 13.6.2).
4.7 Climate Change: ID 7: Ref Paragraph 6.8.16 Assessment methodology – *Guidance:* *"The Scoping Report states that Transport Analysis Guidance (WebTag) Chapter 4: Greenhouse Gases will be used to inform the GHG assessment. The Inspectorate notes that this guidance is an 'appraisal methodology' intended for the development of business cases, applicable to highways and public transport interventions and not necessarily for the purposes of undertaking EIA. The Inspectorate acknowledges that the appraisal advocated by this guidance is intended to complement EIA; however, the Applicant should also take care to ensure that the methodology applied is sufficient to identify and assess the likely significant effects from the Scheme".*	PINS	The assessment methodology for this chapter is presented from paragraph 13.5.8. The Transport Analysis Guidance has been utilised to quantify traffic data for the operational phase end-user GHG emissions specifically. This quantitative assessment forms the basis of the EIA assessment of this emissions source by providing emissions magnitude. This then enables the significance of emissions to be determined and is considered to be a suitable approach to identify and assess likely significant effects from the Scheme.
4.7 Climate Change: ID 8: Ref Paragraph 6.8.17 and	PINS	The assessment methodology, including determination of significance, is presented

Scoping Opinion Item	Consultee	Response
6.8.21 Assessment methodology – Significance: *"The Scoping Report states that no specific criteria currently exist to determine significance for the Climate Change aspect chapter.* *The Scoping Report does not provide a methodology or significance criteria; therefore, the Inspectorate is unable to comment on the suitability of the criteria to be used. The Climate Change aspect chapter should clearly describe the methodology applied to the Climate Change impact assessment presented in the ES. It should also state how significance has been determined, and where professional judgement has been applied (where applicable)"*.		from paragraph 13.5.8.
4.7 Climate Change: ID 9: Ref Paragraphs 6.8.18 and 6.8.28 Limited Information: *"The Scoping Report states that at this stage limited information is available to assess greenhouse gas emissions during construction and operation of the Scheme.*	PINS	The baseline reflects the do-nothing scenario i.e. no construction activity. Construction data (as provided by the Design Team and professional judgement) and end user GHG emissions (from regional traffic flows) have been used to compete the assessment of effects and is presented in

Scoping Opinion Item	Consultee	Response
The Applicant must ensure the assessment provided in the ES is informed by relevant baseline information. In particular, the baseline should establish the quantities of materials and emissions from the construction process. Any limitations in the process of obtaining baseline information should be clearly stated, together with how this may affect the results of the assessment".		Table 13.10. Limitations are clearly stated from paragraph 13.5.48.
4.7 Climate Change: ID 10: Ref Paragraph 6.8.20 Highways England Climate Tool: *"The Scoping Report states that emissions calculations will be completed within Highways England's carbon tool; however, no further details have been provided, so the Inspectorate is unable to provide any comments on its suitability. The ES should clearly explain the calculation tool used for the impact assessment and provide a justification for its selection"*.	PINS	Justification for the use of the Highways England Carbon Tool is provided in paragraph 13.5.13.
4.7 Climate Change: ID 11: Ref Paragraph 6.8.27 Presentation: *"The Scoping Report acknowledges that other*	PINS	Where appropriate, cross referencing to other relevant chapters has been included within this chapter.

Scoping Opinion Item	Consultee	Response
aspect chapters will be including an assessment of climate change matters, such as the assessment of climate resilience related to the proposed drainage system and flooding to be included in the Flooding and Water Environment aspect chapters, and assessment of traffic emissions to air presented in the Air Quality aspect chapter. The Inspectorate does not wish to see duplication of text within numerous chapters but recommends that the Climate Change aspect chapter clearly summarise and cross-refer to the relevant matters included elsewhere in the ES, to ensure that all necessary climate change matters have been assessed".		

Table 13.3 – Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
Please be aware that the next set of climate change projections (UKCP18) replacing UKCP09 is due by the end of 2018. If this guidance is published before the FRA is finalised you must take note of this updated guidance and discuss with the Environment Agency, as to whether you need to change the	Environment Agency	The comment relating to FRA does not form part of this chapter. The baseline data (presented in Appendix 13B, document reference 6.2), has been prepared using UKCP18 data (Ref 13.11). However, at the time of writing this chapter, UKCP18 projection data for snowfall and relative

Section 42 Item	Consultee	Response
climate change scenarios to follow the new guidance.		humidity is not available. Information on projected climate for these variables has therefore been taken from the previous projections, UKCP09 (ref 13.7). Refer to Appendix 13B (document reference 6.2) and the assessment methodology within this chapter (from paragraph 13.6.2).

13.4.4 No further consultation activity has been undertaken in support of the preparation of this chapter.

13.4.5 Details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Insignificant Effects

13.4.6 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would be insignificant and have therefore not been considered further in the assessment:

- The vessel waiting facilities. Due to the negligible quantity of materials required and the floating nature of the facilities, it is unlikely to be affected by the climate change scenarios presented;
- The relocation of existing allotments. As the replacement allotment area is of comparable size, any change in GHG emissions would be negligible; and
- Construction phase GHG emissions associated with materials required for signage and lighting. Not significant due to the negligible quantity of materials required.

13.5 Greenhouse Gases

Scope, Methodology and Significance Criteria

Likely Significant Effects

Construction Phase

13.5.1 Table 13.4 presents the key GHG emissions sources associated with the construction stage of the Scheme.

Table 13.4: Construction Phase Key GHG Emission Sources for the Scheme

Lifecycle Change	Key GHG Source
Product stage (manufacture and transport of raw materials to suppliers)	Manufacture and supply of materials (e.g. steel, reinforced concrete, aggregate and asphalt) for: new dual carriageway road comprising a new double-leaf bascule bridge and associated substructure; new control tower and plant room associated with the double-leaf bascule bridge; reinforced earth embankments; new five-arm roundabout and new signalised junction; single span bridge over Southtown Road; and cycle and pedestrian provision. Manufacturing and supply of ancillary equipment (drainage and vehicle restraint systems).
Construction process stage (transport of materials and arisings to/from site; construction process, earth movements)	GHG emissions from construction activity including: • Constructing double-leaf bascule bridge superstructure including the control tower and plant room and single span bridge over Southtown Road; • Delivery and laying of materials for dual carriageway road; reinforced earth embankments; five-arm roundabout; signalised junction; cycle and pedestrian provision; • Export and disposal of site excavations; and • Delivery and installation of drainage and vehicle restraint systems.

Operational Phase

13.5.2 Table 13.5 presents the key sources of GHG emissions associated with the operational stage of the Scheme and the corresponding conclusion of the scoping assessment.

Table 13.5: Operational Phase Key GHG Emission Source for the Scheme

Lifecycle Change	Key GHG Source
End-user GHG emissions (regional traffic flows)	Vehicles using the highway infrastructure. Change in end-user GHG emissions expected from the surrounding network.

13.5.3 It should be noted that the assessment of traffic emissions on air quality (for example NO_x, PM_{10}) is presented in Chapter 6: Air Quality.

Extent of the Study Area

13.5.4 The GHG assessment is not restricted by geographical area, but instead includes any increase or decrease in GHG emissions as a result of the Scheme, regardless of location. This includes construction GHG emissions in the vicinity of the Scheme, but also related to the transport of materials to and from the site, their extraction, manufacture and disposal, for example GHG emissions for manufacture of concrete and steel.

13.5.5 Operational GHG emissions (or reduction in GHG emissions) which result from the end-use of the Scheme and any shifts in transport modes or patterns which may occur. Such GHG emissions include those associated with traffic using the Scheme as well as the surrounding regional road network.

Method of Baseline Data Collation

Desk Study

13.5.6 Baseline data comprises the 'do nothing' scenario which is modelled as part of the air quality assessments. The modelling includes the total GHG emissions for vehicles covering the strategic and local road network in the vicinity of the Scheme and the surrounding region. Modelling has been undertaken for the year 2023, the first year of operation of the Scheme, and the future year 2038 as detailed in the air quality models.

Site Visit

13.5.7 For the purpose of this assessment, no site visit was required.

Assessment Methodology

13.5.8 GHGs are natural and man-made gases occurring in the atmosphere which absorb and emit infrared radiation, thereby maintaining the Sun's energy within the Earth's atmosphere. There is an overwhelming scientific consensus that the major increase in the concentration of GHGs from man-made sources is contributing to global warming and climate change.

13.5.9 The seven main GHGs defined by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). In combination, these GHG emissions are commonly expressed in terms of carbon dioxide equivalents (CO_2e) according to their relative global warming potential. For this reason, the shorthand 'carbon' may be used to refer to GHGs.

13.5.10 In measurement terms, GHG emissions expressed as carbon dioxide equivalent (CO_2e) are given in kilograms ($kgCO_2e$) or tonnes (tCO_2e).

13.5.11 The assessment approach considers the likely magnitude of GHG emissions (or avoided GHG emissions) relative to the baseline scenario with no Scheme, the 'do nothing' scenario. It considers GHG emissions throughout the lifecycle of the Scheme including:

- Construction stage e.g. embodied GHG emissions associated with materials, transportation of materials to site and waste arisings from the Scheme, and the construction process; and
- Operation e.g. GHG emissions (or avoided GHG emissions) from end-user vehicles.

13.5.12 For the construction and operation lifecycle stages and sub-stages of the Scheme the assessment includes the following:

- Collection of available information on the scale of GHG emitting activities for the baseline scenario and for the Scheme e.g. tonnes of concrete, litres of diesel, average daily traffic flows. In each case this covers the whole study period (life cycle of the assets); and
- Calculation of the GHG emissions using a standard emissions calculation methodology applying a suitable emissions factor (e.g. $kgCO_2e$ per tonne of concrete).

GHG Emissions Calculation

13.5.13 GHG emission calculations for the construction stage have been completed within an industry recognised carbon calculation tool which focuses on GHG emissions throughout the project lifecycle. For this particular assessment, Highways England's carbon tool (Ref 13.5) has been used which is considered to be an appropriate tool to use given the nature of the Scheme. The carbon tool multiplies GHG emissions activity (e.g. quantities of material consumed, transport distances, fuel, power) by the relevant emissions factors expressed in carbon dioxide equivalents. Values are reported as tonnes of carbon dioxide equivalents (tCO_2e). Professional judgement, based on the author's knowledge of other schemes, has been applied when interpreting the material and waste data provided by the Design Team for input into the Highways England carbon calculation tool.

13.5.14 The total operational stage end-user GHG emissions from traffic have been modelled as part of the air quality assessments and presented here. The modelling includes the total GHG emissions for vehicles covering the strategic and local road network in the area of the Scheme and its surrounding region.

Significance Criteria

13.5.15 There are currently no agreed thresholds in published guidance for what level of GHG emissions are considered to be significant in an EIA. IEMA guidance (Ref 13.3) states that, *"in the absence of any significance criteria or a defined threshold, it might be considered that all GHG emissions are significant, and an EIA should ensure the project addresses their occurrence by taking mitigating action"* (section 6.1, page 14).

13.5.16 IEMA guidance (Ref 13.3) continues to advise that using professional judgement to contextualise the GHG emissions of the Scheme against pre-determined published carbon budgets will provide a "*good practice approach*".

13.5.17 IEMA guidance (Ref 13.3) and professional judgement, based on knowledge of similar schemes, has been used to assess the significance of effects relating to GHG emissions. This is done by comparing estimated GHG emissions arising from the Scheme (taking into account embedded mitigation) with the respective UK Carbon Budgets (presented in Table 13.6) which have been set by the UK government covering 2018 to 2032, and total road GHG emissions from Norfolk in 2016 It is considered that the impacts are more significant the greater the total GHG emissions and the greater the proportion they represent of the Carbon Budget.

Table 13.6: National Carbon Budgets set by the Government

Carbon Budget Period	UK Carbon Budget
Third: 2018 - 2022	2,544,000,000 tCO_2e
Fourth: 2023 - 2027	1,950,000,000 tCO_2e
Fifth: 2028 - 2032	1,725,000,000 tCO_2e

13.5.18 Paragraph 5.17 of the NPS NN also sets out that *"… it is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets."*

Sensitive Receptors

13.5.19 The impacts of GHGs relate to their contribution to global warming and climate change. These impacts are global and cumulative in nature, with every tonne of GHGs contributing to impacts on natural and human systems. GHG emissions result in the same global effects wherever and whenever

they occur and, therefore, the sensitivity of different human and natural receptors is not considered. The assessment of significance is purely based on the magnitude of the effects (GHG emissions).

Baseline Conditions

Current GHG Emissions Sources and Future Baseline

13.5.20 No construction works are anticipated to take place in the 'do nothing' scenario. The operation and management of the current assets are likely to require a small number or volume specialist components (for example, light bulbs, signage steelwork, kerbstones) as well as some bulk material (e.g. asphalt for minor re-surfacing) for routine maintenance and repair works. These materials will have embodied GHG emissions associated with them. Due to the small materials quantities required, however, GHG emissions are likely to be negligible. The 'do nothing' option would be unlikely to change the emission sources generated by the current consumption of materials within the Application Site for the Scheme.

13.5.21 Total end-user GHG emissions from traffic (modelled as part of the air quality assessments) are presented in Table 13.7 for the baseline 'do nothing' scenario and future baseline year 2038. Total GHG emissions are expected to increase by 11.7% between 2023 (operational year) and 2038 (future year) as traffic growth outweighs increased vehicle efficiency. The total end-user traffic GHG emissions based on a 60-year operational life of the Scheme (2023 to 2083) are also presented along with the average annual GHG emissions for that period. The Scheme bascule bridge will be designed to have a life of at least 120 years, however it is not considered proportionate to model GHG emissions beyond a 60-year timeframe for the Scheme due to a lack of certainty in GHG emissions beyond this timeframe.

Table 13.7: Baseline GHG Emissions Data for End User Traffic in the Region of the Scheme

Scenario	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO_2e)			
	2023 (operational year)	2038 (future year)	Average per year (2023 – 2083)	Total (2023 - 2083
Baseline ('do nothing')	59,008	65,931	65,008	3,900,476

13.5.22 Total CO_2e emissions are expected to increase after 2023 (opening year). This is because the effects of increased vehicle numbers (traffic growth) dominate over improvements to vehicle emission rates, in terms of the overall mass of CO_2e emissions.

Establishing the Scenario for Assessment

Construction Phase

13.5.23 In the 'do-something' scenario, the Scheme will change the emission sources through the consumption of new materials, manufacturing and transportation of these materials during its construction. GHG emissions will also occur associated with the construction process stage, including the transport of materials to and from site, and through the use of a construction plant.

13.5.24 Examples of GHG emitting activity sources for the construction phase in the scope of this assessment are presented in Table 13.8.

Table 13.8: Potential Construction Phase GHG Emission Sources

Sub Stage of Lifecycle	Potential Sources of GHG Emissions	Examples of GHG Emissions Generated during Construction
Product stage; including raw material supply, transport and manufacture.	Main works include: • A double-leaf bascule bridge and associated substructure; • Control tower and plant room structures; • Reinforced earth embankments • New five-arm roundabout and signalised junction; • Single span bridge over Southtown Road; • Cycle and pedestrian provision of; and • Additional ancillary equipment such as drainage arrangements and safety barriers.	Construction materials required for this Scheme include: • Bulk materials for earthworks; • Road paving materials, including sub-base and bituminous materials; • Steel – for structures, reinforcement and safety barriers; • Concrete including pre-cast or prefabricated elements; • Aggregate; • Drainage materials; • Timber for fencing and formwork; • Imported topsoil and decorative stone for landscaping; and • Other general construction materials.

Sub Stage of Lifecycle	Potential Sources of GHG Emissions	Examples of GHG Emissions Generated during Construction
Construction process stage; including transport to and from works site, and construction and installation processes.	GHG emissions from the construction stage would include GHG emissions sources such as fuel or energy consumption.	Fuel or electricity consumption and construction activity type and duration. Transportation of materials from point of purchase to site, mode and distance. Generation of waste materials and associated transportation.

13.5.25 A number of embedded mitigation measures to reduce the impact of GHG emissions during construction have been identified and incorporated into the assessment of effects where the mitigation measures affect the estimated material and waste type and quantity data. These mitigation measures include:

- Introduction of seeding on embankments and landscaping to absorb CO_2e emissions as secured by the Landscaping Requirement in the draft DCO (document reference 3.1);
- Re-using site-won arisings where practicable, minimising transportation and manufacture of raw materials as secured by the Outline CoCP (document ref 6.16); Minimising the number and journey lengths of construction-related transport movements and maximising river transport for key items where practicable. Implemented through the Framework Construction Traffic Management Plan (appended to the CoCP (document reference 6.16));
- Maximising local sourcing of materials, suppliers and waste management facilities where practicable as secured by the Outline CoCP (document ref 6.16);
- Review GHG emissions from transportation and seek to minimise GHG emissions through a no-idling policy, reducing travelling during peak congestion and reviewing the best mode of transport for products. Implemented through the Framework Construction Traffic Management Plan (appended to the Outline CoCP (document reference 6.16));
- Operating a well-maintained fleet of construction vehicles and using mains electricity of battery powered equipment over diesel and petrol-powered equipment where practicable. Implemented by the Framework Construction Traffic Management Plan (appended to the Outline CoCP (document reference 6.16)); and

- Implementing a Framework Construction Worker Travel Plan (appended to the Outline CoCP (document reference 6.16)) to minimise GHG emissions from employees and sub-contractors.

Operational Phase

13.5.26 Table 13.9 presents the main GHG emitting activity data for the operational phase in the scope of this assessment.

Table 13.9: Potential Operational Phase GHG Emission Sources

Sub Stage of Lifecycle	Potential Sources of GHG Emissions	Examples of GHG Emissions Generated During Operation
Use of the infrastructure by the end-user.	End-user GHG emissions from the surrounding network will change (increase or decrease).	Traffic count, vehicle type and speed by vehicle type for highway links.

13.5.27 No embedded mitigation has been identified for the operational phase.

Assessment of Effects, Mitigation and Residual Effects

Construction Phase

Likely Significant Effects

13.5.28 The total estimated GHG emissions arising from the construction phase of the Scheme have been calculated using the Highways England Carbon Tool (Ref 13.4) as presented in Plate 13.1.

13.5.29 Table 13.10 provides a summary of the material and waste types and quantities inputted into the Highways England Carbon Tool. The material and waste types and quantities have been obtained from the Chapter 15: Materials from design estimates and information provided by the Design Team. Professional judgement has been used to input the data into the Highways England Carbon Tool (Ref 13.4).

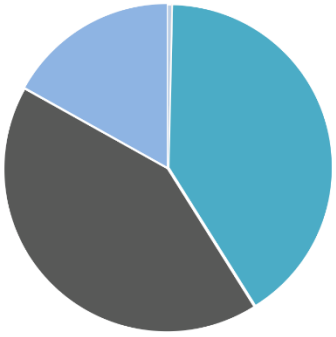
Table 13.10: Material and Waste Types and Quantities for the Scheme

Materials	Approximate Quantity (tonnes)
Concrete (Structural and ST1-ST4)	15,000
Precast concrete (piles, drainage and kerbs)	8,600
Steel	4,800
Topsoil	400
Aggregate	83,500
Asphalt	17,300
Plastic (drainage)	20
Timber	110
Waste	**Approximate Quantity (tonnes)**
Demolition wastes (brick, timber, glass etc)	200
Topsoil, Earthworks, Excavated material from dewatered cofferdam	6,625
Road pavings	900
Concrete	200
Hazardous materials	30
Construction waste (surplus materials)	350

13.5.30 The total GHG emissions arising from material supply, the manufacturing of materials, waste generation and disposal, and transportation of materials to and from site for the construction of the Scheme are estimated to be 22,842 tCO_2e as presented in Plate 13.1.

Materials

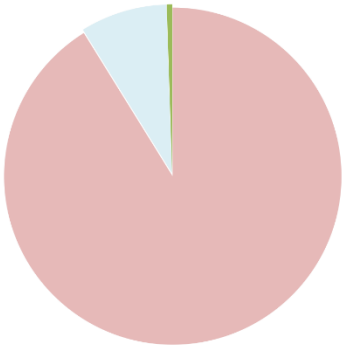
The table and pie chart displayed below show the total CO_2e emissions associated with materials purchased for the contract.



Category	CO_2e Emissions
Fencing / RRS / barriers	0.000
Drainage	67.529
Earthworks	9.600
Pavements	8,477.000
Street furniture	0.000
Civil Structures	8,752.020
Bulk Materials	3,515.800
Total	**20,821.949**

Materials, Transport, Energy and Waste Emissions

This table and pie chart show the total CO_2e emissions associated with materials compared to materials transport, energy use, business and employee transport and waste



Category	CO_2e Emissions
Materials Total	20,821.949
Materials Transport	1,902.299
Energy Use	0.000
Business and Employee transport	0.000
Waste	118.100
Total	**22,842.348**

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Plate 13.1: Total GHG Emissions Breakdown Associated with Materials

13.5.31 The majority (approximately 91%) of GHG emissions are associated with materials (product stage 'cradle to gate' or 'embodied' GHG emissions), with approximately 8% of GHG emissions from transportation and minimal GHG emissions from waste (approximately 0.5%). As noted in the Limitations and Assumptions Section (paragraphs 13.5.48 - 13.5.51), the completion of the Highways England Carbon Tool is based on information provided by the Design Team and completed using professional judgement.

13.5.32 Of the GHG emissions for materials, the majority of GHG emissions are from pavement materials and civil structures (approximately 41% and 42% respectively). The materials comprise aggregate, bituminous materials, concrete and steelwork. Other significant contributions relate to bulk materials (approximately 17%) drainage (approximately 0.3%) and earthworks (approximately 0.05%).

13.5.33 In line with the methodology for assessing significance of effects (paragraphs 13.5.15 to 13.5.17) and in the absence of agreed thresholds for what level of GHG emissions is considered significant in an EIA, IEMA

guidance and professional judgement including previous experience of road infrastructure schemes has been used to assess the significance of effects based on schemes of a similar size and nature.

13.5.34 The magnitude of change in GHG emissions during construction is predicted to be negligible. GHG emissions from the construction of the Scheme is likely to have a neutral impact.

13.5.35 The Scheme is therefore expected to have a **neutral effect** on climate change during construction. IEMA guidance suggests that all GHG emissions are significant in the absence of any significance criteria or defined threshold. However, given the construction phase embedded mitigation measures (paragraph 13.5.24), the magnitude of GHG emissions (reported in paragraph 13.5.34) and the context of the Scheme, using professional judgement it is considered that the neutral effect of this Scheme will **not be significant**. Furthermore, as presented in Table 13.12, the GHG impacts of the Scheme would not have a material impact on the Government meeting its carbon reduction targets.

Operational Phase

13.5.36 The Scheme will result in changes to end-user traffic GHG emissions throughout its operational life, which could be an increase or decrease depending on the effect on traffic flows and speeds. Any increase in GHG emissions and the corresponding concentrations of GHGs present in the atmosphere will contribute to global warming and climate change.

13.5.37 Total end user GHG emissions (modelled as part of the air quality assessments) are presented in Table 13.11 for the year 2023 (the first year of operation for the Scheme) and the year 2038 (the future modelled year). In addition, the average annual and total GHG emissions based on a 60-year operational period of 2023 to 2082 are presented. The baseline figures (without the Scheme) are included for comparison.

Table 13.11: End User GHG Emissions Data for Traffic in the Region of the Scheme

Scenario	Total GHG Emissions for Traffic in the Strategic and Local Road Network (tCO2e)			
	2023 (operational year)	2038 (future year)	Average per year (2023 – 2083)	Total (2023 - 2083
Baseline (‘Do Nothing’)	59,008	65,931	65,008	3,900,476
Scheme (‘Do Something’)	57,949	65,055	64,108	3,846,452

13.5.38 The total regional traffic GHG emissions for the operational lifespan of the Scheme (2023-2082) are 54.024 tCO_2e lower (approximately -1.4%) than the baseline scenario. The decrease in GHG emissions is due to the predicted change in traffic speed and improvements in traffic flow.

13.5.39 The magnitude of change in GHG emissions during operation (as modelled as part of the air quality assessment) is likely to be a slight reduction. Total GHG emissions during the operation of the Scheme are predicted to reduce in comparison to the 'do nothing' scenario, as such, the Scheme is anticipated to have a slight beneficial impact.

13.5.40 Although the operational GHG emissions are forecast to reduce, GHG emission are still being produced by the Scheme. The Scheme is therefore expected to have a **neutral effect** on climate change during operation. IEMA guidance suggests that all GHG emissions are significant in the absence of any significance criteria or defined threshold. However, given the magnitude of GHG emissions (slight reduction) and the context of the Scheme, using professional judgement including previous experience of road infrastructure schemes, it is considered that the neutral effect of this Scheme will **not be significant**. Furthermore, as presented in Table 13.12, the GHG impacts of the Scheme would not have a material impact on the Government meeting its carbon reduction targets.

Scheme Impacts on UK Carbon Budgets and Norfolk 2016 Road Emissions

13.5.41 The total estimated GHG emissions arising from the Scheme are presented in Table 13.12 below. They are presented for the construction stage (2020-2022), the operation stage (2023-2082) and the overall total for the design life (2020-2082) as modelled as part of the Air quality assessment (presented in Chapter 6: Air Quality).

13.5.42 In line with Paragraph 5.17 of the NPS NN (Ref 13.2), and to provide context of the Scheme GHG emissions against pre-determined published carbon budgets to aid the assessment of the magnitude of change to the total GHG emissions during each of the UK National Carbon Budget periods are presented and compared in percentage terms to the respective National budget. The Third Carbon Budget covering 2018 to 2022 is 2,544 million tCO_2e. The Fourth Carbon Budget covering 2023 to 2027 is 1,950 million tCO_2e. The Fifth Carbon Budget covering 2028 to 2032 is 1,725 million tCO_2e (the latest Carbon Budget agreed by the government).

13.5.43 An annual average of the total GHG emissions arising from the Scheme are also presented in comparison with the 2016 road CO_2e emissions for Norfolk in 2016 (Ref 13.6).

Table 13.12: Scheme impacts on Carbon Budgets

Stage / Timing	Total GHG Emissions (tCO_2e)
Scheme GHG Emissions	
Construction phase (2020-2022)	22,842
Operational phase (2023-2082)	-54,024 (approximately -900 per annum)
Total for lifecycle (2020-2082)	-31,158
Comparison of the Scheme GHG Emissions against Carbon Budget	
Total during third Carbon Budget period (2018-2022) (% of budget)	22,842 (0.00090%)
Total during fourth Carbon Budget period (2023-2027) (% of budget)	-5,173 (-0.00027%)
Total during fifth Carbon Budget period (2028-2032) (% of budget)	-4,868 (-0.00028%)
Comparison of 1 Year Operational Scheme GHG Emissions against Norfolk Total Road CO_2e Emissions for 2016	
Norfolk Total Road CO_2e emission estimates 2016 (% of one year's operational phase)	1,064,732 (-0.0845%)

Mitigation

13.5.44 Embedded mitigation measures have been identified for the Scheme and noted in 13.5.25. No additional mitigation measures are required.

13.5.45 The following are additional measures which may be implemented at construction phase but are not necessary for the purposes of assessment.

- Select and engage with material suppliers considering their policies and commitments to reduction of GHG emissions, including embodied GHG emission in materials.
- Ensure designs are focussed upon reduction of GHG emissions from end-user vehicle movement (traffic) for example by providing the conditions for efficient low-carbon vehicles and driving practices, such as increasing capacity, which would potentially result in a reduction in emission per vehicle where congestion is relieved.

- Consideration of temporary features to be incorporated into permanent features throughout the design process.
- Select sustainable and low energy materials where reasonably practicable to do so.
- Standardise sizes of shuttering to allow repeat usage and reduce GHG emission from increased materials usage and waste generation.
- Select size appropriate generators which provide operational bridge functionality whilst minimising GHG emissions.

Residual Effects

13.5.46 No additional mitigation has been identified and therefore residual effects are assessed to be the same as those described above.

Monitoring

13.5.47 No monitoring is considered to be required over and above that which is included in the Outline CoCP (document reference 6.16) and its subsequent development by the Contractor into a full CoCP. The full CoCP, once detailed, will provide a review, monitoring and audit mechanism to determine the effectiveness of and compliance with environmental control measures, which include the consideration manufacturing, transportation and materials supplies.

Limitations and Assumptions

13.5.48 There is currently no specific guidance or carbon emissions threshold, which is considered significant if exceeded. Professional judgement has been used to undertake the assessment based on knowledge of similar schemes and guidance available at the time of undertaking the assessment.

13.5.49 This chapter has been completed based on the information regarding the scale and nature of the Scheme available at the time of writing. Type and quantities of material and waste provided at this stage are indicative, as provided from the Design Team. The type and quantities of materials and waste provided are considered adequate to complete the assessment, based on the current design. Any minor variations are not considered to alter the findings of the assessment.

13.5.50 Professional judgement has been used when completing the Highways England Carbon Tool. Where necessary, WRAP conversion factors (Ref 13.9) have been used to convert units from cubic meters to tonnes. The use of such conversion factors are not anticipated to have a material impact on the assessment findings. Materials such as rubber and packaging have not been included in the Highways England Carbon Tool as no provision for entering these material types is available within the tool. The omission of

these materials is not considered to have a material impact on the assessment findings.

13.5.51 Where information on the anticipated transportation distance of materials has not been provided, transportation scenarios have been taken from RICS (Ref 13.7). The use of such data is not anticipated to have a material impact on the assessment findings.

13.5.52 Estimations of potential contaminated arisings excavated during construction are unknown but are considered to be minimal given the proposed construction methods. The absence of this material within the Highways England Carbon Tool is not anticipated to have a material impact on the assessment findings.

Summary

13.5.53 The baseline ('do nothing') characteristics indicate that no construction is anticipated. The operation and management of the current assets will have associated embodied GHG emissions, but due to the small materials quantities required, GHG emissions are likely to be negligible.

13.5.54 The implementation of embedded mitigation measures is anticipated to reduce adverse effects, particularly in relation to the generation of GHG emissions during the construction phase.

13.5.55 The magnitude of change in GHG emissions, taking into account embedded mitigation measures provided by the Design Team is predicted to be negligible during construction and have a slight reduction during operation. GHG emissions from the construction of the Scheme are expected to have a neutral impact and a slight beneficial impact during operation. Overall, the Scheme is expected to have a **neutral effect** on climate change during construction and a **neutral effect** on climate change during operation. IEMA guidance suggests that all GHG emissions are significant in the absence of any significance criteria or defined threshold. However, given the construction phase embedded mitigation measures, the magnitude of GHG emissions during the construction and operation phase and the context of the Scheme, using professional judgement including previous experience of road infrastructure schemes, it is considered that the neutral effect of this Scheme will **not be significant**. Furthermore, the GHG impacts of the Scheme would not have a material impact on the Government meeting its carbon reduction targets.

13.5.56 The table below presents a summary of the significant effects for GHG emissions.

Table 13.13: Summary of Effects Table for GHG Emissions

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Increase in GHG emissions from manufacture and supply of materials and construction activities	GHG emissions result in the same global effects wherever and whenever they occur and, therefore, the sensitivity of different human and natural receptors is not considered.	Not significant based on identified embedded mitigation (see paragraph 13.5.25) - / P / D / LT	No additional mitigation required.	Not Significant - / P / D / LT
Operational Phase				
Change GHG emissions from end-user emissions (regional traffic flows)	GHG emissions result in the same global effects wherever and whenever they occur and, therefore, the sensitivity of different human and natural receptors is not considered.	Not Significant - / P / D / LT	No additional mitigation required.	Not Significant - / P / D / LT

Key to table:

+ / - = Positive or Negative P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short-Term, Medium-Term or Long-Term N/A = Not Applicable

13.6 Climate Resilience

Scope, Methodology and Significance Criteria

Extent of the Study Area

13.6.1 The assessment of the vulnerability of the Scheme to the impacts of climate change has been informed by regional scale information on historic and projected change in climate variables. The vulnerability of the Scheme to climate change has been assessed against the UK Climate Projections 2018 (Ref 13.11) (UKCP18) projections for the 2080s for the East of England region for a high emissions ('worst-case') scenario (termed Representative Concentration pathway (RCP) 8.5).

Assessment Methodology

13.6.2 In line with published guidance (primarily IEMA (2015), Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation (Ref 13.8) and European Commission (2016), the assessment of climate vulnerability and risk in the EIA process Climate Change and Major Projects, consists of five steps:

- **Step 1**: Identify receptors and analyse policy context;
- **Step 2**: Climate vulnerability assessment;
- **Step 3**: Risk assessment;
- **Step 4**: Adaptation measures and
- **Step 5**: Determination of significance.

13.6.3 Climate resilience relative to the functioning and capacity of the Scheme's drainage system, and the risk of flooding is considered in Chapter 11: Road Drainage and the Water Environment and Chapter 12: Flood Risk.

13.6.4 The PEIR, published for public consultation in August 2018, presented the results of Steps 1 and 2. Step 2 has been updated (specifically the Projected Climate section to include UKCP18. Step 1 is presented partly in Appendix 13A (document reference 6.2) regarding policy context and Appendix 13B (document reference 6.2) presents the identification of receptors and climate vulnerability assessment. Steps 1 and 2 are completed in order to describe the level of vulnerability of the Scheme to the impacts of climate change and determine which vulnerabilities should be assessed further (Steps 3 to 5). This chapter completes the assessment of Steps 3 to 5.

13.6.5 The five-step approach to assessing climate resilience is outlined below.

Step 1: Identify Receptors and Analyse Policy Context

13.6.6 During this stage, relevant receptors which may be affected by climate change are identified, whilst considering the impact of extreme weather and changes in climate on the Scheme over its lifetime. These receptors may comprise both known (i.e. receptors affected by historic weather events) and unknown (new) receptors. This stage includes a definition of the policy context.

Step 2: Climate Vulnerability Assessment

13.6.7 This stage comprises an assessment of the vulnerability of the receptors identified in Step 1 to projected climate change and extreme weather variables. The vulnerability of a receptor to extreme weather and climate change is a function of:

- The typical sensitivity of the receptor to climate variables – based on literature review and professional judgement from knowledge of similar schemes; and
- The exposure of the receptor to projected change in climate variables, based on information on observed climate and projected climate. UKCP18 provide probabilistic projections of future climate for a range of emissions scenarios. However, future GHG emissions and the resultant effects on climate is uncertain. As such, a precautionary approach has been adopted by selecting the RCP8.5 emissions ('worst-case') scenarios for the longest term timeslice (2080s), which offer the longest-term projections into the Scheme timescale.

13.6.8 For each element of the assessment (i.e. sensitivity and exposure), a vulnerability category is assigned to each climate variable relative to each receptor based on the following scale:

- High: High climate sensitivity or exposure;
- Medium: Moderate climate sensitivity or exposure; and
- Low: No significant climate sensitivity or exposure.

13.6.9 This is a qualitative assessment informed by expert opinion and supporting literature.

13.6.10 The vulnerability of receptors to climate variables is determined from the combination of the sensitivity and exposure categorisation, using the matrix shown in Table 13.14. At this point 'Low' vulnerabilities are scoped out of further assessment, whilst 'High' and 'Medium' vulnerabilities are taken forward to Steps 3 and 4.

Table 13.14: Vulnerability Rating

Sensitivity	Exposure		
	Low	Medium	High
Low	Low Vulnerability	Low Vulnerability	Low Vulnerability
Medium	Low Vulnerability	Medium Vulnerability	Medium Vulnerability
High	Low Vulnerability	Medium Vulnerability	High Vulnerability

Step 3: Risk Assessment

13.6.11 Firstly, hazards related to the 'Medium' and 'High' vulnerabilities are identified. Typical hazards are shown in Table 13.15.

Table 13.15: Typical Hazards associated with Climate Variables

Climate Variable	Associated Hazards
Average Air Temperature Change (annual, seasonal, monthly)	Prolonged warm periods, drought, change in growing season. Reduction in ice and snow.
Extreme Air Temperature (frequency and magnitude)	Heatwaves, water availability/drought.
Average Precipitation (annual, seasonal, monthly)	Water availability / drought, flooding (pluvial and fluvial), soil moisture deficit, erosion, snow, ice and hail.
Extreme Rainfall (frequency and magnitude)	Flooding (fluvial and pluvial), subsidence and reduced ground stability, erosion.
Average Wind Speed Change (annual, seasonal, monthly)	Increased wind loading on structures, erosion.
Gales and Extreme Winds (frequency and magnitude)	Storms, lightening, storm surge.
Humidity	Fog.
Solar Radiation	Increased ultra violet radiation.
Sea Level	Sea level rise (plus local land movements), storm surge and tide, coastal flooding.

13.6.12 The risk assessment is undertaken by considering the likelihood of climate hazards occurring and the consequences to Scheme elements. Likelihood and consequence can be qualitatively assessed using the descriptions in Table 13.16 and Table 13.17.

Table 13.16: Qualitative Description of Consequence

Measure of Consequence	Description
Negligible	No infrastructure damage, minimal adverse effects on health, safety and the environment or financial loss. Little change to service and disruption lasting less than one day.
Minor Adverse	Localised infrastructure disruption or loss of service. No permanent damage, minor restoration work required: disruption lasting less than one day. Small financial losses and/or slight adverse health or environmental effects.
Moderate Adverse	Limited infrastructure damage and loss of service with damage recoverable by maintenance or minor repair. Disruption lasting more than one day but less than one week. Moderate financial losses. Adverse effects on health or the environment.
Large Adverse	Extensive infrastructure damage and severe loss of service. Disruption lasting more than one week. Early renewal of 50-90% of the infrastructure. Permanent physical injuries and/or fatalities. Major financial loss. Significant effect on the environment, requiring remediation.
Very Large Adverse	Permanent damage and complete loss of service. Disruption lasting more than one week. Early renewal of infrastructure >90%. Severe health effects or fatalities. Extreme financial loss. Very significant loss to the environment requiring remediation and restoration.

Table 13.17: Qualitative Description of Likelihood

Measure of Likelihood	Description
Very High	The event occurs multiple times during the lifetime of the Scheme e.g. approximately annually.
High	The event occurs several times during the lifetime of the Scheme e.g. approximately once every five years.
Medium	The event occurs limited times during the lifetime of

Measure of Likelihood	Description
	the Scheme e.g. approximately once every 15 years.
Low	The event occurs occasionally during the lifetime of the Scheme e.g. once in 60 years.
Very Low	The event may occur once during the lifetime of the Scheme.

13.6.13 These determinants are then combined to develop a climate risk rating for each element of the Scheme relative to specific climate hazards. The risk assessment is a qualitative assessment based on professional judgment based on knowledge of similar schemes, engagement with the wider Project Team and a review of relevant literature. This process is supplemented with quantitative data and information where available.

Table 13.18: Risk Rating Matrix

Likelihood of Hazard Occurring	Consequence of Hazard Occurring				
	Negligible	Minor Adverse	Moderate Adverse	Large Adverse	Very Large Adverse
Very High	Low	Medium	High	Extreme	Extreme
High	Low	Medium	Medium	High	Extreme
Medium	Low	Low	Medium	High	Extreme
Low	Low	Low	Medium	Medium	High
Very Low	Low	Low	Low	Medium	Medium

13.6.14 An overall risk rating is determined based on the assessment of likelihood and consequence (using Table 13.18), where:

- Extreme Risk – requires immediate action;
- High Risk – requires detailed research and planning at senior management level;
- Medium Risk – requires change to design standard and/or maintenance of assets; and
- Low Risk – requires action through routine maintenance of assets.

Step 4: Adaptation Measures

13.6.15 In the fourth step, adaptation measures for any Extreme, High and Medium risks are identified through expert opinion based on knowledge of similar schemes and consultation with the project team. Accounting for the contribution of incorporated adaptation measures, a summary of the level of climate resilience of the Scheme elements to climate change is applied. This is in line with these descriptions:

- Highly resilient – a strong degree of climate resilience, remedial action or adaptation may be beneficial but is not a priority.
- Moderately resilient – a moderate degree of climate resilience, remedial action or adaptation is suggested.
- Low resilience – a low level of climate resilience, remedial action or adaptation is required as a priority.

Step 5: Determination of Significance

13.6.16 The final step is to determine the significance of climate impacts. This is defined based on the risk rating (pre-mitigation) and the resilience rating (post-mitigation) for each impact, as shown in Table 13.19.

Table 13.19: Determination of Significance

Risk Rating	Resilience Rating		
	High	Moderate	Low
Extreme	Significant	Significant	Significant
High	Not significant	Significant	Significant
Medium	Not significant	Not significant	Significant
Low	Not significant	Not significant	Not significant

13.6.17 Recommendations for supplementary climate change adaptation measures are then identified where necessary.

Assessment Findings

Step 1: Identify Receptors and Analyse Policy Context and Step 2: Climate Vulnerability Assessment Findings

13.6.18 Steps 1 and 2 were completed in the PEIR, which was published for public consultation in August 2018. The Projected Climate section of Step 2 has been updated to include UKCP18 data. Step 1 is presented in Appendix

13A (document reference 6.2). Step 2, the climate vulnerability assessment, is presented in Appendix 13B (document reference 6.2).

13.6.19 The Scheme elements are summarised below and the terms 'road', 'bridges' and 'cycle and footway' used within this chapter, Appendix 13B and 13C (document reference 6.2) comprise the following Scheme elements:

- The 'road' including the new dual carriageway road, five-arm roundabout signalised junction junctions and reinforced earth embankments;
- 'Bridges' including the new double-leaf bascule bridge and associated substructure and 'knuckle' walls and associated control tower, plant room control equipment, and single span bridge over Southtown Road; and
- The 'cycle and footway' comprising the cycle and pedestrian provision.

13.6.20 The overall assessment of vulnerability (output from Step 2 and using the methodology presented in paragraphs 13.6.7 to 13.6.10 and Table 13.14) for the road, bridge and cycle and footway elements of the Scheme are presented in Table 13.20, Table 13.21 and Table 13.22 below.

Table 13.20: Vulnerability Rating Assessment for Road Elements of the Scheme

Climate Variable		Sensitivity	Exposure	Vulnerability
Sea	Sea level rise	Medium	High	Medium
	Storm surge	High	High	High
Precipitation	Changes in annual average	Medium	Medium	Medium
	Drought	Medium	High	Medium
	Extreme events	High	High	High
Temperature	Extreme temperature events	High	High	High
	Solar radiation	Medium	Medium	Medium
Wind	Gales and high winds	Medium	Medium	Medium
	Storms	Low	Medium	Low
Soils	Soil moisture	Medium	High	Medium
	Soil salinity	Low	High	Low
	Runoff	Medium	Medium	Medium
	Soil stability	Medium	High	Medium

Table 13.21: Vulnerability Rating Assessment for Bridge Elements of the Scheme

Climate Variable		Sensitivity	Exposure	Vulnerability
Sea	Sea level rise	Medium	High	Medium
	Storm surge	High	High	High
Precipitation	Extreme events	High	High	High
Temperature	Extreme temperature events	High	High	High
	Solar radiation	Low	Medium	Low
Wind	Gales and high winds	High	Medium	Medium
	Storms	High	Medium	Medium
Soils	Soil stability	High	High	High
	Soil salinity	Medium	High	Medium

Table 13.22: Vulnerability Rating Assessment for Cycle and Footway Elements of the Scheme

Climate Variable		Sensitivity	Exposure	Vulnerability
Sea	Sea level rise	Medium	High	Medium
	Storm surge	Medium	High	Medium
Precipitation	Changes in annual average	Low	Medium	Low
	Drought	Medium	High	Medium
	Extreme events	Medium	High	Medium
Temperature	Extreme temperature events	Medium	High	Medium
	Solar radiation	Low	Medium	Low
Wind	Gales and high winds	Low	Medium	Low
	Storms	Low	Medium	Low
Soils	Soil moisture	Medium	High	Medium
	Soil salinity	Low	High	Low
	Runoff	Medium	Medium	Medium
	Soil stability	Medium	High	Medium

Step 3: Risk Assessment

13.6.21 This section describes the assessment of risk based on the medium and high vulnerability climate variables identified in Step 2.

13.6.22 Climate and weather-related risks affecting the Scheme receptors with medium and high vulnerabilities over both the construction and operational phases are described in Table 1.1 of Appendix 13C (document reference 6.2). Unless stated, the impacts identified in the table are expected to affect the Scheme.

13.6.23 Table 1.2 of Appendix 13C (document reference 6.2) presents risk ratings for each of the identified climate risks to the Scheme across both the construction and operational phases, based on a qualitative assessment of likelihood and consequence.

13.6.24 The risk rating assessment identified only low and medium risks for the Scheme. Medium risks associated with climate and weather-related risks are summarised below:

- Structural damage due to sea level rise, storm surge, changes to annual averages (drier summers and wetter winters), drought, extreme rainfall and temperature events, gales, high winds and storms, soil moisture and soil stability;
- Impacts to the structural robustness of the Scheme due to sea level rise, storm surge, changes to annual averages (drier summers and wetter winters), drought, extreme rainfall and temperature events and soil moisture;
- Damage to ancillary equipment due to sea level rise and storm surge, wetter winters, extreme rainfall and temperature events, storms and soil moisture;
- Impacts to material durability from solar radiation;
- Impacts to site contents and business continuity due to sea level rise, storm surge, wetter winters, extreme rainfall and temperature events, gales, high winds and storms; and
- Health and safety impacts to users (operators and customers) from gales and high winds.

13.6.25 Risks which have been assessed as Low are not considered further in this assessment although ongoing maintenance of the asset by the Applicant in its capacity as highway authority for the Scheme will be upheld to ensure that these risks are addressed in the future if their risk status changes or new information might affect their risk status.

Step 4: Adaptation Measures

13.6.26 This section outlines the adaptation measures that have been integrated into the Scheme in response to the significant risks that have been identified.

Identification of Planned Adaptation Measures

13.6.27 In consultation with the project team, a range of adaptation measures have been identified in Table 13.23 to reduce the vulnerability of the Scheme to the identified climate and weather-related risks.

Table 13.23: Significant Risks and Planned Adaption Measures for the Scheme

Climate Variable	Associated Hazards / Opportunities	Adaption Measure(s)
Sea	Sea Level Rise (applicable to road, bridges, cycle and footway)	The double-leaf bascule bridge and associated abutments are designed to be above flood level and account for climate change. This is as described in the environmental assessment (Chapter 2: Description of the Scheme). Sea level rise may increase incidence of flooding in Great Yarmouth, but the bridge is significantly above the surrounding ground as described in the environmental assessment (Chapter 2: Description of the Scheme).
	Storm Surge (applicable to road, bridges, cycle and footway)	The double-leaf bascule bridge will be supported on piles. The design includes driven piles which will be of sufficient depth to ensure the structure integrity is resistant from scour arising from climate change as described in the environmental assessment (Chapter 2: Description of the Scheme). Where appropriate, ground improvements will be undertaken in accordance with a suitable remediation strategy as secured through Requirement 8 in Schedule 2 of the draft DCO (document reference 3.1). The equipment for the double-leaf bascule bridge will be mounted above mean high water level and covered to protect from precipitation where appropriate as secured by the Outline CoCP (document reference 6.16).
Precipitation	Changes in Annual Average – Drier Summers (applicable to road)	Where appropriate, reinforced soils will be used in embankments to accommodate for changes in precipitation, runoff and soil stability as secured by the Outline CoCP (document reference 6.16). The design of the structure(s) and surfacing, and the specification of equipment, where applicable, includes all allowances for changes in climate conditions (i.e. thermal

Climate Variable	Associated Hazards / Opportunities	Adaption Measure(s)
		cracking) as secured by the Outline CoCP (document reference 6.16).
	Changes in Annual Average – Wetter Winters (applicable to road)	The Drainage Strategy (presented in Appendix 12C (document reference 6.2)) and secured by Requirement 10 in Schedule 2 of the draft DCO (document reference 3.1) incorporates climate change allowance. Where appropriate, reinforced soils will be used in embankments to accommodate for changes in precipitation, runoff and soil stability as secured by the Outline CoCP (document reference 6.16). Ensure that structure(s) associated with the bridge are designed to account for differential settlement as secured by the Outline CoCP (document reference 6.16). The double-leaf bascule bridge and associated abutments are designed to be above flood level and account for climate change. This is as described in the environmental assessment (Chapter 2: Description of the Scheme). The double-leaf bascule bridge will be supported on piles. The design includes driven piles which will be of sufficient depth to ensure the structure integrity is resistant from scour arising from climate change. This is as described in the environmental assessment (Chapter 2: Description of the Scheme). The equipment for the double-leaf bascule bridge will be mounted above mean high water level and covered to protect from precipitation where appropriate as secured by the Outline CoCP (document reference 6.16).
	Drought (applicable to road, cycle and footway)	Where appropriate, reinforced soils will be used in embankments to accommodate for changes in precipitation, runoff and soil stability as secured by the Outline CoCP (document reference 6.16).

Climate Variable	Associated Hazards / Opportunities	Adaption Measure(s)
		The design of the structure(s) and surfacing, and the specification of equipment, where applicable, includes all allowances for changes in climate conditions (i.e. thermal cracking) as secured by the Outline CoCP (document reference 6.16).
	Extreme Rainfall Events (applicable to road, bridges, cycle and footway)	The Drainage Strategy (presented in Appendix 12C (document reference 6.2)) and secured by Requirement 10 in Schedule 2 of the draft DCO (document reference 3.1) incorporates climate change allowance. The double-leaf bascule bridge will be supported on piles. The design includes driven piles which will be of sufficient depth to ensure the structure integrity is resistant from scour arising from climate change. This is as described in the environmental assessment (Chapter 2: Description of the Scheme). Where appropriate, reinforced soils will be used in embankments to accommodate for changes in precipitation, runoff and soil stability as secured by the Outline CoCP (document reference 6.16). The equipment for the double-leaf bascule bridge will be mounted above mean high water level and covered to protect from precipitation where appropriate as secured by the Outline CoCP (document reference 6.16).
Temperature	Extreme Temperature Events (applicable to road, bridges, cycle and footway)	The design of the structure(s) and surfacing, and the specification of equipment, where applicable, includes all allowances for changes in climate conditions (i.e. thermal cracking) as secured by the Outline CoCP (document reference 6.16). Where applicable, ensure the Scheme is designed is in accordance with the appropriate Eurocodes (European standards specifying how structural design should be carried out within the EU) associated with temperature range and wind speeds as secured by the

Climate Variable	Associated Hazards / Opportunities	Adaption Measure(s)
		Outline CoCP (document reference 6.16). The design will incorporate snow loading measures as well as the potential for snow falling or sliding off the lifting bascule leaves, as secured by the Outline CoCP (document reference 6.16). The equipment for the double-leaf bascule bridge will be mounted above mean high water level and covered to protect from precipitation where appropriate as secured by the Outline CoCP (document reference 6.16). The design of the structure(s) and surfacing, and the specification of equipment, where applicable, includes all allowances for changes in climate conditions (i.e. thermal cracking) as secured by the Outline CoCP (document reference 6.16).
	Solar radiation (applicable to road)	The design of the structure(s) and surfacing, and the specification of equipment, where applicable, includes all allowances for changes in climate conditions (i.e. thermal cracking) as secured by the Outline CoCP (document reference 6.16).
Wind	Gales and high winds (applicable to road, bridges)	Where applicable, ensure the Scheme is designed is in accordance with the appropriate Eurocodes associated with temperature range and wind speeds as secured by the Outline CoCP (document reference 6.16).
	Storms (applicable to bridges)	The Drainage Strategy (presented in Appendix 12C (document reference 6.2)) and secured by Requirement 10 in Schedule 2 of the draft DCO (document reference 3.1) incorporates climate change allowance. Ensure that lightning protection measures are included in the design as secured by the Outline CoCP (document reference 6.16). The equipment for the double-leaf bascule bridge will be mounted above mean high water

Climate Variable	Associated Hazards / Opportunities	Adaption Measure(s)
		level and covered to protect from precipitation where appropriate as secured by the Outline CoCP (document reference 6.16).
Soils	Soil Moisture (applicable to road, cycle and footway)	Ensure that, where appropriate soil specifications will reduce susceptibility to changes in soil moisture as secured by the Outline CoCP (document reference 6.16).
	Runoff (applicable to road, cycle and footway)	The Drainage Strategy (presented in Appendix 12C (document reference 6.2)) and secured by Requirement 10 in Schedule 2 of the draft DCO (document reference 3.1) incorporates climate change allowance. Where appropriate reinforced soils will be used in embankments to accommodate for changes in precipitation, runoff and soil stability as secured by the Outline CoCP (document reference 6.16).
	Soil Stability (applicable to road, bridges, cycle and footway)	Ensure that structure(s) associated with the bridge are designed to account for differential settlement as secured by the Outline CoCP (document reference 6.16). Where appropriate reinforced soils will be used in embankments to accommodate for changes in precipitation, runoff and soil stability as secured by the Outline CoCP (document reference 6.16).

Assessment of Likely Significant Effects

Step 5: Determination of Significance

13.6.28 The level of climate resilience of different project components to the identified climate risks has been determined based on the integration of the above adaptation measures. A resilience rating for the medium risks (no high risks have been identified) as presented in Table 1.2 of Appendix 13C (document reference 6.2) has been applied based on the following rankings:

- Highly resilient – a strong degree of climate resilience, remedial action or adaptation may be beneficial but is not a priority;
- Moderately resilient – a moderate degree of climate resilience, ongoing monitoring and/or remedial action or adaptation is suggested; and
- Low resilience – a low level of climate resilience, remedial action or adaptation is required as a priority.

13.6.29 The significance rating is derived from risk rating and resilience rating, as presented in Table 13.19.

Table 13.24: Climate Resilience Rating and Significance Following Integration of the Adaptation Measures

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
Structural stability	Sea level rise (applicable to road, bridges, cycle and footway)	Damage to road, bridge, cycle and footway structures due to flooding.	Medium	High	Not Significant
		Increased slope instability.	Medium	High	Not Significant
	Storm surge (applicable to road, bridges, cycle and footway)	Damage to road, bridge, cycle and footway structures due to flooding.	Medium	High	Not Significant
		Subsidence impacting road, bridge, cycle and footway structures leading to subsidence.	Medium	High	Not Significant
	Changes in annual average – drier summers (applicable to road)	Failure of earthworks due to desiccation.	Medium	High	Not Significant
	Changes in annual average – wetter	Soil softening and erosion leading to	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
	winters (applicable to road)	collapse and settlement of soil structures.			
		Increased slope instability.	Medium	High	Not Significant
	Drought (applicable to road, cycle and footway)	Failure of earthworks due to desiccation, particularly impacting the road structure.	Medium	High	Not Significant
		Shrinking and cracking of soils leading to subsidence.	Medium	High	Not Significant
	Extreme rainfall events (applicable to road, bridges, cycle and footway)	Soil saturation and water damage.	Medium	High	Not Significant
		Undercutting particularly in relation to the double-leaf bascule bridge.	Medium	High	Not Significant
		Increased slope instability.	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
		Softening of subsurface materials.	Medium	High	Not Significant
	Extreme temperature events (applicable to road, bridges, cycle and footway)	Cracking and expansion, particularly impacting road, bridge, cycle and footway structures.	Medium	High	Not Significant
	Gales and high winds (applicable to road, bridges)	Risk of damage to road and bridge structures and foundations.	Medium	High	Not Significant
	Storms (applicable to bridges)	Destabilisation due to lighting strike, particularly to the double-leaf bascule bridge and associated control tower.	Medium	High	Not Significant
	Soil moisture (applicable to road, cycle and footway)	Shrinking and cracking of soils leading to subsidence.	Medium	High	Not Significant
		Soil softening and erosion leading to	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
		collapse and settlement of structures.			
		Increased slope instability.	Medium	High	Not Significant
	Soil stability (applicable to road, bridges, cycle and footway)	Subsidence impacting road, bridge, cycle and footway structures.	Medium	High	Not Significant
		Failure of earthworks due to desiccation.	Medium	High	Not Significant
		Shrinking and cracking of soils.	Medium	High	Not Significant
Structural robustness	Sea level rise (applicable to road, bridges, cycle and footway)	Deformation of rigid structures (road, bridge, cycle and footway etc.).	Medium	High	Not Significant
		Undercutting, particularly in relation to the double-leaf bascule bridge.	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
	Storm surge (applicable to road, bridges, cycle and footway)	Undercutting, particularly in relation to the double-leaf bascule bridge.	Medium	High	Not Significant
	Changes in annual average – drier summers (applicable to road)	Shrinking and cracking of soils leading to cracking of road surface.	Medium	High	Not Significant
	Changes in annual average – wetter winters (applicable to road)	Deformation of rigid structures.	Medium	High	Not Significant
	Drought (applicable to road, cycle and footway)	Deformation of rigid structures, particularly road, cycle and footway.	Medium	High	Not Significant
	Extreme rainfall events (applicable to road, bridges, cycle and footway)	Deformation of rigid structures.	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
	Extreme temperature events (applicable to road, bridges, cycle and footway)	Deformation of structures and materials.	Medium	High	Not Significant
	Soil moisture (applicable to road, cycle and footway)	Cracking of structures.	Medium	High	Not Significant
Ancillary equipment	Sea level rise (applicable to road, bridges, cycle and footway)	Softening of subsurface materials.	Medium	High	Not Significant
		Blockage of drains and associated assets.	Medium	High	Not Significant
	Storm surge (applicable to road, bridges, cycle and footway)	Blockage of drains and associated assets.	Medium	High	Not Significant
	Changes in annual average – wetter winters	Blockage or overwhelming of drains and associated assets.	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
	(applicable to road)	Softening of subsurface materials.	Medium	High	Not Significant
	Extreme rainfall events (applicable to road, bridges, cycle and footway)	Blockages of drainage assets.	Medium	High	Not Significant
	Extreme temperature events (applicable to road, bridges, cycle and footway)	Failure of temperature controls.	Medium	High	Not Significant
	Storms (applicable to bridges)	Destabilisation due to lighting strike, particularly to the double-leaf bascule bridge and associated control tower.	Medium	High	Not Significant
	Soil moisture (applicable to road, cycle and footway)	Shrinking and cracking of soils leading to subsidence.	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
	Runoff (applicable to road, cycle and footway)	Blockage / overwhelming of drains and associated assets.	Medium	High	Not Significant
Material durability	Solar radiation (applicable to road)	Deformation of materials.	Medium	High	Not Significant
Site contents and business continuity	Sea level rise (applicable to road, bridges, cycle and footway)	Road, bridge, cycle and footway closure due to flooding.	Medium	High	Not Significant
		Scour of embankments leading to increased maintenance.	Medium	High	Not Significant
	Storm surge (applicable to road, bridges, cycle and footway	Road, bridge, cycle and footway closure due to flooding.	Medium	High	Not Significant
		Traffic disruption and congestion.	Medium	High	Not Significant
	Changes in annual average – wetter	Increasingly difficult working conditions, including time	Medium	Moderate	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
	winters (applicable to road)	available to undertake works.			
		Reduced opportunities for maintenance.	Medium	Moderate	Not Significant
	Extreme rainfall events (applicable to road, bridges, cycle and footway)	Water accumulation causing disruption to construction and operation.	Medium	High	Not Significant
		Stopping of services due to asset failure.	Medium	High	Not Significant
		Scour of embankments leading to increased maintenance.	Medium	High	Not Significant
		Traffic disruption and congestion.	Medium	High	Not Significant
	Extreme temperature events (applicable to road, bridges, cycle and footway)	Reduced working periods and delays.	Medium	Moderate	Not Significant
		Reduced opportunities for maintenance.	Medium	Moderate	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
	Gales and high winds (applicable to road, bridges)	Operational disruption.	Medium	Moderate	Not Significant
	Storms (applicable to bridges)	Risk to power sources.	Medium	High	Not Significant
		Risk to operation of the double-leaf bascule bridge and control tower through loss of power.	Medium	High	Not Significant
		Fire risk.	Medium	High	Not Significant
	Runoff (applicable to road, cycle and footway)	Increasingly difficult working conditions, including time available to undertake works	Medium	Moderate	Not Significant
H&S of users (operators and customers)	Gales and high winds (applicable to road, bridges)	Difficult working conditions.	Medium	Moderate	Not Significant
		Health and safety risks to road users, particularly high sided	Medium	High	Not Significant

Component	Hazard	Risk	Risk Rating	Resilience Rating	Significance
		vehicles.			
	Soil moisture (applicable to road, cycle and footway)	Risk from slope instability.	Medium	High	Not Significant

Residual Risks

13.6.30 The residual climate risks have been assessed as **not significant**. This is due to the risk rating and the adaptation measures that have been developed and applied as part of the Scheme design. As presented in Table 13.24, the majority of climate risks have been assessed to have a high resilience rating (i.e. where there is a strong degree of climate resilience, remedial action or adaptation).

13.6.31 The climate risks with moderate resilience ratings relate to difficult working conditions, reduced maintenance opportunities, reduced working periods and operational disruption. The following are additional measures which may be implemented at construction and operational phase but are not necessary for the purposes of assessment:

- Providing suitable contingency within construction and maintenance schedules to account for extreme or adverse weather conditions; and scheduling in routine maintenance during fair weather seasons to minimise risk of extreme adverse weather events.
- Implementing maintenance regimes and regular inspections for structures to mitigate the impacts of excessive vegetation growth and deterioration of materials. Inspections should also occur following an extreme weather event (e.g. flood, storm surge, drought, heatwave) to monitor any damage and implement appropriate mitigation as necessary.
- Maintaining a list of weather-related incidents (for example, road surface deformations, snow and ice etc.) to assist in identifying thresholds which require maintenance when exceeded.

13.6.32 Based on the information currently available it is anticipated that the Scheme design has suitably considered climate change aspects such that the risks to critical design features should **not be significant**.

Monitoring

13.6.33 No monitoring is considered to be required over and above that which is included in the Outline CoCP (document reference 6.16) and its subsequent development by the Contractor into a full CoCP.

Limitations and Assumptions

13.6.34 This assessment provides a broad indication of the potential impacts of climate change on the Scheme based on a qualitative and quantitative assessment and professional judgement using knowledge of similar schemes.

13.6.35 UKCP18 provides the most up-to-date projections of climate change for the UK. However, at the time of writing this chapter, UKCP18 projection data for

snowfall and relative humidity were not available. Information on projected climate for these variables has therefore been taken from the previous projections, UKCP09.

13.6.36 Any further decision-making should take account of the uncertainties associated with climate projections. It is also important to note that the analysis is based on selected observational data, the results of climate model ensembles and a selected range of existing climate change research and literature available at the time of assessment.

13.6.37 The determination of resilience has been undertaken under the assumption that the adaptation measures identified by the Design Team will be implemented.

13.6.38 The confirmed climate resilience adaptation measures are based on information provided by the wider Project Team and the Design Team.

Summary

13.6.39 The Scheme is located in the East of England which currently has a warm, dry climate, compared to the UK average. Climate predictions suggest that the East of England will experience wetter winters and drier summers, however extreme rainfall events will increase. Mean winter and summer temperatures in the East of England area projected to increase and more extreme temperature events are likely to occur. Solar radiation is expected to increase although predicted increase in UK cloud cover in winter would reduce solar radiation during winter. Changes in wind speed are hard to project, however results suggest that there could be a future reduction in the summer westerly wind flows over the southern half of the UK and an increase in southerly flows over the UK in winter. Relative humidity projections suggest that by 2080, winter mean relative humidity in the East of England could increase by up to 5% with summer predictions showing a decrease of up to 10%. Sea level rise predictions suggest an increase of 30.5 cm by 2080.

13.6.40 The residual climate risks have been assessed as **not significant**. This is due to the risk rating and the adaptation measures that have been developed and applied as part of the Scheme design.

13.6.41 The climate risks with moderate resilience ratings relate to difficult working conditions, reduced maintenance opportunities, reduced working periods and operational disruption. The following are additional measures which may be implemented at construction and operational phase but are not necessary for the purposes of assessment:

- Providing suitable contingency within construction and maintenance schedules to account for extreme or adverse weather conditions; and

scheduling in routine maintenance during fair weather seasons to minimise risk of extreme adverse weather events.

- Implementing maintenance regimes and regular inspections for structures to mitigate the impacts of excessive vegetation growth and deterioration of materials. Inspections should also occur following an extreme weather event (e.g. flood, storm surge, drought, heatwave) to monitor any damage and implement appropriate mitigation as necessary.
- Maintaining a list of weather-related incidents (for example, road surface deformations, snow and ice etc.) to assist in identifying thresholds which require maintenance when exceeded.
- Undertake monitoring to assess the appropriateness of the mitigation measures and review mitigation measures when new and/or updated information becomes available.

13.6.42 Table 13.24 provides a summary of the findings of the Climate Resilience assessment for construction and operational phase. Table 13.24 details the climate hazards and risks associated with the key receptors (road, bridges, cycle and footway), and presents the risk rating, resilience rating and significance of effect for each climate risk taking into account the embedded mitigation (adaptation measures).

13.7 References

Ref 13.1: Ministry of Housing, Communities and Local Government (2019), National Planning Policy Framework.

Ref 13.2: Department for Transport (2014), National Policy Statement for National Networks.

Ref 13.3: IEMA (2017), EIA guide to Assessing GHG emissions and evaluating their significance.

Ref 13.4: BSI (2016), PAS 2080:2016 Carbon management in infrastructure.

Ref 13.5: Highways England (2016), Carbon emissions calculation tool.

Ref 13.6: Department for Business, Energy & Industrial Strategy (2018), 2005 to 2016 UK Local and regional CO_2 emissions – data tables.

Ref 13.7: RICS (2017), Whole life carbon assessment for the built environment. RICS professional standards and guidance, UK.

Ref 13.8: IEMA (2015), Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation.

Ref 13.9: Waste & Resources Action Programme (WRAP) (undated), Waste recording and reporting.

Ref 13.10: Department for Transport (2012), National Policy Statement for Ports.

Ref 13.11: Department for Environment and Rural Affairs, Department for Business, Energy and Industrial Strategy, Met Office and Environment Agency (2018), UK Climate Projections.

14 People and Communities

14.1 Introduction

14.1.1 This Chapter reports the outcome of the assessment of likely significant effects arising from the Scheme upon people and communities. It considers:

- Changes to Non-Motorised User (NMU) facilities;
- Changes to vehicular journeys;
- Changes to community severance;
- Increased demand for local services due to influx of construction workers;
- Land acquired including residential and commercial properties as well as community assets;
- Severance and disruption to terrestrial and marine businesses and associated activities;
- Changes to access to recreational activities; and
- The generation of direct, indirect and induced employment opportunities, and increases in economic activity.

14.1.2 This chapter describes the assessment methodology, baseline conditions at the Application Site and within the relevant study areas ranging from 500m to Norfolk as a whole (see Section 14.4), any embedded mitigation adopted for the purposes of the assessment, a summary of the likely significant effects, any additional mitigation measures required to prevent, reduce or offset any significant adverse effects, and the likely residual effects taking account of these mitigation measures.

14.1.3 This people and communities assessment is primarily focused on the Principal Application Site. The Satellite Application Sites are not largely not considered to affect the people and communities assessment due to the nature and scale of the Satellite Application Sites. Further details on the Study Area for the assessment are provided in paragraph 14.4.11.

14.1.4 This chapter (and its associated figures and appendices) is intended to be read as part of the wider Environmental Statement, with particular reference to Chapter 10: Townscape and Visual, Chapter 7: Noise and Vibration, Chapter 6: Air Quality, Chapter 11: Road Drainage and the Water Environment, Chapter 16: Geology and Soils, and Chapter 19: Cumulative Effects.

14.2 Competent Experts

14.2.1 The people and communities lead, Julia Laver, is a Principal Socio-economic and Planning Consultant who holds an MSc degree in Town and Country

Planning from UCL (2009). Julia has over ten years' experience in the environmental sector including significant experience regarding project management, the preparation of Environmental Impact Assessments, the Development Consent Order process and sector-specific experience in socio-economic, equalities, health impact, and people and communities assessment.

14.2.2 The author of the people and communities chapter, Lowri McCann, holds an MSc degree in Environmental Consultancy and Project Management from the University of Leeds (2013) and is a practitioner member of IEMA. Lowri has over five years' experience in the environment sector, including undertaking people and communities assessment as well as socio-economic assessment and preparing Environmental Statements.

14.3 Legislative and Policy Framework and Guidance

14.3.1 Table 14.1 provides a summary of the key policy and guidance for this assessment. The aspects that have been included within the assessment methodology have been informed by guidance within DMRB Volume 11, with particular reference to Section 3, Parts 3, 6, and 8, which identify the aspects of the environment that could be significantly impacted by a road scheme proposal. In August 2012, Highways England produced the 'People and Communities Clarification Note' (Ref 14.1), which recommends combining the Interim Advice Note (IAN) assessments of 'Community and Private Assets' and 'Effects on all Travellers' into a single topic entitled 'People and Communities'.

14.3.2 A summary of key relevant legislation, policies, and guidance is outlined in Table 14.1 below, and a detailed summary of all applicable legislation of relevance to this assessment is provided in Appendix 14A (document reference 6.2).

Table 14.1: Summary of Key Legislation, Policy and Guidance

Legislation/ Policy/ Guidance	Summary	Chapter Reference
National Networks National Policy Statement (NN NPS) (Ref 14.2)	The Government's vision and strategic objectives for national networks includes *"supporting a prosperous and competitive economy and improving overall quality of life" and specifically:* • *Networks with the capacity and connectivity to support national, regional and local economic activity and*	The assessment considers the employment opportunities during construction, and the potential effects of the Scheme on businesses during construction and operation. The assessment has considered community severance.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	facilitate growth whilst creating jobs; and • *Networks which sustain cohesion and decreases severance of communities and effectively providing linkages to each other.*	See Sections 14.4 and 14.8.
	Paragraph 2.27 of the NPS NN states that *"in some cases…it will not be sufficient to simply expand capacity on the existing network. In those circumstances new road alignments and corresponding links, including alignments which cross a river or estuary, may be needed to support increased capacity and connectivity".*	The assessment considers increased connectivity for vehicular and non-motorised users afforded by the Scheme. See Sections 14.4 and 14.8.
	Paragraph 3.3 requires that in delivering new schemes, "reasonable opportunities to deliver environmental and social benefits as part of the schemes" should be considered and that environmental and social impacts should be mitigated in line with the principles set out in the NPPF and the Government's planning guidance.	The assessment has considered social benefits and social impacts including: Changes to community severance and business severance; • Changes to Non-Motorised User (NMU) facilities; • Land acquired including community assets; and • Changes to access to recreational activities. Where required, mitigation has been considered as appropriate. See Sections 14.4 and 14.8.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	The (NN NPS) (Ref. 14.2) also states that: *"The Applicant should identify existing and proposed land uses near the project, any effects of replacing an existing development or use of the site with the proposed project or preventing a development or use on a neighbouring site from continuing. Applicants should also assess any effects of precluding a new development or use proposed in the development plan".*	Effects on development land from the Scheme have been assessed as insignificant. See Section 14.4.
National Policy Statement (NPS) for Ports (Ref 14.3)	The NPS for Ports provides a framework for decisions on proposals for new port development to provide port capacity, as well as associated road and rail links for which consent is sought alongside the principal development. Paragraph 3.3.5 of the NPS for Ports states that the Government sees port development as an engine for economic growth that supports sustainable transport and supports sustainable development.	The assessment considers the potential effects on port businesses during construction and operation. See Sections 14.4 and 14.8.
National Planning Policy Framework (NPPF) (Ref 14.4)	Within the revised NPPF, there is an overarching presumption in favour of sustainable development, so that *"sustainable development is pursued in a positive way"*. The NPPF notes in paragraph 8 that there are three dimensions to sustainable development;	The assessment considers both social and economic impacts of the Scheme. See Sections 14.4 and 14.8.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	economic, social and environmental. Planning's role is to contribute to building a strong, responsive and competitive economy and by identifying and coordinating development requirements, including the provision of infrastructure. Section 9 of the NPPF sets out how transport should be considered within the context of planning decisions and sustainable development.	
	The NPPF also encourages development that exploits opportunities for sustainable transport. Particularly by giving priority *"first to pedestrian and cycle movements, both within the scheme and with neighbouring areas; and second – so far as possible – to facilitating access to high quality public transport, with layouts that maximise the catchment area for bus or other public transport services, and appropriate facilities that encourage public transport use"* (paragraph 110).	The assessment considers the changes to non-motorised user facilities, including the designated footway / cycleway across the proposed bridge. See Sections 14.4 and 14.8.
	Paragraph 80 states: *"Significant weight should be placed on the need to support economic growth and productivity, taking into account both local business needs and wider opportunities for development".*	The assessment considers the generation of employment opportunities during construction and the potential effects of the Scheme on businesses during construction and operation. See Sections 14.4 and 14.8.
	Paragraph 81 states that planning policies should "set	

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	out a clear economic vision and strategy which positively and proactively encourages sustainable economic growth, having regard to Local Industrial Strategies and other local policies for economic development and regeneration".	
Great Yarmouth Local Plan: Core Strategy (2013-2030) (Ref 14.5)	Policy CS3 Addressing the Borough's Housing Need: To ensure that new residential development in the borough meets the housing needs of local people, the Council and its partners will seek to make provision for at least 7,140 new homes over the plan period (2013 – 2030). The Council also encourages the effective use of the existing housing stock.	We have made reference to this policy in considering the assessment of housing needs. See Sections 14.4 and 14.8.
	Policy CS6 Supporting the Local Economy: To ensure that the conditions are right for new and existing businesses to thrive and grow, there is a need to continue to strengthen the local economy and make it less seasonally dependent.	The assessment considers the potential effects on businesses during construction and operation. See Sections 14.4 and 14.8.
	Policy CS15 Providing and Protecting Community Assets and Green Infrastructure: The Council will resist the loss of important community facilities and/or green assets unless appropriate alternative provision of equivalent or better quality facilities is made in a location accessible to current and potential users or a detailed assessment	The assessment has considered: • Changes to community severance, including access to community assets; and • Land acquired including community assets, caused by the Scheme. See Sections 14.4 and 14.8.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	clearly demonstrates there is no longer a need for the provision of the facility in the area. Ensure that all new developments contribute to the provision of recreational green space and incorporate improvements to the quality of, and access to, existing green infrastructure in accordance with local circumstances. The Council will also safeguard the natural beauty, openness and recreational value of the borough's beaches and coastal hinterland.	
	Policy CS16 Improving Accessibility and Transport: The Council and its partners will work together to make the best use of, and improve, existing transport infrastructure within and connecting to the Borough.	The assessment has considered: • Changes to community severance; and • Changes to access to recreational activities, caused by the Scheme. See Sections 14.4 and 14.8.
East Marine Plan (Ref 14.6)	Policy TR1: Proposals for development should demonstrate that during construction and operation, in order of preference: a) they will not adversely impact tourism and recreation activities b) how, if there are adverse impacts on tourism and recreation activities, they will minimise them c) how, if the adverse impacts cannot be minimised, they will be mitigated	The assessment has considered changes to access to recreational activities. Where required, mitigation has been considered as appropriate. See Sections 14.4 and 14.8.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
	d) the case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	
	Policy TR2: Proposals that require static objects in the East marine plan areas, should demonstrate, in order of preference: a) that they will not adversely impact on recreational boating routes; b) how, if there are adverse impacts on recreational boating routes, they will minimise them; c) how, if the adverse impacts cannot be minimised, they will be mitigated; and the case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	The assessment has considered changes to access to recreational activities, including recreational vessels accessing the Norfolk Broads. See Sections 14.4 and 14.8.
	Policy EC2: Proposals that provide additional employment benefits should be supported, particularly where these benefits have the potential to meet employment needs in localities close to the marine plan areas.	The assessment considers the generation of employment opportunities during construction and the potential effects of the Scheme on businesses during construction and operation. See Sections 14.4 and 14.8.
	Policy SOC1: Proposals that provide health and social well-being benefits including through maintaining, or enhancing, access to the coast and marine area should be supported.	The Scheme provides access to the coast and marine area. Figure 14.3 displays the PRoW within the Principal Application Site. Hopton-on-Sea to Sea Palling is part of the England Coast Path and is located

Legislation/ Policy/ Guidance	Summary	Chapter Reference
		within the Principal Application Site.
	Policy FISH1: Within areas of fishing activity, proposals should demonstrate in order of preference: a) that they will not prevent fishing activities on, or access to, fishing grounds; b) how, if there are adverse impacts on the ability to undertake fishing activities or access to fishing grounds, they will minimise them; c) how, if the adverse impacts cannot be minimised, they will be mitigated; and d) the case for proceeding with their proposal if it is not possible to minimise or mitigate the adverse impacts.	The assessment has considered changes to access to recreational activities, including fishing. See Sections 14.4 and 14.8.
People and Communities Clarification Note (Ref 14.1)	The IAN indicates that as part of the need to seek efficient reporting there is a requirement to combine DMRB Vol 11 Section 3 Parts 6, 8 and 9 into one chapter titled People & Communities.	This Clarification Note has been adhered to within this assessment and has therefore been considered within this Chapter. See Sections 14.4 and 14.8.
DMRB Volume 11, Section 2, Part 6: Land Use (Ref 14.7)	The guidance covers the assessment of: • Demolition of private property and associated land-take; • Loss of land used by the community; and • Assessing the loss of land used by the community.	The assessment has considered the demolition of properties and land-take as well as loss of community land in accordance with the guidance. See Sections 14.4 and 14.8.

Legislation/ Policy/ Guidance	Summary	Chapter Reference
DMRB Volume 11, Section 2, Part 8: Pedestrians, Equestrians, Cyclists and Community Effects (Ref 14.8)	The Advice Note gives guidance on assessing a scheme's impact on the journeys which people make in its locality. It considers journeys made by people as pedestrians (including ramblers), cyclists and equestrians.	The non-motorised user assessment within this chapter and Chapter 17: Traffic and Transport have considered the Advice Note. See Sections 14.4 and 14.8.
DMRB Volume 11, Section 2, Part 9: Vehicle Travellers (Ref 14.9)	The Advice Note provides guidance, including assessment criteria, for the driver stress assessment.	The driver stress assessment is in accordance with the guidance. See Sections 14.4 and 14.8.
Employment Density Guide 3rd Edition published by Homes and Communities Agency (Ref 14.10)	The guide provides guidance on calculating employment densities.	The guidance has informed the employment calculations. See Sections 14.4 and 14.8.
Additionality Guide 4th Edition published by English Partnerships (Ref 14.11)	The guide explains how to assess the additional impact or additionality of local economic growth and housing interventions when calculating employment opportunities.	The guidance has informed the employment calculations. See Sections 14.4 and 14.8.

14.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

14.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

14.4.2 The study area for the non-motorised user assessment, community severance assessment and recreational activities assessment has been reduced from 2km to 500m as part of the progression of the assessment from the Preliminary Environmental Information Report (PEIR) to the ES. Based on professional judgement and past experience, a 500m study area is deemed appropriate as this would cover the most likely significant effects and would keep the assessment proportionate. This change in scope has been agreed with GYBC.

Consultation

14.4.3 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

14.4.4 Table 14.2 and 14.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter. Consultation has been undertaken with GYBC and NCC regarding the change in scope relating to the study area for the non-motorised user assessment, community severance assessment and recreational activities assessment.

Table 14.2: Summary of Scoping Comments Received and Responses within this Chapter

Scoping Opinion Item	Consultee	Response
The Inspectorate indicated that the ES should assess any likely significant effects associated with the influx of workers during the construction stage (Scoping Opinion Ref 6.9.22, ID1).	PINS	The assessment has considered changes in demand on local services and on recreational / open space due to an influx of construction workers. See Sections 14.4 and 14.8.
The Inspectorate agrees that given the nature of the Proposed Development effects on local services, accommodation and recreational open space during operation can be scoped out of the ES (Scoping Opinion Ref 6.9.23, ID2).	PINS	Noted, no change has been made to the methodology.
The Inspectorate agrees that effects in relation to peoples and communities from crime arising during construction can be scoped out of the ES (Scoping Opinion Ref 6.9.24, ID3).	PINS	Noted, no change has been made to the methodology.
The Inspectorate indicated that the ES should assess any likely significant effects associated with business severance during the construction stage (Scoping Opinion Ref 6.9.25, ID4).	PINS	The assessment has considered the potential impacts on businesses, including business severance, during construction. See Sections 14.4 and 14.8.

Scoping Opinion Item	Consultee	Response
The Inspectorate agrees that effects to people and communities from land use during operation can be scoped out of the ES (Scoping Opinion Ref 6.9.26, ID5).	PINS	Noted, no change has been made to the methodology.
The assessment of impacts to off-site recreational receptors during operation should be undertaken in light of the findings from the hydromorphological assessment and the potential for likely significant effects. Where information to inform the assessment in the Peoples and Communities aspect chapter is presented in other relevant aspect chapters, such as the Water Environment aspect chapter, clear cross-referencing should be included in the ES (Scoping Opinion Ref 6.9.27, ID6).		The assessment has considered the potential effects on offsite recreational activities due to changes in hydromorphology caused by changes to sediment levels. The sediment assessment undertaken for the Scheme is presented in Chapter 11: Road Drainage and the Water Environment. See Sections 14.4 and 14.8.
The Inspectorate agrees that quality of surroundings and sense of place should be considered as part of landscape character and cultural heritage assessments and can be scoped out of the Peoples and Communities aspect chapter (Scoping Opinion Ref 6.9.28, ID7).	PINS	Noted, no change has been made to the methodology. The settings assessment, presented in Chapter 9: Cultural Heritage, has been undertaken in adherence to Historic Environment Good Practice Advice in Planning Policy Notes 2-3 managing significance and setting (2017), which includes assessing the quality and the contribution of the landscape to the value of the asset.
The ES should clearly explain where impacts on health have been considered and assessed within the Peoples and Communities aspect chapter. Cross-referencing to the assessment of relevant health matters	PINS	This chapter has assessed the likely effects of the Scheme associated with community severance, loss of property and

Scoping Opinion Item	Consultee	Response
on people and the communities, as described elsewhere in the ES, is also recommended to ensure adequate consideration has been given to health matters (Scoping Opinion Ref 6.9.29, ID8).		recreational facilities which all have consequential impacts on human health. Chapter 19: Cumulative considers the conclusions of these elements of the People and Communities chapter, alongside other health effects in this ES, to consider the in-combination effects on health arising from the Scheme.
The ES should make clear where an assessment of disturbance, disruption and reduction in amenity has been assessed. The Applicant should avoid duplication of assessments in the ES; however, the ES should include appropriate cross-referencing between the Peoples and Communities aspect chapter and other relevant aspect chapters, to ensure that such effects have been fully considered in the ES The Scoping Report states elsewhere that community severance, loss of property, economic benefits and community facilities are to be assessed within the People and Communities aspect chapter of the ES. (Scoping Opinion Ref 6.9.30, ID9).	PINS	Disturbance, disruption and reduction in amenity has been assessed as an in-combination effect (considering the results of Chapter 6: Air Quality, Chapter 7: Noise and Vibration, Chapter 10: Townscape, and Chapter 17: Traffic and Transport) within Chapter 19: Cumulative Effects. The assessment in this chapter has considered the potential impacts on community severance, loss of property, economic benefits as well as community and recreational facilities. See Sections 14.4 and 14.8.
The Inspectorate notes that DMRB 11, Section 3, Part 8, Paragraph 2.2 states that community facilities 'and their catchment areas' should be addressed by the assessment. The ES should clearly explain the selected study area and justify any deviation from the DMRB methodology (Scoping Opinion Ref 6.9.13, ID10).	PINS	DMRB guidance has been considered when determining the study area for community facilities. Based on professional judgement and past experience, and with consideration of the local context, a 500m

Scoping Opinion Item	Consultee	Response
		study area has been used. GYBC and NCC have been consulted regarding this change in scope.
The Inspectorate welcomes the intention to consult with local groups to identify water sports receptors that may be affected by the Proposed Development. The Applicant is advised to also contact regional bodies such as the Royal Yachting Association and The Broads Authority for information regarding water sports in the Zone of Influence (ZOI) for the Proposed Development (Scoping Opinion Ref 6.9.16, ID11).	PINS	The following groups have been directly consulted regarding water-based recreational activities along the River Yare: • Royal Yachting Association; • The Broads Authority; • Great Yarmouth and Gorleston Sailing Club; and • Great Yarmouth and Norfolk County Angling Association. See Table 14.4.
The ES should clearly identify and justify the applicable marine receptors, together with the study area. The presentation of receptors and study areas on figures accompanying the ES should also be provided (Scoping Opinion Ref 6.9.12, 6.9.21, 6.9.33, 6.9.37-38, 6.9.40, 6.9.42, and 6.9.56-57, ID12).	PINS	Marine receptors have been identified along the River Yare between the river mouth and south of the confluence with the River Bure (see Section 14.4). Receptors have been identified via consultation with key groups (see Table 14.4). The study area for marine receptors is provided in the 'Extent of the Study Area' section of Section 14.4. Figure 14.2 provides an overview of the receptors within the vicinity of the Principal Application Site.

Scoping Opinion Item	Consultee	Response
Where the vessel simulation modelling is being used to inform the assessment of significant effects on Peoples and Communities receptors, the methodology and results should be made available as an appendix to this aspect chapter of the ES. The ES should also clearly describe the baseline data and proposed assessment methodology (Scoping Opinion Ref 6.9.56-57, ID13).	PINS	The Vessel Simulation Model and Preliminary Navigational Risk Assessment are submitted as part of the DCO application (document reference 6.14).
The assessment of marine receptors should consider inter-relationships with other aspect chapters e.g. Geology and Soils or Traffic and Transport. The aspect chapter should include cross-reference to information obtained as part of the Geology and Soils aspect chapter, as relevant, including any information regarding potential changes to sediment depth in the navigational channel as a result of the Proposed Development. Any relevant data/assessment presented in other aspect chapters should be clearly cross-referenced. The MMO, Trinity House, the Maritime & Coastguard Agency (MCA), and the Great Yarmouth Harbour Authority are requesting the Applicant produce a Navigational Risk Assessment in consultation with the Great Yarmouth Harbour Authority (Appendix 2). If the Navigational Risk Assessment indicates the potential for likely significant effects to environmental receptors this should be assessed in the ES. Any likely significant effects associated with the delivery of mitigation measures, including those relevant to the impacts on navigation, should be assessed in the ES (Scoping Opinion Ref 6.9.56-57, ID14).	PINS	A sediment assessment has been undertaken for the Scheme and presented in Chapter 11: Road Drainage and the Water Environment. The results of the sediment assessment have informed the assessment of marine recreational activities. As the recreational vessels are passing through the River Yare, the results of the Traffic and Transport assessment have not been used to inform the assessment of marine recreational activities. The Preliminary Navigational Risk Assessment (document reference 6.14) has been undertaken in consultation with the Great Yarmouth Port Company, which are representing Great Yarmouth Port Authority. It should be noted that there is no Great Yarmouth Harbour Authority operating within the Application Site, only the Great Yarmouth Port

Scoping Opinion Item	Consultee	Response
		Authority. The results of the Preliminary Navigational Risk Assessment have been considered within the assessment reported in this chapter. See Sections 14.4 and 14.8.
The Inspectorate expects the figures and calculations used to generate an assessment of employment opportunities to be clearly stated within the ES, together with adequate justification for their use in the methodology section. The ES should clearly describe the types/sectors of jobs and businesses that may be lost or displaced by the Proposed Development, and also those types/sectors that make up the gains in jobs/businesses. Any assumptions made in relation to this assessment should be explained clearly in the ES (Scoping Opinion Ref 6.9.52, ID15).	PINS	The methodology to the employment calculations is provided within Section 14.4.
The ES should clearly describe the methodology used to assess loss of private land in the ES, as the description provided in the Scoping Report appears to focus on business operations (Scoping Opinion Ref 6.9.53-55, ID16).	PINS	The methodology to the assessment of the loss of private land and marine recreational receptors is provided within Section 14.4.
The proposed assessment methodology for recreational receptors does not specify how marine recreational receptors will be assessed. The ES should clearly describe and justify the methodology used to assess effects on marine recreational receptors in the ES (Scoping Opinion Ref 6.9.60, 6.9.63, ID17).		
The Applicant is reminded that, as stated in Section 3.3 of this Opinion, references must be provided for sources of information	PINS	References have been provided for sources of information, including the

Scoping Opinion Item	Consultee	Response
used to inform the assessment. The 'Additionality Guide' is referenced in paragraph 6.9.52 of the Scoping Report; however, there is no reference provided to this guide (Scoping Opinion ID18).		Additionality Guide (Ref 14.11). See Section 14.4.
The ES should clearly state the assessment criteria which the effects are to be assessed against, and clearly state the value of receptors identified (Scoping Opinion ID19).	PINS	The assessment criterion is provided in Section 14.4. The sensitivity of receptors, and a justification for the sensitivity, is provided within Section 14.8. Table 14.24 also provides an overview of the sensitivity of the receptors.
Great Yarmouth Port Authority (GYPA) acknowledge and welcome the improved connectivity to the peninsular and Out Harbour the crossing will bring, the GYPA do have some concerns over the likely impact the effective 'severance' of the river will have on the considerable commercial activity in the River Yare if the primacy of the Port operation is not acknowledged.	Great Yarmouth Port Authority	The assessment considers the potential effects of the construction and operation of the bridge on marine commercial activities. See Sections 14.4 and 14.8.
Whilst there is currently a transport section [within the Scoping Report] there is little reference in it pertaining to the Port, shipping, navigational arena. Given the importance of both the Outer Harbour and the River Yare to the local economy we would recommend that this be specified in the section so as to clearly capture factors impacting on the Port.	Great Yarmouth Port Authority	The assessment considers the potential effects of the construction and operation of the bridge on marine commercial activities. See Sections 14.4 and 14.8.
In the context of construction and bridge operation it would be prudent to assess the impact the work would have on the sediment depths and the likely effect on the safety navigation.	Great Yarmouth Port Authority	A sediment assessment has been undertaken for the Scheme and presented in Chapter 11: Road Drainage and the Water Environment. The preliminary Navigational Risk Assessment (pNRA)

Scoping Opinion Item	Consultee	Response
		(document reference 6.14) has been prepared for the Scheme. The pNRA assesses the potential effects of the Scheme on navigational safety.
The operation of the bridge needs to consider possible disruption to the upstream commercial activity. This analysis could be supported by the inclusion of historical and projected data on river usage, to highlight he likely number of occasions the bridge will need to be opened in a stipulated period.	Great Yarmouth Port Authority	The assessment considers the potential effects of the construction and operation of the bridge on marine commercial activities. The assessment has drawn on the pNRA which includes a prediction of the number of vessel movements per day. See Sections 14.4 and 14.8.
Great Yarmouth Port Company (GYPC) note within the Scoping Report that there are only limited references to the Port and the likely environmental / operational impacts. We would have expected the inclusion of a specific chapter pertaining to the "port, shipping and navigation" taking into account the comments previously submitted in October 2017.	Great Yarmouth Port Company / Peels Port	The assessment of effects on marine commercial businesses and activities focuses on land-take, severance and disruption to operations within the River Yare and Port operations, including the potential for negative impacts of the bridge as a barrier to the river port north of the new bridge location. Vessel Simulation Modelling has been undertaken that allows virtual navigation of a vessel through the River Yare to test how the Scheme interacts with Port operations. The Vessel Simulation Report which summarises the Vessel Simulation Modelling is included as Appendix C to the Navigational Risk

Scoping Opinion Item	Consultee	Response
		Assessment (Document reference 6.14).
Whilst GYPC acknowledge and welcome the improved road connectivity to the peninsular and Out Harbour the crossing will bring, they do have significant concerns over the likely impact upon the considerable commercial activity upon the River Yare. This is because the new crossing will sever their operational landholdings and a number of the tenants/ operators. Of particular relevance is the safeguarding of commercial port activity upstream of the proposed crossing.	Great Yarmouth Port Company / Peels Port	The assessment considers the potential effects of the construction and operation of the bridge on marine commercial activities. In addition, the assessment considers the effects of permanent and temporary land-take required for the construction and operation of the bridge. See Sections 14.4 and 14.8.
GYPC note that the Scoping Report provides no quantitative assessment of likely bridge openings as this will have a direct impact upon traffic flows and congestion air quality (from stationary traffic) and driver stress.	Great Yarmouth Port Company / Peel Ports	The assessment considers the potential effects of the construction and operation of the bridge on marine commercial activities. The assessment has drawn on the pNRA which includes a prediction of the number of vessel movements / bridge openings per day. See Sections 14.4 and 14.8.
It would be useful to better understand the basis of the facts regarding bridge opening numbers and length in terms of road network v vessel activity presented in the consultation material.	Great Yarmouth Port Company / Peels Port	The preliminary Navigational Risk Assessment (pNRA) (document reference 6.14) has been prepared for the Scheme. The pNRA has estimated the number of bridge openings required for the Scheme.
The MMO welcomes the intention to identify water sports through consultation with local groups, but would also expect regional bodies such as the RYA and The Broads	MMO	The following groups have been directly consulted regarding water based recreational

Scoping Opinion Item	Consultee	Response
Authority to be consulted to identify the extent of individuals taking part in water sports in the river.		activities along the River Yare: • Royal Yachting Association; • The Broads Authority; • Great Yarmouth and Gorleston Sailing Club; and • Great Yarmouth and Norfolk County Angling Association. See Table 14.4.
Natural England encourages any proposal to incorporate measures to help encourage people to access the countryside for quiet enjoyment. Measures such as reinstating existing footpaths together with the creation of new footpaths and bridleways are to be encouraged. Links to other green networks and, where appropriate, urban fringe areas should also be explored to help promote the creation of wider green infrastructure. Relevant aspects of local authority green infrastructure strategies should be incorporated where appropriate.	Natural England	The Scheme includes facilities for NMU. An assessment of the potential effects on NMU has been undertaken as part of the assessment. See Sections 14.4 and 14.8.
The EIA should consider potential impacts on access land, public open land, rights of way and coastal access routes in the vicinity of the development. Consideration should also be given to the potential impacts on the adjacent England Coast Path National Trail. The National Trails website www.nationaltrail.co.uk provides information including contact details for the National Trail Officer. Appropriate mitigation measures should be incorporated for any adverse impacts. We also recommend reference to the relevant Right of Way Improvement Plans (ROWIP) to identify public rights of	Natural England	The assessment considers potential impacts on open land, PRoW and coastal access routes, in particular the England Coast Path. The ROWIP has been considered as part of the assessment. See Sections 14.4 and 14.8.

Scoping Opinion Item	Consultee	Response
way within or adjacent to the proposed site that should be maintained or enhanced.		
No PRoW are within the red line of the proposed development, or within a reasonable distance that means they might be affected. However, a promoted Sustrans Cycle Route is within the scheme boundary. This does not appear to be specifically referenced in the Scoping Report but is depicted in Figure 5.	Norfolk County Council (NCC)	The National Cycle Network has been considered within the assessment. See Sections 14.4 and 14.8.

Table 14.3: Summary of Section 42 Comments Received

Section 42 Item	Consultee	Response
Provision for off-road carriageway routes for pedestrians and cyclists be incorporated into the scheme, including improvement of links to the town centre and the south to reinforce the historic and functional connections with the wider hinterland.	Broads Authority	The Scheme includes facilities for pedestrians and cyclists, including a designated footway / cycleway across the proposed bridge. The footbridge over William Adams Way would be demolished as part of the Scheme. However, safe crossing points and a footway would be provided along William Adams Way. Table 14.22 provides details of the NMU facilities that would be provided as part of the Scheme.

14.4.5 Table 14.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

14.4.6 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 14.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
NCC	Public Right of Way Officer	Email (06/09/18)	Officer confirmed the following routes are to be considered as part of the assessment: • Public Rights of Way (PRoW); • Footways and the pedestrian footbridge over William Adams Way; • Sustrans Cycle Route 517; • England Coast Path: Hopton-on-Sea to Sea Palling; and • The NCC scheme to improve cycle facilities along Southtown Road.
NCC	Planning Services	Email (28/02/2019)	Discussion regarding the refinement in the study area for the non-motorised user assessment, community severance assessment and recreational activities assessment from 2km to 500m as part of the progression of the assessment from the PEIR to the ES.
GYBC	Head of Planning and Growth	E-mails (11/03/2019)	GYBC consulted regarding the refinement in the study area for the non-motorised user assessment, community severance assessment and recreational activities assessment from 2km to 500m as part of the progression of the assessment from the PEIR to the ES. The refinement of the study area was agreed.

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
GYBC	Strategic Director	Email (14/03/2019)	GYBC confirmed the scrubland that would be lost as part of the Scheme should not be considered as Open Space in policy terms because it is undeveloped and has a limited degree of visual amenity by virtue of the trees and shrubs. It has no recreational or sports value, current or planned, because there is no public access and is overgrown, and also there is substantial sports & recreation provision very close by. The Council has no objections regarding the loss of this small piece of scrub land to enable provision of the Third River Crossing.
The Broads Authority	Director of Operations	Email (25/02/2019)	The Broads Authority confirmed that the River Yare, from the confluence of the River Bure to the sea, is the responsibility of Peel Ports. In addition, the Broads Authority confirmed the link between the River Yare and the sea at Great Yarmouth is an important route for vessels wanting to enter or leave the Norfolk Broads. The assessment considers the potential effects of Scheme on recreational vessels using the River Yare. See Sections 14.4 and 14.8.
Royal Yachting Association	Planning and Environment-al Officer	Email (08/03/2019)	The Yare itself is navigable to Norwich and as such is used regularly. A number of clubs, including Yare Sailing Club, and Yare Valley Sailing Club

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			are located upriver of the proposed crossing. The Yare also provides access to the wider Norfolk Broads, a hugely important boating destination. It is acknowledged that the proposed crossing provides greater clearance (without lifting) than the Haven and Breydon bridges upriver, in which case it does not present an insurmountable obstacle. It is more of an extra inconvenience to those needing to lower masts, or wait for lifting. There may be slipways in between the Haven bridge and the proposed crossing, whose users, if travelling to the sea, will not routinely have to navigate a bridge. It is therefore essential to consult local users with regard to lifting schedules, and temporary mooring facilities while waiting for lifting. Local user groups have been consulted as part of statutory consultation and the vessel waiting facilities has been considered within the assessment. See Sections 14.4 and 14.8.
Great Yarmouth and Norfolk County Angling Association (GYNCAA)	GYNCAA Secretary	Email (26/02/2019)	GYNCAA confirmed that the club does not fish in the vicinity of the Great Yarmouth harbour. The club does lease banks further upstream between Rockland Dyke and Langley along the freshwater stretch and the Scheme would

Body / Organisation	Individual / Stat Body / Organisation	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
			have no impact on the club's activities. GYNCAA confirmed that a number of anglers do fish the harbour area around the Scheme. GYNCAA was not aware of any organisations involved with this angling and it is assumed that any angling activity is by individuals for pleasure rather than organised events. The assessment considers the potential effects of Scheme on angling within the vicinity of the Principal Application Site. See Sections 14.4 and 14.8.
Great Yarmouth and Gorleston Sailing Club	Commodore	Email (25/02/2019)	Great Yarmouth and Gorleston Sailing Club confirmed that the club only sail on the sea. The club sail to the south side of the harbour's mouth with the club house being located adjacent to the pier hotel in Gorleston.

Insignificant Effects

14.4.7 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would be insignificant and have therefore not been considered further in the assessment:

- Operational criminal risks as they are dealt with in Chapter 18: Major Accidents and Disasters.
- Changes in development land. There is no development land within the Order limits and study area, so there are anticipated to be no effects on development land (see Paragraphs 14.5.16 - 14.5.17 for more information on development land).

14.4.8 Table 14.5 details the effects covered elsewhere within this Environmental Statement. In addition, different aspects of the assessment on walkers, cyclist and pedestrians (known as non-motorised users - NMUs) is covered within different chapters of the ES as detailed in paragraph 14.4.27 and Table 14.6.

Table 14.5: Summary of Topics Covered Elsewhere within this Environmental Statement

Topic	Chapters
Effects in relation to quality of surroundings and sense of place	• Chapter 9: Historic Environment • Chapter 10: Townscape and Visual
Potential for disturbance, disruption, and reduction in amenity	• Chapter 6: Air Quality • Chapter 10: Townscape and Visual • Chapter 19: Cumulative Effects
Potential for changes to bus users	• Chapter 17: Traffic and Transport

Likely Significant Effects

14.4.9 The following likely significant effects have been assessed in this chapter:

- Changes to Non-Motorised User (NMU) facilities;
- Changes to vehicular journeys;
- Changes to community severance;
- Increased demand for local services due to influx of construction workers;
- Land acquired including residential and commercial properties as well as community assets;
- Severance and disruption to terrestrial and marine businesses and associated activities;
- Changes to access to recreational activities; and
- The generation of direct, indirect and induced employment opportunities and increases in economic activity.

Operational Phase

14.4.10 The following likely significant effects have been assessed in this chapter:

- Changes to NMU facilities;
- Changes to vehicular journeys;
- Changes to community severance;

- Changes to access and activities associated with terrestrial and marine businesses; and
- Changes to access to recreational activities.

Extent of the Study Area

14.4.11 This people and communities assessment is primarily focused on the Principal Application Site. The Satellite Application Sites are largely not considered to effect the people and communities assessment due to the nature and scale of the works required to undertake the Satellite Application Sites.

14.4.12 However, the driver stress assessment does consider the Application Site as a whole, as the Satellite Application Sites have the potential to result in changes to traffic flows and resultant driver stress across the extent of the Scheme. In addition, the assessment of potential impacts on NMUs, in particular footways, has considered the Application Site as a whole. It should be noted that the distances outlined in the below sections relate to the Principal Application Site, except for the distances relating to driver stress which include both the Principal Application Site and Satellite Application Sites.

Effects on Travellers

Non-motorised Users

14.4.13 The study area that has been used for the assessment of NMUs includes all public routes that are potentially affected by the Scheme. An initial study area of 2km from the Principal Application Site was used in the PEIR to identify key routes but this list has been refined to those within 500m for the purposes of the ES, as they are the routes most likely to be significantly affected by the Scheme (see Table 14.4 for further detail). Footways adjacent to the Satellite Application Sites have also been considered as part of the assessment.

Vehicle Travellers

14.4.14 The study area for the assessment of driver stress and delay includes the relevant links in the SATURN[1] traffic modelling. The Transport Assessment (presented as DCO document 7.2) provides further detail on the SATURN traffic model used to determine changes in traffic flows due to the Scheme. The traffic model considers two scenarios which have been considered within the driver stress assessment:

- Do minimum – this scenario considers the traffic flows without the Scheme; and

[1] SATURN: Simulation and Assignment of Traffic in Urban Road Networks modelling software, developed by the University of Leeds and Atkins.

- Do something – this scenario considers traffic flows with the Scheme in place.

Effects on Communities

Community Severance

14.4.15 An initial study area of 2km was used in the PEIR to identify key community receptors but this list has been refined to those within 500m for the purposes of the ES, as these receptors are the ones most likely to be significantly affected by the Scheme due to their location relative to the Principal Application Site or location relative to the temporary diversion routes (see Table 14.4 for further detail).

Demand for Local Services

14.4.16 A proportion of the construction workers could be sourced from beyond the local (Great Yarmouth Borough) and regional (East of England) areas (potentially due to the need to source construction workers with specific skills to undertake aspects of construction of the Scheme). This may result in the need for workers to relocate to an area local to the Scheme for the duration of the construction phase. These construction workers have the potential to place additional demand on local services such as education and healthcare (particularly if they have families). At this stage, it is not known where the construction workers moving to the area would be residing, however for the purposes for the assessment it is assumed construction workers would reside in Great Yarmouth town centre.

Physical Assets: Residential and Commercial Properties, including temporary and permanent land take

14.4.17 The study area that has been used for the assessment on land-take (including residential and commercial properties) includes the land within and immediately adjacent to the Scheme. However, the loss of residential and commercial properties is considered in the context of the wider housing market and existing demand across the Great Yarmouth Borough.

Physical Assets: Community Assets

14.4.18 The study area that has been used for the assessment of land-take from community assets includes the land within and immediately adjacent to the Principal Application Site.

Effects on People

Economy and Employment

14.4.19 As the Scheme is located within Great Yarmouth, the 'local level'[2] comprises Great Yarmouth Borough as noted in the EIA Scoping Report (DCO Document 6.6). Given the scale of the Scheme, strong transport connections, economic linkages, and travel to work patterns, the employment effects of the Scheme are considered to extend beyond Great Yarmouth. Based on the travel to work information identified in the Census 2011, a larger number of workers travel throughout Norfolk. As such, Norfolk comprises the 'regional level' for the assessment of economic impacts. Suffolk Coastal and Waveney have also been considered, to provide more context to the assessment.

14.4.20 Statistics for the East of England region / England / Great Britain / UK have been provided within the baseline to provide context and enable comparisons against national averages.

Severance and Disruption to Terrestrial and Marine Businesses and Associated Activities

14.4.21 Terrestrial and marine commercial properties within and immediately adjacent to the Principal Application Site have been identified for the assessment of severance to commercial receptors.

Recreational Activities

Terrestrial recreational activities

14.4.22 An initial study area of 2km was used in the PEIR to identify key recreational assets but this list has been refined to those within 500m for the purposes of the ES, as these receptors are the ones most likely to be significantly affected by the Scheme (see Table 14.4 for further detail).

Marine recreational activities

14.4.23 A sediment assessment has been undertaken for the Scheme and is presented within Chapter 11: Road Drainage and the Water Environment. Based on the sediment assessment, the study area for marine recreational facilities is between the river mouth and south of the confluence with River Bure.

[2] The local level for interventions that generate employment effects or other economic benefits is often considered to be within the relevant travel to work area or if this is not appropriate then a 10-15-mile (circa 16-24 kilometres) radius of the site concerned if it is a physical development (Ref 14.15).

Method of Baseline Data Collation

Desk Study

14.4.24 A desktop study has been undertaken to gather all the relevant information. The following data sources have been consulted to inform the baseline conditions reported within this chapter:

- Office of National Statistics (ONS) Census 2011 (Ref 14.12);
- ONS Labour Market Statistics Report (NOMIS) (Ref 14.13);
- Office of National Statistics English Indices of Multiple Deprivation (2015) (Ref 14.14);
- GYBC Local Plan: Core Strategy (2013-2030) (Ref 14.15);
- GYBC Local Plan Policies Map (2015) (Ref 14.16);
- A replacement GYBC Local Plan (2021-2036) Development Plan Document (Ref 14.17);
- Great Yarmouth Open Space Study (2013) (Ref 14.18);
- WebTRIS (Highways England's online traffic database) (Ref 14.19);
- Great Yarmouth Third River Crossing: Outline Business Case (Ref 14.20);
- MAGIC Interactive Map (Ref 14.21); and
- Collison Map (Ref 14.22).

Site Visit

14.4.25 A site visit was undertaken by two surveyors on 13th and 14th September 2018. The purpose of the site visit was to verify the baseline and to gain a greater understanding of the local context and potential effects of the Scheme on sensitive receptors.

Assessment Methodology

Construction Phase

Effects on Travellers: Non-motorised Users

14.4.26 During construction, the Scheme could have adverse effects on public routes (including PRoW and non-designated public routes) both on-site (i.e. within the Principal Application Site, Satellite Application Sites, and their immediate vicinity), and off-site (i.e. within a 500m catchment of the Principal Application Site).

14.4.27 The Scheme could affect NMUs in three different ways including: changes to accessibility; changes to disturbance, disruption and reduction in amenity;

and changes to fear and intimidation. Table 14.6 details where within this ES these different aspects of the NMU assessment are presented.

Table 14.6: Summary of Non-Motorised User Assessment within this Environmental Statement

NMU Assessment	Chapter
Changes to accessibility	The assessment is covered within this chapter
Changes to disturbance, disruption and reduction in amenity	Chapter 6: Air Quality Chapter 10: Townscape and Visual Chapter 19: Cumulative Effects.
Changes to fear and intimidation	Chapter 17: Traffic and Transport

14.4.28 The qualitative assessment of changes to accessibility considers disruption to routes due to construction activities, increases in journey length, and effects on the route / recreational resource (e.g. recreational grounds).

14.4.29 The impacts on NMUs are categorised using the criteria in DMRB Volume 11, Section 3: Part 8 (i.e. as Slight, Moderate or Severe). A description of each of these categorisations is outlined in Table 14.7 below and has been used to determine the magnitude of change in relation to NMU severance. It should be noted that other assessments within this chapter do not have DMRB specific assessment criteria and therefore this information is not available for these assessments.

Table 14.7: DMRB Assessment Criteria for NMUs

Categorisation	Description
Slight	In general, the current journey pattern is likely to be maintained, but there will probably be some hindrance to movement.
Moderate	Some residents, particularly children and elderly people, are likely to be dissuaded from making trips. Other trips will be made longer or less attractive.
Severe	People are likely to be deterred from making trips to an extent sufficient to induce a re-organisation of their habits. This would lead to a change in the location of centres of activity or in some cases to a permanent loss to a particular community. Alternatively, considerable hindrance will be caused to people trying to make their existing journeys.

Effects on Travellers: Vehicle Travellers

14.4.30 The assessment of vehicle travellers focuses on driver stress and delay. Driver stress is described as the adverse mental and psychological effects

experienced by a driver traversing a road network. Stress can lead to feelings of discomfort, annoyance, frustration or fear; culminating in physical or emotional tension that detracts from the value and safety of the journey.

14.4.31 The assessment follows the methodology outlined in DMRB Volume 11 Section 3: Part 9 (Ref 14.9), and considers three key components of driver stress:

- **Driver frustration,** which is caused by an inability to drive at a speed consistent with the standard of the road and increases as speed falls in relation to expectations.
- **Driver fear,** where the main factors are 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 proportion of heavy vehicles are all high, becoming more important in adverse weather conditions.
- **Driver uncertainty,** caused primarily by signage that is inadequate for the individual's purposes.

14.4.32 Volume 11 Section 3: Part 9 of the DMRB (Ref 14.9) indicates that increased driver stress leads to a lowering of driving standards, which may be expressed as aggression towards other road users or a diminished response to visual and other stimuli.

14.4.33 The assessment of the construction of the Scheme on vehicle travellers will consider both the anticipated delay (in terms of time) for vehicle receptors to travel and driver stress caused by the proposed diversion routes, traffic management systems, and road closures.

Effects on Communities

Community Severance

14.4.34 It is anticipated that during the construction phase, the roads within the vicinity of the Principal Application Site would be subject to temporary closure and / or diversion to facilitate the Scheme. This may cause severance and / or disruption of accesses to community receptors. In addition, the construction of the Scheme could cause disruption to community receptors. A qualitative assessment has, therefore, been undertaken in relation to community severance.

Demand for Local Services

14.4.35 A proportion of the construction workers would be sourced from beyond Great Yarmouth area and may be required to relocate to an area local to the Principal Application Site for periods of the construction phase (for example, if workers with particular training or skills are required to construct the Scheme). This could lead to an increased demand for local services (e.g.

education, healthcare and community facilities) and recreational / open space.

14.4.36 A qualitative assessment of effects relating to demand for local services (e.g. education, healthcare and community facilities) and recreational / open space from construction workers has been undertaken by evaluating the likely number of additional individuals coming to live in the study area. The influx of these construction workers has been used to estimate the magnitude of change and any additional pressure which may arise on local services and recreational / open space in context of existing demand within Great Yarmouth.

Physical Assets: Residential and commercial properties, including temporary and permanent land-take

14.4.37 During the construction of the Scheme, there is anticipated to be land required from existing business premises. A qualitative assessment has been undertaken to determine the land required from commercial properties, the importance of the land to that business (i.e. whether it is imperative to a business operation), the availability of alternative land within the vicinity, and the proportion of the land-take as an overall quantum of each landholding. The assessment of the permanent loss of residential receptors and access to residential receptors considers the importance of the land (i.e. whether it also serves business operation), the availability of alternative land / facilities of the same type within the vicinity, and compensation / provisions provided as part of the Scheme.

14.4.38 The impact of land take is assessed during the construction phase as this is when land take would occur, resulting in potential impacts. The assessment will consider whether the land take is permanent or temporary in nature.

14.4.39 In the absence of overall significance criteria within DMRB Volume 11, Section 3: Part 6 (Ref 14.7), applying professional judgement, the effects related to physical assets have been described as: beneficial, negligible, or adverse; permanent or temporary; and of minor, moderate, or major significance (see paragraph 14.4.68).

Physical Assets: Community Assets

14.4.40 The assessment of loss of community assets will consider the importance of the land, the availability of alternative land / facilities of the same type within the vicinity, and community provisions provided as part of the Scheme.

14.4.41 The impact of land take is assessed during the construction phase as this is when land take would occur, resulting in potential impacts. The assessment will consider whether the land take is permanent or temporary in nature.

14.4.42 In the absence of overall significance criteria within DMRB Volume 11, Section 3: Part 6 (Ref 14.7), applying professional judgement, the effects related to physical assets has been described as: beneficial, negligible, or

adverse; permanent or temporary; and of minor, moderate, or major significance (see paragraph 14.4.68).

Effects on People

Economy and Employment

14.4.43 The assessment of the generation of employment opportunities has been based on the indicative employment numbers estimated by the Design Team and professional judgement and experience from other schemes of a similar size.

14.4.44 To determine the magnitude of change, the net employment opportunities created by the Scheme have been evaluated against the total number of employees in the industry sectors anticipated to be benefited by the direct and induced job creation. It is assumed that these include the following industry sectors (which align with ONS industry classifications):

- F (Construction);
- G (Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles);
- H (Transportation and Storage);
- I (Accommodation and Food Service Activities);
- J (Information and Communication);
- N (Administrative and Support Service Activities);
- R (Arts, Entertainment and Recreation); and
- S (Other Service Activities).

Severance and Disruption to Terrestrial and Marine Businesses and Associated Activities

14.4.45 The level of severance and disruption has also been considered qualitatively in terms of a reduction in footfall and pedestrian and vessel access for terrestrial and marine businesses, for example off Queen Anne's Road and including increases in journey length for non-motorised and motorised users to reach the businesses. In accordance with DMRB, the average journey speeds for users has been assumed to be 5km/hr for non-vulnerable pedestrians (i.e. able-bodied adults), 3km/hr for vulnerable pedestrians (i.e. elderly, disabled persons and children), 20km/hr for cyclists (assuming these are non-vulnerable) and 50km/hr for vehicle travellers. These speeds have been considered within the context of the length of the journey in terms of an increase / decrease to determine whether there is a significant change.

Recreational Activities, including both terrestrial and marine activities

14.4.46 During construction, the Scheme would require changes to access for terrestrial and marine recreational resources[3] both on-site (i.e. within the Principal Application Site and immediate vicinity) and off-site (i.e. within the wider area and along the Norfolk coast).

14.4.47 A qualitative assessment of changes in accessibility to terrestrial and marine recreational resources considers disruption to routes due to construction activities, increases in journey length, and effects on the route / recreational resource (e.g. recreational grounds). The assessment in this chapter also considers the potential effects to recreational vessel movements during the construction period.

Operational Phase

Effect on Travellers

Non-motorised Users

14.4.48 During the operational phase, the assessment considers the changes to the availability of routes and access to the public routes within the immediate area of the Principal Application Site. The same assessment methodology used for the assessment of construction effects on NMUs has been used for operational effects.

Vehicle Travellers

14.4.49 To assess driver stress during the operation of the Scheme, DMRB guidance provides advice on categorising stress as high, moderate or low. This is based upon speeds and flows during peak hour flows on road links, e.g. the section of a road between junctions. Driver stress has been calculated by comparing average hourly flow per lane and average vehicle speed during morning (AM) and evening (PM) peak hours against the thresholds for single carriageways and dual carriageways provided in the DMRB guidance.

14.4.50 Driver stress has been calculated for each link in each of the following scenarios to determine the level of impact:

- The existing layout in the baseline year (2018);
- The do minimum scenario (i.e. without the Scheme) in 2023;
- The do something scenario (i.e. with the Scheme) in 2023;
- The do minimum scenario (i.e. without the Scheme) in 2038; and
- The do something scenario (i.e. with the Scheme) in 2038.

[3] Open space, sport, marine recreational activities and recreational facilities.

14.4.51 Levels of driver stress have been assessed through a quantitative assessment of the three components of driver stress listed in paragraph 14.4.31, with reference to Chapter 4 of DMRB Part 9, which recommends a broad three-point descriptive scale of Low, Moderate or High. This three-point scale is based on the thresholds detailed in Tables 2 and 3 of DMRB, Volume 11, Section 3, Part 9 (Ref 14.9), as shown below in Table 14.8 and Table 14.9.

Table 14.8: Dual-Carriageway Roads from DMRB, Volume 11, Section 3, Part 9

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 areas.

Table 14.9: Stage Single-Carriageway Roads from DMRB, Volume 11, Section 3, Part 9

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 areas.

Effects on Communities

Community Severance

14.4.52 During the operational phase, the Scheme would provide access across the River Yare. A qualitative assessment has been undertaken based on the potential for enhanced access for community facilities.

14.4.53 The impact on community amenity has been assessed elsewhere within this ES as outlined in Table 14.5.

Demand for Local Services

14.4.54 Demand for local services has not been considered during operation. This is because construction workers would be unlikely to continue residing in the area local to the Principal Application Site once it is complete and operational. In addition, as the Scheme is an infrastructure project it would not generate a new residential population.

Physical Assets

14.4.55 Physical assets have not been considered during operation. This is because the impact of land take has been assessed during the construction phase as this is the point of impact when the land would be taken.

Effects on People

Terrestrial Businesses and Associated Activities

14.4.56 Once operational, the Scheme is anticipated to lead to an increase in economic activity due to greater connectivity afforded by the Scheme. The assessment will consider the potential effects on enhanced access for local businesses and industrial estates (e.g. Harfrey's Industrial Estate) and reduction in journey times / delay.

Marine Businesses and Associated Activities

14.4.57 Once operational, the placement and opening of the bridge have the potential to affect vessel transport and port operations. A qualitative assessment has been undertaken considering the effects of the Scheme on navigational risk identified as part of the Vessel Simulation Model and the number of future vessel movements at the proposed bridge location estimated as part of the pNRA document reference 6.17) that could be affected by the Scheme.

Recreational Activities, including terrestrial and marine recreational activities

14.4.58 During the operational phase, the assessment will consider the changes to the availability and access to the recreational resources within the immediate area of the Principal Application Site. The assessment also considers potential changes to the number of recreational vessel movements at the proposed bridge location and disruption to recreational access along the River Yare as indicated within the pNRA (document reference 6.17).

14.4.59 For the wider resources which may be affected, the outputs of the hydromorphological analysis has been used to qualitatively determine what the change / impact may be at the off-site recreational resources (e.g. reduction in sand deposition at beaches and associated loss of recreational resources) – see Chapter 11: Road Drainage and the Water Environment for further details.

Significance Criteria

14.4.60 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Scheme, and the sensitivity of the affected

receptor, as well as a number of other factors that are outlined in more detail in Chapter 4: Approach to EIA.

14.4.61 DMRB guidance (Volume 11, Section 3: Parts 6, Part 8 and Part 9) does not outline a methodology for determining the magnitude of impacts, or for measuring the sensitivity of receptors when assessing the Effects on Communities and Effects on People. As such, overall EIA guidance has been referred to when determining the significance of effects, and professional judgement has been applied.

14.4.62 The assessment process aims to be objective and quantifies effects as far as possible. However, some effects can only be evaluated on a qualitative basis. Effects are defined as follows:

- **Beneficial**, classifications of significance indicate an advantageous or beneficial effect on an effect area, which may be minor, moderate, or major in effect; and
- **Adverse**, classifications of significance indicate a disadvantageous or adverse effect on an effect area, which may be minor, moderate or major in effect.

14.4.63 The overall significance of the likely people and community effects has been based on:

Sensitivity

14.4.64 The sensitivity of the affected receptor is assessed on a scale of high, medium, low and negligible. The magnitude of change is assessed on a scale of large, medium, small and negligible (as shown in Chapter 5: Approach to EIA).

14.4.65 Determining the sensitivity of receptors is based upon the baseline conditions. The criteria for sensitivity of community receptors are outlined in Table 14.10. A precautionary approach, based on professional judgement, has been used when applying the below criteria.

Table 14.10: Criteria for Sensitivity

Sensitivity	Criteria
High	A vulnerable receptor with little capacity to absorb change, such as: Areas with levels of considerable unemployment well in excess of the national / regional averages and level of relative deprivation (top 10%). Community facilities that are used by a very high number of individuals / limited in number within the area. Limited local services and recreational / open space available / that have the capability to cope with a limited increased demand.

Sensitivity	Criteria
	Businesses that depend on a high level of footfall / vehicular access / marine access. Residential properties / private land / access needed for ongoing business operations. PRoW frequently used by NMU (including pedestrians and cyclists) for commuting, recreational and leisure purposes (e.g. National Trails). Also for use by vulnerable travellers (e.g. elderly, school children and people with disabilities). Frequently used recreational areas. Routes of high driver stress (defined as a route with 1600+ average peak hourly flow per lane in flow units / 1 hour at any speed).
Medium	A non-vulnerable receptor with limited capacity to absorb change, such as: Areas with levels of unemployment above the national / regional averages and level of relative deprivation (top 50%). Community facilities that are used by a moderate number of individuals / several present within the area. Several local services and recreational / open space available / that have the capability to cope with some increased demand. Businesses that depend on a medium level of footfall / vehicular access / port operations. Businesses that would still have alternative access. PRoW moderately used by NMU for commuting, recreational and leisure purposes (e.g. regional trails). Moderately used recreational areas. Routes of medium driver stress (defined as a route with under 1,200 average peak hourly flow per lane in flow unit / 1 hour with average speed of 60-80 or 1200 - 1600 average peak hourly flow per lane in flow units / 1 hour with average journey speed of 60+km/hr).
Low	A non-vulnerable receptor with capacity to absorb change, such as: Areas with levels of unemployment in line with national / regional averages and level of relative deprivation (bottom 50%). Community facilities that are used by a limited number of individuals / a number are present within the area.

Sensitivity	Criteria
	A number of local services and recreational / open space available / that have the capability to cope with increased demand. Businesses that depend on a low level of footfall / vehicular access / port operations. Private land / access that is only required occasionally for ongoing business operations or where an alternative access is available. PRoW sometimes used by NMU for recreational / leisure purposes (e.g. local routes). Recreational areas with limited use by the general public. Routes of low driver stress (defined as a route with under 1,200 average peak hourly flow per lane in flow units / 1 hour with average journey speed of 80+km/hr).
Negligible	A non-vulnerable receptor with ability to absorb changes, such as: Areas of very limited unemployment (well below the national / regional averages) and level of relative deprivation (bottom 50%). Community facilities that are used by infrequently by individuals / a large number are present within the area. Large number of local services and recreational / open space available / that have the capability to cope with increased demand. Businesses that do not depend on a footfall / vehicular access / port operations. Private land / access that is not required for ongoing business operations. PRoW not / infrequently used by NMU for recreational purposes. Recreational areas not / minimally used by the general public. Routes with very limited driver stress due to infrequent use.

Magnitude

14.4.66 Determining the impact magnitude relates to whether the Scheme would result in changes to the receptor and the scale of these effects. The criteria for impact magnitude are outlined in Table 14.11. A precautionary approach, based on professional judgement, has been used with regard to the level of impact on landholdings.

Table 14.11: Criteria for Impact Magnitude

Impact Magnitude	Criteria
Major	• Greater than 5% increase / decrease on existing baseline levels of employment. • Where there would be a major impact on an asset used by the community due to disturbance (e.g. the asset could no longer fulfil its function). • Where there would be a major impact on landholdings, tenants and commercial terrestrial and maritime businesses/ access to landholdings and commercial terrestrial and maritime businesses (e.g. permanent loss of land / access to landholdings with no alternative access available). • Permanent loss / severance of an existing recreational route / resource used by NMU. • Where there would be a major increase / reduction in driver stress resulting from the Scheme compared to the do minimum.
Moderate	• 1% - 5% increase / decrease on baseline levels of employment. • Where there would be a medium change on an asset used by the community due to disturbance (e.g. temporary impact on the ability to asset to fulfil its function). • Where there would be temporary land take / small amount of permanent land take / moderate impact on tenants / reduction in accessibility of private land and commercial terrestrial and maritime businesses. • Disruption of a recreational route / resource used by NMU with significant increase / decrease in journey length / time. • Where there would be a moderate increase / reduction in driver stress resulting from the Scheme compared to the do minimum.
Minor	• 0.01 – 0.9 % increase / decrease on existing baseline levels of employment. • Where there would be a small change on an asset used by the community due to disturbance (e.g. limited impact on the ability to asset to fulfil its function).

Impact Magnitude	Criteria
	• Where there would be limited land take / impact on tenants / reduction in accessibility of private land and commercial terrestrial and maritime businesses. • Alteration of a recreational route / resource used by NMU but with no significant increase in journey length / time. • Limited increase in driver stress above baseline levels.
Negligible	• Less than 0.01% increase / decrease on existing baseline levels of employment. • Limited disturbance to assets used by community receptors. • No change in land take / impact on tenants / reduction in accessibility of private land and commercial terrestrial and maritime businesses. • No change to recreational route / resource used by NMU. • No change to levels of driver stress above baseline levels.

Duration

14.4.67 The duration of effect is also considered, with more weight given to permanent changes than to temporary ones. Temporary effects are considered to be those associated with the enabling, demolition and construction works, and may be short (0-2 years) or medium term (3-5 years). Permanent effects are considered to be long-term effects associated with the construction of the Scheme as well as effects associated with the operational phase of the Scheme.

Effect Significance

14.4.68 The level of significance of an effect takes into consideration the sensitivity of the receptor and the magnitude of an impact. The matrix set out in Table 4.6 and descriptors of the significance of effect set out in Table 4.7 has been used to determine the level of significance for this assessment taking into account the sensitivity of the receptor (see Table 14.10) and magnitude of an impact (see Table 14.11). For the purposes of this assessment, a moderate or major effect has been considered significant.

14.5 Baseline Conditions

Population

14.5.1 The resident population in Great Yarmouth was estimated to be 99,400 (49,200 males and 50,200 females) in 2017 based on ONS NOMIS data (Ref 14.13). There is a slightly lower proportion of working age individuals (aged 16-64) in Great Yarmouth (58.4%), compared with the averages across the East of England region (61.3%) and Great Britain (62.9%).

Deprivation

14.5.2 The Index of Multiple Deprivation (IMD) is the official measure of relative deprivation in England and provides a rank of the 326 local authorities in England, with 1 being the most deprived.

14.5.3 The IMD combines information from seven domains to produce an overall relative measure of deprivation. The domains are combined using the following weights:

- Income Deprivation (22.5%);
- Employment Deprivation (22.5%);
- Education, Skills and Training Deprivation (13.5%);
- Health Deprivation and Disability (13.5%);
- Crime (9.3%);
- Barriers to Housing and Services (9.3%); and
- Living Environment Deprivation (9.3%).

14.5.4 In the IMD 2015, Great Yarmouth was ranked 29 in England out of 326 local authorities and, as such, is in the 10% most deprived Local Authority areas in England. The Scheme is located within two Lower Layer Super Output Areas (LSOAs): Great Yarmouth 006A and Great Yarmouth 007B. The eastern extent of the Scheme is located in Great Yarmouth 006A LSOA, which is in the top 10% most deprived areas in England. The western extent of the Scheme is located in the Great Yarmouth 007B LSOA, which is amongst the 20% most deprived areas in England (Ref 14.13).

14.5.5 The IMD is used to determine the sensitivity of economic receptors using the criterion detailed in Table 14.10.

Employment and Local Economy

14.5.6 There are a number of local businesses located within the Application Site and study area. Local businesses, including the Kingsgate Centre and Simpsons New and Used Motorhomes, are located off Queen Anne's Road and Suffolk Road. Businesses are also located off Suffolk Road, including,

but not limited to, Space 4 U Storage Ltd and Great Yarmouth Community Hub. Harfrey's Industrial Estate is situated immediately west of the A47 / Williams Adam Way roundabout and comprises a variety of mixed industrial premises. To the east of the River Yare, an industrial area including UK Power Networks (UKPN), Asco, and Perenco is located adjacent to the river. A summary of the landholdings within the vicinity of the Principal Application Site is provided in Table 14.13.

14.5.7 In Great Yarmouth, the proportion of individuals aged 16-64 who were estimated to be economically active in 2017/18 was 71.1% (40,300 people), compared with an average of 78.9% (432,000 people) in Norfolk, 81.9% in Suffolk Coastal (60,300 people), 78.3% in Waveney (52,500 people), 81.1% in the East of England and 78.4% across Great Britain. In 2017, there was an estimated 37,000 jobs in Great Yarmouth, with 59.5% full time and 40.5% part time (Ref 14.13).

14.5.8 In 2016, the job density levels (i.e. the ratio of total jobs to the population aged 16-64) was 0.73 in Great Yarmouth, 0.82 in Norfolk, 0.81 in Suffolk Coastal and 0.74 in Waveney. As the job densities are lower than the averages across the East of England region (0.83) and Great Britain (0.84), this indicates less availability of employment opportunities within Great Yarmouth (Ref 14.13).

14.5.9 The Borough of Great Yarmouth has a diverse local economy. The Great Yarmouth Local Plan states it is the main service base in England for the offshore energy industry and has a thriving seasonal visitor economy (Ref 14.15).

14.5.10 Table 14.12 details the estimated employee jobs by industry sector in 2016. It should be noted that Table 14.12 provides an overview of all the industry sectors to provide a wider context of the study area. However, only the industry sectors identified within Paragraph 14.4.44 have been considered in the assessment.

14.5.11 In Great Yarmouth, the highest proportion of employee jobs were in the Human Health and Social Work Activities (Sector Q) at 21.6% in 2017. This is a greater proportion than the average across Norfolk (16.1%), Suffolk Coastal (10.2%), Waveney (11.5%), the East of England region (12.6%), and Great Britain (13.3%). The construction industry (Sector F) constituted 4.1% of the workforce (approximately 1,500 jobs) in Great Yarmouth in 2017, which is the same as Suffolk Coastal (4.1%) and slightly lower than Norfolk (5.3%) and Waveney (5.1%), as well as the national average (4.8%) (Ref 14.13).

Table 14.12: Overview of Estimated Employees by Jobs in Industry Sector (2017)

Industry Sector	Great Yarmouth (%)	Norfolk (%)	Suffolk Coastal (%)	Waveney (%)	East of England	Great Britain
B: Mining and quarrying	0.8	0.3	0.0	0.1	0.1	0.2
C: Manufacturing	8.1	9.7	6.1	17.9	8.0	8.2
D: Electricity, gas, steam and air conditioning supply	0.2	0.2	1.2	0.3	0.3	0.5
E: Water supply; sewerage, waste management and remediation activities	1.1	0.7	0.5	0.9	0.6	0.7
F: Construction	4.1	5.3	4.1	5.1	5.5	4.8
G: Wholesale and retail trade; repair of motor vehicles and motorcycles	16.2	17.2	14.3	17.9	17.1	15.2
H: Transportation and storage	3.4	3.6	16.3	3.2	4.9	4.7
I: Accommodation and food service activities	13.5	8.6	10.2	10.3	6.8	7.5
J: Information and communication	1.1	1.9	8.2	1.0	3.6	4.4
K: Financial and insurance activities	0.8	3.6	0.6	1.0	2.4	3.5
L: Real estate activities	0.6	1.2	1.0	1.0	1.5	1.7
M: Professional, scientific and technical activities	8.1	6.1	6.1	6.4	9.3	8.4
N: Administrative and support service activities	4.7	7.8	4.1	5.8	10.5	9.1
O: Public administration and defence;	2.4	3.9	4.1	3.8	3.0	4.3

Industry Sector	Great Yarmouth (%)	Norfolk (%)	Suffolk Coastal (%)	Waveney (%)	East of England	Great Britain
compulsory social security						
P: Education	9.5	9.1	8.2	9.0	8.8	8.9
Q: Human health and social work activities	21.6	16.1	10.2	11.5	12.6	13.3
R: Arts, entertainment and recreation	4.7	3.0	3.1	3.2	2.7	2.6
S: Other service activities	1.2	1.9	2.0	1.5	1.9	2.0

Land Uses

14.5.12 Land within the Principal Application Site and surrounding areas is in a mixture of private and public ownership (see Figure 14.1). Private landholdings are owned by a mixture of companies as outlined in Table 14.13. The public-sector landholdings, including residential properties, are owned by Highways England, NCC and GYBC.

14.5.13 The Principal Application Site also includes a section of the River Yare used for berthing and as a navigation channel for commercial and leisure vessels. In addition, six sections of road that would be improved via VMS are also included within the Satellite Application Site. The six sections of road are located along (from south to north): A47 (south of the western junction improvement); Gapton Hall Road; Yarmouth Way; Fullers Hill; North Quay; and Acle New Road. The Order limits for all these six sites lies within the existing highway boundary.

14.5.14 Table 14.13 provides a summary of the landholdings within the Principal Application Site. The plot numbers detailed in Table 14.13 relate to the plot numbers shown on the Land Plans.

Table 14.13: Landholdings within the Principal Application Site

Landowner	Lessees or Reputed Lessees / Occupiers	Description	Plot Number(s)
Highways England	N/A	A47, Harfreys Roundabout and William Adams Way, Great Yarmouth	1-01, 1-25, 2-01, 2-02

Landowner	Lessees or Reputed Lessees / Occupiers	Description	Plot Number(s)
NCC/ GYBC	N/A	Suffolk Road, Queen Anne's Road, Boundary Road, Beccles Road, Cromwell Road, Southtown Road, Southgates Road, A1243 South Denes Road, Fish Wharf, Sutton Road, Admiralty Road, Middle Road East, Middle Road West and Swanston's Road, Great Yarmouth	1-19, 1-28, 1-51, 1-64, 1-66, 1-67, 2-04, 2-17, 2-18, 2-19, 3-10, 3-12, 3-15, 4-04, 4-32, 4-37, 4-41, 4-42, 4-43, 4-44, 4-45, 4-46
Hope (Borough of Great Yarmouth)	N/A	Land associated with Kingsgate Community Centre, Queen Anne's Road, Great Yarmouth	1-10, 1-11
Simpsons Garage (Great Yarmouth) Limited	N/A	Land and buildings on the west side of Suffolk Road, Great Yarmouth	1-08, 1-09, 1-15
Private Landowner[4]	DPL (Discount Paving and Landscaping)	Land and buildings on the south side of Boundary Road, Great Yarmouth	1-04
Private Landowner[4]	3Sun Group Limited	Land and buildings on the south side of Boundary Road, Great Yarmouth	1-05
Private Landowner[4]	CVS (UK) Limited	Land associated with Haven Veterinary Surgeons, Queen Anne's Road, Great Yarmouth	1-07

[4] Due to the General Data Protection Regulations, it is not possible to disclose information regarding individual private landowners.

Landowner	Lessees or Reputed Lessees / Occupiers	Description	Plot Number(s)
Regaland Limited	N/A	Commercial units and associated curtilage, Suffolk Road Enterprise Park, Suffolk Road, Great Yarmouth, NR32 0LN	1-20, 1-45
Regaland Limited	MMC Performance Limited	Unit 10, Suffolk Road Enterprise Park, Suffolk Road, Great Yarmouth	1-46
Regaland Limited	Ses Fabrication Limited	Unit 11, Suffolk Road Enterprise Park, Suffolk Road, Great Yarmouth	1-47
Regaland Limited	N/A	Unit 12, Suffolk Road Enterprise Park, Suffolk Road, Great Yarmouth	1-48
Regaland Limited	N/A	Unit 13, Suffolk Road Enterprise Park, Suffolk Road, Great Yarmouth	1-49
Great Yarmouth and Gorleston Allotments Association Limited	N/A	Allotment sites on the north side of Queen Anne's Road, Great Yarmouth	1-23
Great Yarmouth And Gorleston Allotments Association Limited	Great Yarmouth and Waveney Mind	Allotment sites on the south side of Queen Anne's Road, Great Yarmouth	1-27, 2-03
GYBC	Great Yarmouth and Waveney Mind	Buildings and allotment sites on the south side of Queen Anne's Road, Great Yarmouth	2-05, 2-06, 2-07

Landowner	Lessees or Reputed Lessees / Occupiers	Description	Plot Number(s)
Church Commissioners for England	NCC/ Saffron Housing Trust Limited/ The Occupier	22 Queen Anne's Road, Great Yarmouth, NR31 0LE	1-29
Church Commissioners for England	NCC/ Ad Hoc Property Management Limited/ The Occupier	20, 19, 18, 17, 16 and 15 Queen Anne's Road, Great Yarmouth, NR31 0LE	1-33, 1-36, 1-37, 1-38, 1-39, 1-40
NCC	Ad Hoc Property Management Limited/ The Occupier	21 Queen Anne's Road, Great Yarmouth, NR31 0LE	1-32
Church Commissioners for England	Private leaseholders and occupiers	14 Queen Anne's Road, Great Yarmouth, NR31 0LE	1-41
Church Commissioners for England	Private leaseholders and occupiers	13 Queen Anne's Road, Great Yarmouth, NR31 0LE	1-42
NCC	Saffron Housing Trust Limited/ The Occupier	11 Cromwell Road, Great Yarmouth, NR31 0LD	1-52
NCC	Saffron Housing Trust Limited/ The Occupier	156 and 152 Southtown Road, Great Yarmouth, NR31 0LA	1-55, 1-59
Private Landowner[4]	The Occupier	155 Southtown Road, Great Yarmouth, NR31 0LA	1-56

Landowner	Lessees or Reputed Lessees / Occupiers	Description	Plot Number(s)
NCC	Ad Hoc Property Management Limited/ The Occupier	154, 153, 151, 150, 149 and 148 Southtown Road, Great Yarmouth, NR31 0LA	1-57, 1-58, 1-60, 1-61, 1-62, 1-63
Private Landowners[4]	Private leaseholders and occupiers	Car parking and hardstanding associated with Cromwell Court, Cromwell Road, Great Yarmouth, NR31 0QU	1-50
National Grid Property Holdings Limited	Space 4 U Storage Limited	Land to the south of William Adams Way, Great Yarmouth	2-12
National Grid Property Holdings Limited	Cadent Services Limited	Land to the south of William Adams Way, Great Yarmouth	2-13, 2-14
Cadent Services Limited	N/A	Land to the south of William Adams Way, Great Yarmouth	2-15, 2-16
GYBC	Great Yarmouth Port Company Limited	Land at Bollard Quay, Southtown Road, Great Yarmouth	3-01, 3-02, 4-01, 4-02
GYBC	N/A	River Yare, Great Yarmouth	3-03, 3-04, 3-05, 4-05, 4-06, 4-07, 4-08, 4-09, 4-10, 4-11
GYBC	Great Yarmouth Port Authority/ Great Yarmouth Port Company Limited/ E.On Climate & Renewables UK	Land and buildings on the west side of Southgates Road, Great Yarmouth	3-18

Landowner	Lessees or Reputed Lessees / Occupiers	Description	Plot Number(s)
	Offshore Wind Limited		
Great Yarmouth Port Authority	Great Yarmouth Port Company Limited/ Peel Ports Group Limited	Land associated with Atlas Terminal, Southgates Road, Great Yarmouth	3-06, 3-17, 4-12, 4-13, 4-21
GYBC	Great Yarmouth Port Authority/ Great Yarmouth Port Company Limited/ Peel Ports Group Limited	Land associated with Atlas Terminal, Southgates Road, Great Yarmouth	3-09, 3-14
Private landowner[4]	Great Yarmouth Port Authority/ Great Yarmouth Port Company Limited/ Peel Ports Group Limited	Land associated with Atlas Terminal, Southgates Road, Great Yarmouth	3-08
Private landowner[4]	Great Yarmouth Port Authority/ Great Yarmouth Port Company Limited/ Peel Ports Group Limited	Land associated with Atlas Terminal, Southgates Road, Great Yarmouth	3-07
Great Yarmouth Port Authority	Great Yarmouth Port Company Limited/ Asco UK Limited/ Perenco UK Limited	Land associated with The Neptune Warehouse, South Denes Road, Great Yarmouth, NR30 3LX	4-18, 4-23, 4-24, 4-25, 4-26, 4-27
GYBC	Great Yarmouth Port Authority/ Great Yarmouth	Land associated with The Neptune Warehouse, South	4-28, 4-29, 4-30, 4-31, 4-34

Landowner	Lessees or Reputed Lessees / Occupiers	Description	Plot Number(s)
	Port Company Limited/ Asco UK Limited/ Perenco UK Limited	Denes Road, Great Yarmouth, NR30 3LX	
GYBC	Asco UK Limited/ Perenco UK Limited	Land on the west side of South Denes Road, Great Yarmouth	4-36
GYBC	Eastern Power Networks plc	Land on the west side of South Denes Road, Great Yarmouth	4-38
National Grid Property Holdings Limited	Great Yarmouth Port Company Limited	Land on the east side of South Denes Road, Great Yarmouth	3-13
GYBC	Private leaseholders and occupiers	Land and buildings associated with South Denes Car Centre, South Denes Road, Great Yarmouth, NR30 3LW	3-11, 4-33
Yarmouth Stores Limited	Score (Europe) Limited	Land and buildings associated with Score (Europe) Limited, 33-36 Southgates Road, Great Yarmouth, NR30 3LL	3-20, 3-21, 3-22
GYBC	Private occupier	Land and buildings on the east side of Southgates Road, Great Yarmouth	3-16

14.5.15 Local businesses and community facilities are also situated within the Principal Application Site and surrounding area (see below sections for further detail).

14.5.16 The route of the alignment is allocated as the 'Third River Crossing Adopted Route' (Policy CS16) in the Great Yarmouth Core Strategy Proposals Map. The Scheme alignment has, however, developed since this allocation and now requires permanent construction on the scrubland to the east of Kingsgate Community Centre. Although this scrubland is allocated as an Open Amenity Space (Saved Policy REC11) in the Great Yarmouth Core Strategy Proposals Map, it offers limited recreational value due to the lack of public paths / routes and limited access due to the overgrown vegetation. Therefore, it has not been considered as open space for the purposes of this assessment as it does not provide this function. This approach has been agreed with GYBC (see Table 14.4).

14.5.17 In addition, the green space adjoining the Kingsgate Community Centre is also allocated as an Open Amenity Space (Saved Policy REC11). This green space would be temporarily used as a construction site compound during the construction period. It is understood that this green space is not open to the public and therefore cannot considered open amenity space as it does not provide this function. The green space would, however, be restored to its previous condition, unless otherwise agreed with Kingsgate Community Centre.

14.5.18 The Scheme also includes a part of a Safeguarded Employment Area (CS6) to the north of Queen's Anne Road and a Safeguarded Employment Area (CS6) to the east of the River Yare. A further Safeguarded Employment Area (CS6) is located to the south of Southtown Road, albeit this falls outside of the Application Site (Ref 14.16).

Community Facilities

14.5.19 The only community receptors located within the Principal Application Site itself are two allotment gardens, situated immediately north-east of the Queen Anne's Road and Suffolk Road junction, and the MIND Centre and Grounds (see Figure 14.2). As shown in Table 14.14, there are also a number of community facilities located within the Study Area. Appendix 14C details the community receptors within 2km of the Principal Application Site.

14.5.20 An Equality Impact Assessment (EqIA) has been developed for the Scheme (document reference 6.15). The EqIA has also identified community and recreational facilities within 500m of the Principal Application Site. The majority of the receptors identified for the people and communities assessment and the EqIA are the same. However, the assessment methodologies for the EqIA and people and communities assessment differ due to the different scope and purpose of the reports, which means the receptors assessed within these two reports do not align completely.

Table 14.14: Community Facilities within the Study Area

Name	Type of Facility	Direction from the Principal Application Site	Distance from the Principal Application Site
Two allotment gardens (north-east of the Queen's Anne Road and Suffolk Road junction)	Allotment Garden	N/A	Within the Principal Application Site
MIND Centre and Grounds	Community Centre / Allotment Garden	N/A	Within the Principal Application Site
Southtown Common Recreation Ground (including children's play area and sports pitches)	Recreation Ground	S and E	0 m
Harfrey's Industrial Estate	Shops	W	0m
East Coast Black Belt School	Sports Centre	E	10m
Peggotty Community Centre	Community Centre	E	11m
Kingsgate Community Centre	Community Centre	N	15m
Allotment gardens (south-west of the recreation ground)	Allotment Garden	SE	35m
Sure Start Children's Centre	Childcare Centre	E	40m
Community Centre Harry Miller Court	Community Centre	E	77m
Great Yarmouth Community Hub	Community Centre	S	81m
The Redeemed Christian Church of God	Church	NE	105m
Claydon Pavilion Community Centre	Community Centre	SW	125m
Allotments on Common Road	Allotment Garden	S	159m
Nova Training Centre	Community Centre	S	160m
The Shine Centre	Community Centre	S	170m
St James Church	Church	NE	200m
St John Ambulance	Community Centre	N	230m

Name	Type of Facility	Direction from the Principal Application Site	Distance from the Principal Application Site
Great Yarmouth Primary Academy	Primary School	NE	243m
Trafalgar College	Secondary School	N	244m
East Coast College	Secondary School	N	253m
Manor Close Communal Rooms	Community Centre	SW	380m
Edward Worlledge Ormiston Academy	Primary School	N	384m
Lichfield Community Centre	Community Centre	NW	424m
King Street	High Street	N	500m
Seventh Day Adventist Church	Church	SE	500m

14.5.21 The community facilities that have been considered within the community severance assessment due to their location relative to the Principal Application Site or location relative to the temporary vehicular and pedestrian diversion routes during the construction phase (see paragraphs 14.8.1, 14.8.2, 14.8.8 and 14.8.9 for further detail) are described in more detail below. It is anticipated that the other community receptors identified within Table 14.14 and Appendix 14C would not be affected by the Scheme due to their location in relation to the Principal Application Site or temporary vehicular and pedestrian diversion routes.

MIND Centre and Grounds

14.5.22 The MIND Centre and Grounds is the base for Great Yarmouth & Waveney Mind; one of 129 local MIND centres in England and Wales, working in partnership with the national MIND mental health charity (Ref 14.23). The centre works within the community and tailors its services in response to local needs, to encourage social inclusion and continued learning. The centre provides a supportive social framework and stability of a routine as well as allowing group members to learn new transferable skills which can continue to qualifications as recovery progresses. The MIND Centre and Grounds was observed during the site walkover; it appeared to be well used and well maintained.

Queen Anne's Road and Suffolk Road Allotments

14.5.23 There is a small allotment plot located immediately north-east of Suffolk Road and Queen Anne's Road within the Principal Application Site. Based on the size of the plot it is likely to support a small number of users.

Kingsgate Community Centre

14.5.24 Kingsgate Community Centre is situated immediately west of the Principal Application Site and approximately 15m north of the Principal Application Site. The Centre provides a place for Christian worship but also includes a coffee shop, conference rooms, and hosts a variety of community groups services operated independently from the Centre in the hireable premises onsite. Activities include a parent and toddler group with an affordable pre-loved clothes shop and support for local new mums; a puzzle group; craft groups; volunteer placements in the kitchen; and providing food and shelter for homeless people within the local community. The Centre was observed during the site walkover and appeared to be well used, with cars entering and leaving the car park. Notices outside indicated that the church was used as a community centre with different events, such as fitness, general interest, and activities clubs and societies, happening on a regular basis. A green space associated with the church (and accessible by users of the church) was observed to the south-east of the car park (see Paragraphs 14.5.16 - 14.5.17 for more information on development land).

Nova Training Great Yarmouth

14.5.25 Nova Training provide study programmes, traineeships and apprenticeships for 16 - 18 year olds and school provision and apprenticeships for 14-16 year olds. The Nova Training Centre is located 160m south of the Application Site.

Southtown Common Recreation Ground

14.5.26 Southtown Common Recreation Ground is located to the south of William Adams Way (see Figure 14.2). A children's play area is located at the northern end of Southtown Recreation Ground, approximately 35m south of William Adams Way (and approximately 15m from the Principal Application Site). A sports court and marked sports pitches are also located within Southdown Recreation Ground. The recreation ground was observed during the site walkover and appeared to be well used and well maintained. Views of the road are screened by a line of trees along the northern and western edge of the recreation ground. However, the existing road does generate background noise.

East Coast Blackbelt School

14.5.27 The East Coast Blackbelt School is located approximately 50m east of the Application Site off Suffolk Road. The school provides a range of services teaching martial arts to both adults and children.

Great Yarmouth Community Hub

14.5.28 The Great Yarmouth Community Hub is a day care centre located south of the Principal Application Site. The centre provides day care and daily assistance for disabled and elderly residents who reside locally.

Sure Start Children's Centre

14.5.29 The Sure Start Children's Centre is located 40m east of the Principal Application Site and provides help and support for families with children under five. The Centre provides a diverse range of services during weekdays, including family support workers, specialist mental health support for mothers and families who have a child with special educational needs and/or disabilities.

Pegotty Road Community Centre

14.5.30 The Pegotty Road Community Centre offers hireable space and meeting facilities for local groups and clubs, including:

- **Green Acre Children's Centre**, which provides term time services for parents and under-five year olds. In addition, the nursery runs a weekly parent and toddler group on Mondays, allowing parents/carers and their toddlers to play with the nursery toys/equipment and to meet other families. The centre also provides a 'Swap Shop' run by local parents providing the opportunity for parents to swap clothes, toys, equipment and school uniform.
- **The Redeemed Christian Church of God**, which is based within the Centre and holds weekly services on Thursday evenings and Sundays each week.

Shine Centre

14.5.31 The Shine Centre provides a range of services and activities for children and young people with additional needs or disabilities, and their families. The Shine Centre is located approximately 170m south of the Application Site.

Claydon Pavilion Community Centre

14.5.32 Claydon Pavilion Community Centre provides services for adults and aims to encourage a comfortable and fun environment for people to meet and make new friends. The community centre is located 125m south west of the Application Site

Hafrey's Industrial Estate

14.5.33 Harfrey's Industrial Estate is located directly west of the A47 / Williams Adam Way roundabout, offering a range of shops and also a gym. The industrial estate was observed during the site walkover as being busy with vehicular traffic and offered a range of light industrial premises and retailers such as builders merchants.

Recreational Resources

14.5.34 The only recreational resources located within the Principal Application Site itself are two allotment sites, situated immediately north-east of the Queen's

Anne Road and Suffolk Road junction, and the MIND Centre and Grounds. Table 14.15 and Figure 14.1 show the open / recreation spaces within 500m of the Principal Application Site. Appendix 14B details the open / recreation spaces within 2km of the Principal Application Site.

Table 14.15: Recreational Facilities within the Study Area

Name	Description	Direction from the Principal Application Site	Distance from the Principal Application Site
Two allotment gardens (north-east of the Queen's Anne Road and Suffolk Road junction)	Allotment Garden	N/A	Within the Principal Application Site
MIND Centre and Grounds	Community Centre / Allotment Garden	N/A	Within the Principal Application Site
Southtown Common Recreation Ground (including children's play area and sports pitches)	Recreation Ground	SE	0 m
East Coast Black Belt School	Sport centre	E	10m
Peggotty Community Centre	Community Centre	E	11m
Peggotty Road	Play Area	E	30m
Playground East Community Centre	Play Area	E	33m
Allotment gardens (south-west of the recreation ground)	Allotment Garden	SE	35m
Community Centre Harry Miller Court	Community Centre	E	77m
Suffolk Road Recreation Ground	Play Area	SE	95m
Claydon Pavilion Community Centre	Community Centre	SW	125m
Admirals Quay	Play Area	NW	143m
Jump Warehouse Trampoline Park	Leisure Attraction	SE	150m
Allotments on Common Road	Allotment Garden	S	159m
Anchor Court Play area	Play Area	NW	276m
Louise Close Playground	Play Area	NE	362m

Name	Description	Direction from the Principal Application Site	Distance from the Principal Application Site
Great Yarmouth sea front (including Pleasure Beach, a scenic railway and Pleasure Beach Gardens)	Sea Front	E	363m
B Well Gym	Gym	W	369m
St Nicholas Recreation Ground	Sports pitches	E	370m
Lichfield Community Centre	Community Centre	NW	424m
Fitness 2000	Gym	NW	468m
Sidney Close	Play Area	N	500m

14.5.35 The recreational facilities that have been considered within the recreational activities assessment due to their location relative to the Principal Application Site or location relative to the temporary vehicular and pedestrian diversion routes during the construction phase (see paragraphs 14.8.1, 14.8.2, 14.8.8 and 14.8.9 for further detail) are described in more detail in the section above. It is anticipated that the other recreational facilities identified within Table 14.15 and Appendix 14D would not be affected by the Scheme due to their location in relation to the Principal Application Site or temporary vehicular and pedestrian diversion routes.

Marine Recreational Activities

14.5.36 The River Yare provides access to the Norfolk Broads for recreational vessels via Braydon Water. These vessels have to pass through two existing lifting bridges; the Haven Bridge and Braydon Bridge. The number of movements of these vessels is limited and they are currently controlled over the timings at which their passage through the port can occur. The current baseline number of recreational vessel movements was unknown; however, it is anticipated with the Scheme in place there would be 800 recreational vessel movements in the location of the Scheme per annum.

14.5.37 GYNCAA confirmed that a number of anglers do fish around the Great Yarmouth harbour. However, GYNCAA was not aware of any organisations involved with this angling and it is assumed that any angling activity is by individuals for pleasure rather than organised events.

Great Yarmouth Sea Front

14.5.38 Great Yarmouth sea front is located approximately 325m to the east of the Principal Application Site at its closest point. There are numerous recreational attractions along the beach, including a Pleasure Beach, a

scenic railway and Pleasure Beach Gardens. The Pleasure Beach offers family rides, arcades, and attractions and is located approximately 460m east of the most eastern extent of the Principal Application Site. The Pleasure Beach was fairly busy during the site walkover, which was undertaken on a Thursday outside of school holidays. It is anticipated that the Pleasure Beach is very busy on weekends and over the summer holidays.

England Coast Path Coastal Margin

14.5.39 An area to the east of Southtown Road, and east of the River Yare, stretching to the coast is within the England Coast Path Coastal Margin. The margin includes all land between the England Coast Path and the sea. As part of the coastal margin, individuals usually have rights to enjoy areas like beaches. However, the land affected by the Scheme within the Coast Path Coastal Margin does not qualify as open space and therefore has not been considered further within this Chapter. The England Coast Path has however been considered within the non-motorised user assessment.

Great Yarmouth Open Space Study

14.5.40 The Scheme is located within the Southtown and Cobholm ward and Nelson ward. The Great Yarmouth Open Space Study (Open Space Audits and Local Standards) (Ref 14.18) identified that there is a ratio of 5.63 ha of open space per 1,000 people in the Southtown and Cobholm ward and 4.38 ha per 1,000 people in the Nelson ward. Across all wards, the total area of open space per ward ranges from 2.77 ha to 77.93 ha.

14.5.41 The Great Yarmouth Open Space Study (Open Space Audits and Local Standards) indicates that the quality of open space in the Borough is generally very high (Ref 14.18). The average quality of outdoor sports facilities meets the proposed standard and for most types of sport there is sufficient supply. However, there are local variations and deficiencies in rural areas which were identified in the study. The average amenity greenspace is considered sufficient for the Borough. Sports facilities are considered to be well maintained across the Borough, but issues were identified in the Open Space study audits with the ancillary facilities which require improvements (e.g. changing rooms and floodlighting). Outdoor sports facilities are considered to be accessible, with most of the facilities' catchment population within 0.5-mile radius, and many are accessible by public transport.

Port Activities

14.5.42 The channel is maintained by the port operator Peel Ports and includes a large vessel waiting facility. The location of the Scheme crosses the navigation waterway within the River Yare and the port has operational quays both north and south of the Scheme. The port handles a wide variety of cargos including aggregates, cement, grain, fertilisers, forest products, dry and liquid bulks, pipeline and onshore wind farm equipment as well as providing facilities for the offshore windfarm servicing industry. A total of 1.28

million tonnes of cargo passed through the port during 2016 (Ref 14.24). Great Yarmouth port company's data, covering the period 2008 to 2016 (the most recently available data at the time of writing) revealed an average of 10,000 vessel moves per year occurred within the port. Approximately 40% of these involved movements to or from berths north of the Scheme location. The River Yare also provides access to the Norfolk Broads for recreational vessels via Braydon Water, however this is covered within the recreational resources section of this chapter.

Public Rights of Way and Non-Designated Public Routes

14.5.43 Figure 14.3 shows the PRoW and NMU facilities within 500m of the Principal Application Site. Sustrans Cycle Route 517 intersects the Principal Application Site and runs along Southtown Road and Malthouse Lane, which both join William Adams Way. It should be noted that NCC are currently in the process of progressing a separate scheme to improve cycle facilities along Southtown Road. This scheme includes widening the footway into the carriageway to provide a shared use facility for pedestrians and cyclists, between Queen Anne's Road and to the north of Waveney Road.

14.5.44 Hopton-on-Sea to Sea Palling is a national trail with the trail forming part of the England Coast Path. It is located within the Principal Application Site and also runs along Southtown Road and Malthouse Lane. Bollard Quay is located within the Principal Application Site; however, it is not publicly accessible as it is fenced off and gated. Therefore, Bollard Quay is not considered further within this Chapter.

14.5.45 At a local level, a pedestrian footway is currently located along William Adams Way, with a pedestrian footbridge over this road providing access to Southtown Common Recreation Ground. The footway and footbridge were observed during the site walkover as being well used and well maintained. There are also a number of PRoW located within 2km of the Principal Application Site, mainly located to the west of the Principal Application Site, around Harfrey's Industrial Estate.

14.5.46 A pedestrian and cyclist survey was undertaken for the existing Haven Bridge in June 2016 (Ref 14.20). The survey counted the number of pedestrians and / or cyclists observed crossing at this location during a 12-hour (7am – 7pm) period. Surveys were not taken at the A47 Breydon Bridge due to the nature of the road (50mph) with no facilities for walking or cycling. Table 14.16 provides an overview of the survey count data for June 2016.

Table 14.16: Summary of Pedestrian and Cyclist Survey Count (June 2016)

Date	Location	Pedestrian Count	Cyclist Count
30/06/2016	Haven Bridge	5,453	1,214

14.5.47 Additional surveys were undertaken in February 2017 at four locations, listed in Table 14.17. This survey data was used to supplement the June 2016

count data, mainly assessing the impact of replacing the footbridge on William Adams Way with a toucan crossing.

Table 14.17: Summary of Pedestrian and Cyclist Survey Count (February 2017)

Date	Location	Pedestrian Count	Cyclist Count
21/02/2017	Suffolk Road / Queen Anne's Road / William Adams Way	466	159
21/02/2017	William Adams Way Footbridge	386	79
21/02/2017	South Denes Road	45	59
21/02/2017	William Adams Way / Beccles	527	258

Highway Network

14.5.48 The A47 is a key arterial road in Great Yarmouth and connects the area to Norwich, links south to Lowestoft and other areas to the west. To the south, the A12 provides links to Ipswich, while the A143 links Great Yarmouth with areas in the south-west such as Bury St Edmunds.

14.5.49 Table 14.18 outlines the average volume of traffic (measured in Annual Average Daily Traffic) for the A47 northbound and southbound carriageways (Ref 14.19).

Table 14.18: Average Annual Daily Traffic between 01/01/2017 and 01/01/2018

		Average Annual Daily Traffic			
Site Ref	Direction	24hr	18hr	16hr	12hr
30360732	A47 northbound between A143 and A1243	16,894	16,324	15,934	13,812
6337/2	A47 southbound between A149 and A1243	17,634	17,182	16,623	14,439

14.5.50 A driver stress assessment was undertaken for the baseline scenario (2018) with the majority of traffic links within the Application Site being assessed as Moderate for AM driver stress (69 of 79 links) and PM driver stress (67 of 77 links). Appendix 14D provides an overview of the AM and PM driver stress by traffic link.

14.5.51 'Collison Map' is an interactive map showing road collisions across Britain; the map is based on STATS19 data which is collected by the police at the scene of an incident or reported by a member of the public. A review of Collison Map (Ref 14.22) indicates that a number of minor (or 'slight') accidents and one serious accident have occurred between 2013 and 2016 at the A47 / Williams Adam Way roundabout and the North Quay / Fuller's Hill / Acle New Road / North Quay roundabout, as well as on the approaches

to these roundabouts (see Table 14.19). Accidents have also occurred adjacent to the Satellite Application Site along the A47, Gapton Hall Road, Fuller's Hill, Yarmouth Way, North Quay, and Acle New Road.

Table 14.19: Accidents within the Study Area between 31/12/13 and 31/12/17

Location Description	Application Site	Date	Severity	Number Casualties
A47 / Williams Adam Way Roundabout / Suffolk Road / Queen Anne's Road / William Adams Way				
A47 / Williams Adam Way roundabout	Within Principal Application Site	February 2015	Slight	4
A47 / Williams Adam Way roundabout	Within Principal Application Site	August 2016	Slight	2
A47 / Williams Adam Way roundabout	Within Principal Application Site	November 2015	Slight	1
Williams Adams Way	Within Principal Application Site	August 2017	Slight	2
Kingsgate Community Centre	Outside of Principal Application Site	November 2016	Slight	2
Approx. 70m north of roundabout	Within Principal Application Site	November 2016	Serious	3
Approx. 140m north of roundabout	Within Principal Application Site	August 2014	Slight	1
Approx. 170m north of roundabout	Outside of Principal Application Site	April 2015	Slight	1
Approx. 210m north of roundabout	Outside of Principal Application Site	November 2014	Slight	1
Suffolk Road				
Suffolk Road	Within Principal Application Site	June 2014	Slight	1
Southtown Road	Within Principal Application Site	February 2015	Serious	1
Southtown Road	Within Principal Application Site	July 2015	Serious	1
Southtown Road	Within Principal Application Site	March 2014	Slight	2
Southtown Road	Outside of Principal Application Site	June 2014	Slight	2
Beccles Road	Outside of Principal Application Site	October 2015	Serious	1
Beccles Road	Outside of Principal Application Site	November 2015	Slight	1

Location Description	Application Site	Date	Severity	Number Casualties
A47				
Approx. 200m south of roundabout	Adjacent to Satellite Application Site	October 2015	Slight	1
Gapton Hall Road				
Gapton Hall Road	Adjacent to Satellite Application Site	November 2014	Slight	2
Gapton Hall Road	Adjacent to Satellite Application Site	July 2015	Slight	2
Quay / Fuller's Hill / Acle New Road / North Quay Roundabout				
North Quay / Fuller's Hill / Acle New Road / North Quay roundabout	Outside of Satellite Application Site	October 2014	Slight	2
North Quay / Fuller's Hill / Acle New Road / North Quay roundabout	Outside of Satellite Application Site	September 2014	Slight	1
North Quay / Fuller's Hill / Acle New Road / North Quay roundabout	Outside of Satellite Application Site	August 2016	Slight	1
North Quay / Fuller's Hill / Acle New Road / North Quay roundabout	Outside of Satellite Application Site	June 2016	Slight	1
North Quay / Fuller's Hill / Acle New Road / North Quay roundabout	Outside of Satellite Application Site	November 2017	Slight	1
Fuller's Hill (approx. 135m south-east of roundabout)	Adjacent to Satellite Application Site	January 2016	Serious	1
Fuller's Hill (approx. 150m south of roundabout)	Outside of Satellite Application Site	April 2015	Slight	1
North Quay (approx. 55m south-west of roundabout)	Outside of Satellite Application Site	November 2016	Slight	1
North Quay (approx. 65m south-west of roundabout)	Outside of Satellite Application Site	December 2014	Slight	1

Location Description	Application Site	Date	Severity	Number Casualties
North Quay (approx. 200m south-west of roundabout)	Outside of Satellite Application Site	May 2014	Serious	1
North Quay (approx. 195m north of roundabout)	Adjacent to Satellite Application Site	November 2015	Slight	1
Acle New Road (approx. 180m north-west of roundabout)	Outside of Satellite Application Site	February 2014	Serious	1
Acle New Road				
Acle New Road	Adjacent to Satellite Application Site	March 2016	Slight	1
Yarmouth Way				
Yarmouth Way	Adjacent to Satellite Application Site	December 2017	Slight	1

Future Baseline

14.5.52 The future baseline describes the baseline conditions that are expected to develop and evolve over an approximate ten-year period if the Scheme were not to proceed. Where the assessment of effects has drawn on the results of other technical assessments, any forecasting undertaken for those assessments applies.

14.5.53 For the non-traffic elements of the people and communities assessment, it is anticipated that there would be changes to recreational and community receptors, land uses, the highway network, NMU facilities and a growth in development at a local and regional scale. For example, the Principal Application Site is allocated as Safeguarded Employment Area (CS6) within the Great Yarmouth Core Strategy Proposals Map. In addition, the draft Norfolk Access Improvement Plan 2018-2028 includes new trails within Great Yarmouth. However, there is no certainty whether these proposals would be taken forward and progressed. Therefore, the non-traffic elements of the assessment presented below are an assessment of the Scheme against the existing baseline conditions.

14.5.54 There could also be an increase in port traffic and changes in traffic flows due to future developments along the Affected-Road Network. The traffic model has taken into consideration future developments that are likely to be progressed along the Affected-Road Network, meaning the traffic-based people and communities assessments have inherently considered a future baseline. These traffic-based assessments include the driver stress assessment and economic assessment which has been informed by the Economic Assessment Report (document reference 7.6).

14.6 Sensitive Receptors

14.6.1 The below categories of sensitive receptors have been assessed as part of this people and communities assessment. The receptors within these categories have been considered within the relevant assessment based on their location in relation to the Principal Application Site and temporary vehicular and pedestrian diversion routes during construction (see paragraphs 14.8.1, 14.8.2, 14.8.8 and 14.8.914.8.8 for further details), with receptors not being assessed if they are unlikely to be affected by the Scheme.

- Economic receptors, e.g. individuals of working age, and terrestrial and marine commercial businesses;
- Community receptors, e.g. Kingsgate Community Centre and the MIND Centre and Grounds;
- Recreational receptors, including terrestrial (e.g. to the Southtown Common Recreational Ground) and marine (e.g. users of the River Yare);
- Residential properties;
- Commercial properties;
- Community assets;
- NMU receptors, including pedestrian and cyclist users of the local PRoW and non-designated public routes; and
- Vehicle user receptors, including drivers along the highway network.

14.6.2 A map identifying the location of sensitive receptors is shown in Figure 14.2.

14.7 Establishing the Scenario for Assessment

Construction Phase

14.7.1 The key aspects of the construction of the Scheme which inform this Chapter include:

- Demolition of a number of existing residential and commercial / business properties;
- The demolition of the existing pedestrian bridge on William Adams Way;
- The relocation of existing allotment gardens situated immediately north-east of the Queen's Anne Road and Suffolk Road junction to the east of the proposed roundabout to compensate for an area to be lost as a result of the Scheme;
- Implementation of Traffic Management systems for vehicular and NMUs within the Principal and Satellite Application Site, causing severance and affecting access to premises;

- Diversion of marine vessels during temporary closures of navigation during the construction period;
- Creation of temporary construction sites and accesses from the public highway; and
- Construction activities and movement of plant and workers along the highway network.

14.7.2 Embedded mitigation for the construction phase that is of relevance to this Chapter is as follows:

- An outline CoCP has been submitted with the application (Document Reference 6.16). This includes proposed measures to limit disturbance, including dust, noise, vibration and lighting, to nearby sensitive residential, recreational and commercial receptors, where practicable. As required by the DCO, this outline CoCP will be developed into a full CoCP which will provide more details on these measures. The CoCP must be in accordance with the outline CoCP and be submitted to the county planning authority for approval.
- A Framework Construction Traffic Management Plan has been submitted as an appendix to the Outline CoCP which sets out measures for the management of construction traffic and the management of effects to pedestrians and access from construction. Post grant of a DCO this Framework Construction Traffic Management Plan will be developed into a full Construction Traffic Management Plan to be approved by the county planning authority.

14.7.3 As this chapter contains a variety of different assessments, examples of the measures included within these documents is set out where relevant in the assessment sections below.

Operational Phase

14.7.4 The key aspects of the operation of the Scheme which inform this Chapter include:

- A new dual carriageway road, crossing the River Yare in an east-west orientation, comprising of:
  - A new double-leaf bascule bridge providing an opening span to facilitate vessel movement within the river. This would include structures to support and accommodate the operational requirements of the bridge-opening mechanism, including counterweights below the level of the bridge deck. The bridge will be supported on driven piles.
  - A new five-arm roundabout connecting the new dual carriageway road with Suffolk Road, William Adams Way and the western end of Queen Anne's Road. Sections of the new five arm roundabout would be supported on driven piles where deep soft ground is encountered.

- A single-span bridge to provide an accommodation underpass on the eastern side of the river, with reinforced earth embankments joining that single span bridge to South Denes Road. The underpass and reinforced earth embankments would be supported on driven piles.
- A new signalised junction connecting the new road with A1243 South Denes Road.

- The closure of Queen Anne's Road, at its junction with Suffolk Road, and the opening of a new junction onto Southtown Road. The latter would provide vehicular and pedestrian access to residential properties and the MIND Centre and Grounds at the eastern end of Queen Anne's Road.
- Revised access arrangements for existing businesses onto the local highway network.
- Dedicated provision for cyclists and pedestrians which would link into existing networks.
- A control tower structure located immediately south of the crossing on the western side of the river. The control tower would facilitate the 24/7 operation of the opening span of the new double-leaf bascule bridge.
- The demolition of an existing footbridge on William Adams Way.
- Associated changes, modifications and/or improvements to the existing local highway network.
- Additional signage, including Variable Message Signs (VMS) at discrete locations, to assist the movement of traffic in response to network conditions and the openings / closings of the double-leaf bascule bridge.
- The relocation of existing allotments to the east of the proposed roundabout to compensate for an area to be lost as a result of the Scheme and other accommodation works including those at the MIND Centre and Grounds.
- New public realm, landscape, ecology and sustainable drainage measures.

14.7.5 Works to facilitate the construction, operation and maintenance of the above elements include:

- Creation of temporary construction sites and accesses from the public highway;
- Provision of drainage infrastructure, lighting and landscaping;
- Demolition of a number of existing residential and commercial / business properties; and
- Provision of vessel waiting facilities to the north and south of the new crossing, either as floating pontoons or additional fendering to the

existing berths, including any dredging and quay strengthening works that may be required.

14.7.6 A full description of the Scheme is provided in Chapter 2: Description of the Scheme.

14.8 Assessment of Effects, Mitigation and Residual Effects

Construction Phase: Effect on Travellers

Non-Motorised Users

14.8.1 It is anticipated that the Scheme would cause temporary disruption and changes in accessibility for public routes as a result of temporary road closures and diversions. As described in the outline CoCP, the Contractor would maintain pedestrian and cycle access and provide reasonable adjustments for inclusive access.

14.8.2 As described in the Framework CTMP (Appendix of CoCP), it is intended that the pedestrian route from Suffolk Road over Williams Adams Way would be maintained once the footway has been removed. The route would be via the controlled crossings at the traffic signals at the junction with Southtown Road. In addition, as detailed in the outline CoCP and Framework CTMP, public notices would be issued in advance informing local residents and businesses of dates and durations of rights of way closures. The CTMP would ensure provision and maintenance of suitable and sufficient signs and barriers indicating temporary and permanent closures to public accesses and rights of way.

14.8.3 The below assessment considers general NMUs surrounding the Application Site and national routes (e.g. NCN Route 17) separately.

14.8.4 The sensitivity of NMUs surrounding the Application Site, including non-designated footways adjacent to the Satellite Application Site, is considered to be medium as the routes surrounding the Application Site are likely to be used moderately by NMUs for commuting, recreational and leisure purposes. The magnitude of change is considered to be minor as there would be no significant increase in journey time. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on NMUs.

14.8.5 NCN route 517, Hopton-on-Sea to Sea Palling (national trail) and proposed cycle route are located along Southtown Road. The sensitivity of these NMU routes is considered to be high as they form part of a national trail. As described in the Vehicle Travellers section (see paragraphs 14.8.8) of the closure of Southtown Road would be limited, meaning the magnitude of change is considered to be minor as the alteration of the route would be minimal. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on NMUs.

Mitigation

14.8.6 As not significant effects are identified, no additional mitigation would be implemented as part of the Scheme.

Residual Effects

14.8.7 Given that no additional mitigation is proposed in relation to effects on NMUs, there would be no change in the residual findings.

Vehicle Travellers

14.8.8 Temporary road blockades / partial closures and diversions would be required during the construction of the Scheme. As described in the outline CoCP, the provision of appropriate and quality diversions which are established prior to construction and clear directions for any alternative routes and appropriate alternative diversions would be clearly publicised to maintain public access. When diversions are in place any changes or amendments to public transport services because of the Scheme construction should be clearly communicated in advance to the local community.

14.8.9 As detailed in the outline CoCP and Framework CTMP, public notices would be issued in advance to inform local residents and businesses of dates and durations of road closures. Provision and maintenance of suitable and sufficient signs and barriers indicating temporary and permanent closures to public accesses should be provided.

14.8.10 The construction works would take place over an approximately two year period. It is anticipated that the closures and diversions could, temporarily, increase driver stress and delay for vehicle receptors during construction.

14.8.11 The sensitivity of vehicle travellers is considered to be medium due to the results of the baseline driver stress assessment; whilst the magnitude of change prior to mitigation is considered to be minor as there would be a limited increase in driver stress. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on vehicle travellers.

Mitigation

14.8.12 No additional mitigation would be implemented as part of the Scheme.

Residual Effects

14.8.13 Given that no additional mitigation is proposed in relation to effects on vehicle travellers, there would be no change in the residual findings.

Construction Phase: Effects on Communities

Community Severance

14.8.14 It is anticipated that the Scheme would cause temporary disruption and change in accessibility for community resources, as outlined in paragraphs 14.8.1, 14.8.2, 14.8.8 and 14.8.9. In addition, as described in the outline CoCP, the Contractor should ensure that advance notice of any road or footpath closures and/or diversions to be communicated to the local community. In addition, inclusive access (including for people with reduced mobility) would be maintained to community facilities where they have been temporarily disrupted during construction. If additional measures or reasonable adjustments are identified through the community liaison process to ensure accessibility by persons with a disability or reduced mobility, routes and / or diversions should be reviewed.

14.8.15 The road closures and vehicular and pedestrian diversions could disrupt access to: Kingsgate Community Centre; the MIND Centre and Grounds; reallocated allotment gardens to the east of the proposed roundabout; Southtown Common Recreation Ground; East Coast Blackbelt School, Claydon Pavilion Community Centre; Great Yarmouth Community Hub; Nova Training Great Yarmouth; Shine; Sure Start Children's Centre; and Peggotty Community Centre. It should be noted that the receptors have been included within this assessment based on their location in relation to the Principal Application Site and temporary vehicular and pedestrian diversion routes during construction (see paragraphs 14.8.1, 14.8.2, 14.8.8 and 14.8.9 for further details), with receptors not being assessed if they are unlikely to be affected by the Scheme. The loss of accessibility to the allotment gardens and green space adjoining Kingsgate Community Centre during the construction period is assessed below, whilst the permanent change in community assets is assessed in the 'community assets' assessment.

14.8.16 The sensitivity of Kingsgate Community Centre is considered to be medium as it was noted as being moderately well used during the site visit. There would be a minor reduction in vehicular access to the Kingsgate Community Centre. However, the green space that is understood to be used by the Kingsgate Community Church would be used as a construction site compound during the construction period. Therefore, the magnitude of change on the Kingsgate Community Church prior to mitigation is considered to be moderate. There is therefore likely to be a direct, temporary, short-term, **moderate adverse (significant)** effect on Kingsgate Community Centre.

14.8.17 The sensitivity of East Coast Blackbelt School is considered to be moderate as a number of classes take place each week. The magnitude of change prior to mitigation is considered to be minor due to the limited reduction in accessibility via Suffolk Road. Therefore, there is likely to be a direct,

temporary, short-term, **slight adverse (not significant)** effect on access to East Coast Blackbelt School.

14.8.18 The footprint of the MIND Centre and Grounds would be reduced during construction and an additional site provided (assessed in the community assets section below). Access to the MIND Centre and Grounds would be maintained throughout the construction period via the Queen Anne's Road and Southtown Road junction, which would be constructed during the first phase of the construction works. The sensitivity of the MIND Centre and Grounds is considered to be high, as the site is used by vulnerable users and there is limited availability of alternative mental health resources within Great Yarmouth. The magnitude of change is considered to be minor as there would be a limited change in accessibility to the MIND Centre and Grounds. Therefore, there is likely to be a direct, permanent, long-term, **slight adverse (not significant)** effect on the MIND Centre and Grounds.

14.8.19 As shown on Figure 14.4, two allotments gardens to the north-east of Suffolk Road and Queen Anne's Road junction would be lost as a result of the construction works, and replacement allotment gardens provided to the north of Queen Anne's Road. It is assumed, based on a worst-case scenario, that the allotment gardens (existing and replacement) would not be available for the duration of the construction period (approximately two years). The sensitivity of the allotment gardens is considered to be moderate due to the limited availability of alternative similar resources within the locality. The magnitude of change is considered to be moderate as there would be a temporary reduction in accessibility to the allotment gardens during construction. Therefore, there is likely to be a direct, permanent, short-term, **moderate adverse (significant)** effect on the allotment gardens.

14.8.20 Claydon Pavilion Community Centre, Great Yarmouth Community Hub, Nova Training Great Yarmouth, and Shine are located to the east of Southtown Common Recreation Ground. It is likely that these receptors are most commonly accessed via vehicular routes and the footbridge over William Adams Way at present. It is anticipated that users of these facilities would need to travel along William Adams Way or Southtown Road to access these facilities during construction. However, it is anticipated that closures of Southtown Road and William Adams Way would be limited. In addition, temporary diversions would be put in place for pedestrians and cyclists as described in paragraph 14.8.1, including NMUs crossing Williams Adam Way.

14.8.21 The sensitivity of Claydon Pavilion Community Centre is considered to be medium as a moderate number of people currently use the facility. The sensitivity of Nova Training Great Yarmouth, Great Yarmouth Community Hub and Shine is high as these facilities cater for vulnerable users. The magnitude of change prior to any additional mitigation is considered to be minor as there would be a limited reduction in accessibility. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not**

significant) effect on Claydon Pavilion Community Centre, Great Yarmouth Community Hub, Nova Training Great Yarmouth and Shine.

14.8.22 Peggotty Community Centre is located immediately east of the Principal Application Site along Peggotty Road. The Sure Start Children's Centre is located approximately 40m east of the Principal Application Site. It is anticipated that the users of Peggotty Community Centre and Sure Start Children's Centre would access the facilities from the east and north, as industrial storage areas are located to the west and south of the facilities. The sensitivity of Peggotty Community Centre and Sure Start Children's Centre is considered to be high as the facilities cater for vulnerable users. The magnitude of change prior to mitigation is considered to be minor due to the limited reduction in accessibility to these facilities. There is anticipated to be a limited reduction in accessibility due to the location of the Principal Application Site in relation to the facility and users of the facility, which are anticipated to be to the east and north of the Principal Application Site. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on Peggotty Community Centre and Sure Start Children's Centre.

14.8.23 It is likely that Southtown Common Recreation Ground is currently frequently accessed via the footbridge over William Adams Way, and therefore pedestrian / cyclist access could be affected during the construction of the Scheme. During construction, temporary diversions would be put in place for pedestrian and cyclists as described in paragraph 14.8.1.The sensitivity of Southtown Common Recreation Ground is considered to be medium, as based on the site visit, it is considered that a moderate number of people currently use the recreation ground. The magnitude of change prior to mitigation is considered to be minor as there would be no significant increase in journey time in accessing the recreation ground. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on Southtown Common Recreation Ground.

Mitigation

14.8.24 No additional mitigation would be implemented as part of the Scheme.

Residual Effects

14.8.25 Given that no additional mitigation is proposed in relation to effects on community severance, there would be no change in the residual findings.

Demand for Local Services

14.8.26 A proportion of the construction workers would be from beyond Great Yarmouth and need to relocate to an area local to the Principal Application Site for periods of the construction phase. It is anticipated that workers living greater than 50 miles from Great Yarmouth would need to relocate during the construction period. The anticipated number of workers that would be required to relocate for the construction of the Scheme are shown in Table

14.20. The indicative employment numbers, including the number of workers that would need to be relocated, have been estimated by the Contractor. It is anticipated that these figures represent a worst-case scenario based on professional judgement and experience.

Table 14.20: Indicative Daily Employment Numbers

Quarter	No. of Home Address < 50 Mile Radius to Great Yarmouth	No. of Home Address ≥ 50 Mile Radius to Great Yarmouth	Total No.
4Q - 2020	38	29	67
1Q - 2021	44	38	82
2Q - 2021	58	59	117
3Q - 2021	78	89	167
4Q - 2021	86	101	187
1Q - 2022	80	92	172
2Q - 2022	48	44	92
3Q - 2022	52	50	102
4Q - 2022	38	29	67

14.8.27 The influx of construction workers could place additional pressure on local services (e.g. education, healthcare and community facilities) and recreational / open space. However, as the construction period would last approximately two years it is assumed that the construction workers would be temporarily located within Great Yarmouth during the working week and would not relocate their families. Therefore, it is not anticipated that there would be any increased demand on educational and healthcare facilities.

14.8.28 At the time of writing, the location of accommodation for the construction workers is unknown. Due to the location of the Scheme and its proximity to the town centre, it is assumed for the purposes of this assessment that the workers would reside in the town centre where a range of existing temporary accommodation is located. There is also a high level of community facilities within Great Yarmouth town centre which would offer a range of facilities for temporary workers, which do not typically have set capacities associated with their use (such as shops, bars and seafront attractions). It is assumed that the seafront and beach would be the main recreational / open space utilised by the relocated construction workers in addition to shops and bars.

14.8.29 The sensitivity of community and recreational receptors is considered to be medium as it is understood that the facilities are currently used by a moderate number of individuals and the majority of facilities have the capability to cope with increased demand. The magnitude of change prior to mitigation is considered to be minor as there would be as there would be a small difference in the facilities ability to fulfil their function. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on community and recreational facilities.

Mitigation

Landowner	Lessees or Reputed Lessees / Occupiers	Description

14.8.30 No additional mitigation measures are proposed as part of the Scheme.

Residual Effects

14.8.31 Given that no additional mitigation is proposed in relation to effects on demand for local services, there would be no change in the residual findings.

Construction Phase: Physical Assets

Residential Properties

14.8.32 Demolition of a number of NCC and GYBC owned and privately owned residential properties would be required to deliver the Scheme. Figure 14.4 and

14.8.33 Table 14.21 provide more detail on the residential properties that would need to be demolished to accommodate the Scheme.

Table 14.21: Residential, Commercial and Industrial Properties for Demolition

Landowner	Lessees or Reputed Lessees / Occupiers	Description
Church Commissioners for England	NCC/ Saffron Housing Trust Limited/ The Occupier	22, 19, 17 and 15 Queen Anne's Road, Great Yarmouth, NR31 0LE
Church Commissioners for England	NCC/ Ad Hoc Property Management Limited/ The Occupier	20, 18 and 16 Queen Anne's Road, Great Yarmouth, NR31 0LE
NCC	Saffron Housing Trust Limited/ The Occupier	21 Queen Anne's Road, Great Yarmouth, NR31 0LE
NCC	Private leaseholders and occupiers	14 Queen Anne's Road, Great Yarmouth, NR31 0LE
Church Commissioners for England	Private leaseholders and occupiers	13 Queen Anne's Road, Great Yarmouth, NR31 0LE
NCC	Saffron Housing Trust Limited/ The Occupier	11 Cromwell Road, Great Yarmouth, NR31 0LD
NCC	Saffron Housing Trust Limited/ The Occupier	156, 153, 152, 149 and 148 Southtown Road, Great Yarmouth, NR31 0LA

Landowner	Lessees or Reputed Lessees / Occupiers	Description
Private landowner	The Occupier	155 Southtown Road, Great Yarmouth, NR31 0LA
NCC	Ad Hoc Property Management Limited/ The Occupier	154, 151 and 150 Southtown Road, Great Yarmouth, NR31 0LA
Regaland Limited	N/A	Warehouses (including MMC Performance Ltd)
GYBC Freehold	Private leaseholders and occupiers	Warehouse (including South Denes Car Centre)

14.8.34 The properties that are owned by NCC (see Table 14.21) were formerly market tenure dwellings which were acquired by the Council in anticipation of the Scheme coming forward for development. As there is currently a shortfall in social housing stock in the NCC area (confirmed through conversations with the Council), these properties are temporarily being used to house social housing tenants until the construction of the Scheme commences.

14.8.35 The majority of the tenants of the NCC-owned properties have already been relocated to alternative housing association dwellings, with only five of the 17 properties still occupied by tenants at the time of writing. At the present time, the housing body[5] is in the process of relocating the remaining tenants to alternative Norfolk District Council owned properties. It is assumed this process will have been completed prior to commencement of the construction period. The sensitivity of the NCC housing tenants is considered to be high as the tenants are considered to be vulnerable given their occupation of housing association properties. The magnitude of change is considered to be minor as it is assumed the tenants would be relocated to alternative properties fit for their requirements prior to the start of construction. Therefore, there is likely to be a direct, permanent, long-term, **slight adverse (not significant)** effect on the social housing tenants who occupy these properties.

14.8.36 It should be noted that the 17 properties in question are not permanent NCC housing stock. Following the end of the lease term in 2017, NCC granted Saffron Housing a 'Tenancy at Will' allowing their use to continue but facilitating termination of occupancy on short notice. As such, the sensitivity of the NCC housing stock is considered to be medium. The magnitude of change is considered to be minor as there would be limited reduction of availability of housing stock managed by NCC. Therefore, there is likely to

[5] NCC acquired seventeen residential properties (on Queen Anne's Road, Southtown Road and Cromwell Road) between 2010 and 2012. Following their acquisition, NPS Saffron and Ad-hoc management companies took on the Housing Association letting role on behalf of NCC. NCC, NPS Saffron and GYBC Housing have worked together to help try and facilitate the rehousing of the existing occupiers.

be a direct, permanent, long-term, **slight adverse (not significant)** effect on the NCC housing stock.

14.8.37 In addition to the NCC owned properties, three privately owned residential properties would be demolished as part of the Scheme. The three privately owned properties are all occupied by private rental tenants rather than the property owners.

14.8.38 The sensitivity of the private rental tenants is considered to be high as the tenants are vulnerable to the change in their housing circumstances. The magnitude of change is considered to be moderate as there would be a change in tenants' ability to access rental housing stock, potentially prior to the end of their lease period. Therefore, there is likely to be a direct, permanent, long-term, **moderate adverse (significant)** effect on the private rental tenants residing within privately owned residential receptors.

14.8.39 The sensitivity of the homeowners of the privately owned residential properties is considered to be high. The magnitude of change is considered to be major as there would be a major impact on personal income from the capital of their dwellings and loss of rental earnings. Therefore, there is likely to be a direct, permanent, long-term, **large adverse (significant)** effect on the homeowners of the privately owned residential receptors**.** However, the Applicant are currently in negotiations with the owners of these properties with a view to purchasing the properties at market price. Should this be agreed, the magnitude of change could be reduced to minor as the homeowners would be compensated appropriately for the loss of their dwellings. Therefore, there is likely to be a direct, permanent, long-term **slight adverse (not significant)** effect on the homeowners of private residential properties.

14.8.40 The construction of the Scheme would also require access to residential properties along Queen Anne's Road to be permanently changed. As part of the Scheme access to the properties along Queen Anne's Road would be via the proposed Queen Anne's Road and Southtown Road junction. As described in the outline CoCP, access from the public highway to affected residences should be allowed during the construction of the Scheme. The sensitivity of the residential properties is considered to be high. The magnitude of change is considered to be minor as there would be a limited change in accessibility to the properties. Therefore, there is likely to be a direct, permanent, long-term, **slight adverse (not significant)** effect on the residential properties.

Mitigation

14.8.41 No additional mitigation for the effects set out here because as noted above, the most appropriate mitigation is to seek to compensate the relevant property interests for their loss of property.

Residual Effects

14.8.42 Given that no additional mitigation is proposed in relation to effects on residential properties, there would be no change in the residual findings.

Commercial Properties

14.8.43 Demolition and land-take from commercial properties would be required to deliver the Scheme. Four industrial units to the south of Cromwell Road (see Land Plots 1-46, 1-47, 1-48 and 1-49 on the Lands Plans), including MMC Performance Ltd, and a warehouse off South Denes Road including South Denes Car Centre (see Land Plots 4-33 and 3-11 on the Lands Plans) would be demolished to accommodate the Scheme. The Scheme would also permanently require an industrial storage area associated with Perenco (see LandPlots 4-36 and 4-18 on the Lands Plans) and Peel Ports (see Land Plots 4-34, 4-12 and 4-31 on the Lands Plans), and temporarily require an industrial storage area associated with Peel Ports (see Land Plots 4-13, 3-06, 3-07, 3-08, 3-09 and 4-21 on the Lands Plans) and Perenco (see Land Plot 4-27 on the Land Plans). Figure 14.4 outlines the commercial properties that would need to be demolished to accommodate the Scheme. Figure 14.2 provides an overview of the key sensitive receptors, including commercial receptors, within the Principal Application Site.

14.8.44 At the time of writing, three of the four industrial units to the south of Cromwell Road, to the south of the River Yare, were occupied, with tenants leasing the units from the property owners. The land associated with the South Denes Car Centre, to the east of the River Yare, is owned by GYBC but the owner of the car centre has a long-term ground lease of the site. The sensitivity of all these commercial tenants is high as the land is required for their ongoing business operations and it is understood that the tenants are not operating in any other premises locally (so they cannot easily transfer their operations to an alternative site nearby). The magnitude of change of the Scheme on the commercial tenants is considered to be major as there would be a permanent loss of land required for their business operations. Therefore, there is likely to be a direct, permanent, long-term, **large adverse (significant)** effect on the commercial receptor tenants prior to the implementation of mitigation measures. However, commercial tenants would be financially compensated pursuant to the Compensation Code as part of the Scheme and assisted in finding alternative premises through the use of local agents, as detailed in the outline CoCP. Due to the location of commercial premises and the presence of a number of other industrial estates within central Great Yarmouth it is anticipated that alternative, suitable premises would be available for the three businesses. As such, the magnitude of change could be reduced to minor. Therefore, there would be a direct, permanent, long-term effect on the commercial receptor tenants of **slight adverse (not significant)**

14.8.45 The sensitivity of the owners of the commercial premises is high as the land is required for generating commercial income. The magnitude of change is

considered to be major as there would be a major impact on commercial income from their premises. Therefore, there is likely to be a direct, permanent, long-term **large adverse (significant)** effect on the owners of the commercial premises prior to the implementation of mitigation measures. However, owners of the commercial premises would be financially compensated pursuant to the Compensation Code as part of the Scheme. As such, the magnitude of change could be reduced to minor. Therefore, there would be a direct, permanent, long-term, **slight adverse (not significant)** effect on the owners of the commercial premises.

Land-Take

14.8.46 GYBC and Great Yarmouth Port Authority own the land to the east of the River Yare which included in the Principal Application Site. This land is under long-term lease to Peel Ports which operates the land to the north of the Scheme and subleases the majority of the permanent land take required to Pereneco.

Temporary Land-take

14.8.47 Part of the land associated with Peel Ports and Perenco would be used only temporarily during the two year construction period. The sensitivity of land associated with Peel Ports and Perenco is high as the land is required for ongoing business operations associated with in-river port activities and, for Peel Ports, the warehouses to the north of the Scheme. The magnitude of change on Peel Ports and Perenco is considered to be moderate as there would be a temporary loss of land during the construction phase which is currently required for their business operations. However, for Peel Ports access to their warehouses and in-river port activities would be maintained for the duration of the construction phase, and the use of the powers of temporary possession would be controlled through the Port Authority's Protective Provisions in the DCO. Therefore, there is likely to be a direct, temporary, short-term, **moderate adverse (significant)** effect in relation to the specific parcels of land affected on Peel Ports and Perenco.

Permanent Land-take

14.8.48 The sensitivity of land associated with Perenco is high as the land is required for ongoing business operations. The magnitude of change of the Scheme on the Perenco site is considered to be major as there would be a permanent loss of land required for their business operations. Therefore, there is likely to be a direct, permanent, long-term, **large adverse (significant)** effect on the commercial receptors prior to the implementation of mitigation measures. However, Perenco would be financially compensated under the Compensation Code as part of the Scheme and an underpass would be provided to maintain access between the Peel Ports site to the north and Perenco land. As such, the magnitude of change could be reduced to minor. Therefore, there would be a direct, permanent, long-term **slight adverse (not significant)** effect on Perenco.

14.8.49 A small parcel of land associated with Peel Ports would be required permanently to accommodate the Scheme. The sensitivity of land associated with Peel Ports is high as the land is required for ongoing business operations. The magnitude of change on Peel Ports is considered to be moderate as there would be a small amount of permanent loss of land required for their business operations (but this does not represent a significant proportion of the overall quantum of the Peel Ports site). Therefore, there is likely to be a direct, permanent, long-term, **large adverse (significant)** effect on Peel Ports prior to the implementation of mitigation measures. However, Peel Ports would be financially compensated under the Compensation Code as part of the Scheme. As such, the magnitude of change could be reduced to minor. Therefore, there would be a direct, permanent, long-term, **slight adverse (not significant)** effect on Peel Ports.

14.8.50 The sensitivity of the landowners (GYBC and Great Yarmouth Port Authority) of the land associated with Perenco and Peel Ports is high as the land generates commercial income for the landowners. The magnitude of change is considered to be major, as there would be a major impact on commercial income from the changes to operations at premises on their land. Therefore, there is likely to be a direct, permanent, long-term, **large adverse (significant)** effect on the landowners prior to the implementation of mitigation measures. However, landowners would be financially compensated under the Compensation Code as part of the Scheme. As such, the magnitude of change could be reduced to minor. Therefore, there would be a direct, permanent, long-term, **slight adverse (not significant)** effect on the owners of the commercial premises occupied by Peel Ports and Perenco.

Mitigation

14.8.51 No additional mitigation is proposed as part of the Scheme.

Residual Effects

14.8.52 Given that no additional mitigation is proposed in relation to effects on commercial properties, there would be no change in the residual findings.

Community Assets

14.8.53 As shown on Figure 14.4, two allotment gardens, to the north-east of Suffolk Road and Queen Anne's Road junction, would be permanently lost as part of the Scheme. Replacement allotment gardens would be provided to the north of Queen Anne's Road as part of the Scheme. This replacement allotment area would be of a comparable size to the current provision and would include four individual plots. The relocated allotments would be accessible from the walking and cycling route to the south of the crossing, and also from Queen Anne's Road for vehicles. The loss of accessibility to the allotment gardens during construction is assessed within the 'community severance' and 'recreational facilities' assessment, whilst the permanent change in the community asset is assessed below.

14.8.54 The sensitivity of the allotment gardens is considered to be moderate due to the moderate availability of this type of resource within the locality. The magnitude of change is considered to be negligible due to the provision of the replacement gardens in a similar location to the existing allotment gardens. Therefore, there is likely to be a direct, permanent, long-term, **neutral effect (not significant)** effect on the allotment gardens.

14.8.55 Land associated with the MIND Centre and Grounds would also be permanently lost, including a sculpture called the Labyrinth and orchard land. As part of the Scheme, land to the south-east of the roundabout would be available together with additional land that would be acquired as part of the Scheme between the south-west boundary of the current MIND Centre and Grounds and William Adams Way (further details provided in Chapter 3: Consideration of Alternatives). The MIND Centre and Grounds would be accessible from the walking and cycling route to the south of the crossing, and also from Queen Anne's Road for vehicles. However, the overall footprint of the MIND Centre and Grounds would be reduced somewhat.

14.8.56 The sensitivity of the MIND Centre and Grounds is considered to be high as the site is used by vulnerable users and there are limited similar mental health resources currently located within Great Yarmouth. The magnitude of change is considered to be moderate due to the reduced footprint of the site. Therefore, there is likely to be a direct, permanent, long-term, **moderate adverse (significant)** effect on the MIND Centre and Grounds

Mitigation

14.8.57 No additional mitigation is proposed as part of the Scheme.

Residual Effects

14.8.58 Given that no additional mitigation is proposed in relation to effects on the Mind Centre and Grounds and allotment gardens, there would be no change in the residual findings.

Construction Phase: Effects on People

Economy and Employment

14.8.59 The Contractor has provided an indicative profile of numbers of staff employed on site on a daily basis which is shown in Table 14.20. The peak quarterly projections of construction workers on site varies between 67 and 187. The average daily employment opportunities would be 117, with an average of 58 employment opportunities for residents at a local level and 59 employment opportunities for residents residing outside of Great Yarmouth at a regional level.

14.8.60 It is anticipated that the construction of the Scheme would generate a total of 58 employee jobs per annum at the local level (Great Yarmouth) over the construction period (see Table 14.20). The total number of employee jobs

recorded within the local study area (Great Yarmouth) according to ONS data is approximately 37,000 as of 2017, with 18,100 being with the sectors that would benefit from the construction of the Scheme (see paragraph 14.4.44). The total net employment represents approximately 0.3% of the employee jobs within the sectors that would benefit from the Scheme, meaning the overall magnitude of change is minor at the local level.

14.8.61 The sensitivity of economic receptors at the local level (Great Yarmouth) is considered to be medium due to the relative levels of deprivation which are present within the area and the importance of employment opportunities. Therefore, there is likely to be a direct, temporary, short-term, **slight beneficial (not significant)** effect on economic receptors at the local scale (Great Yarmouth) prior to the implementation of mitigation measures.

14.8.62 It is anticipated that the construction of the Scheme would generate a total of 59 employee jobs at the regional level (see paragraph 14.8.59). The total number of employee jobs estimated within the regional study area (Norfolk) is approximately 361,000 as of 2017 according to ONS data, with 178,000 jobs being with the sectors that would benefit from the construction of the Scheme (see paragraph 14.4.44). The estimated net employment represents approximately 0.03% of the employee jobs within the sectors that would benefit from the Scheme, meaning the overall the magnitude of change is minor at the regional level.

14.8.63 The sensitivity of economic receptors at the regional scale (Norfolk) is considered to be medium due to the level of unemployment in the area. Therefore, there is likely to be a direct, temporary, short-term, **slight beneficial (not significant)** effect on economic receptors at the regional scale (Norfolk).

Mitigation

14.8.64 As described in the Outline CoCP (document reference 6.16) the Applicant would work proactively with contractors and suppliers to provide employment opportunities and to enable access to training. The processes used to recruit and manage employees working to build the Scheme would be demonstrably fair and offer equal opportunities to all.

Residual Effects

14.8.65 There would be no change in the residual findings in relation to the economy and employment.

Construction Phase: Severance and Disruption to Terrestrial and Marine Businesses and Associated Activities

14.8.66 Temporary road blockades / partial closures and diversions would be required during the construction of the Scheme, as outlined in paragraphs 14.8.8 However, these temporary / partial closures and diversions could

have adverse effects on access to local businesses surrounding the Scheme, as explained below.

14.8.67 The sensitivity of terrestrial businesses to the north of William Adams Way is considered to be medium as it is anticipated that the businesses depend on a low level of footfall due to their location, and a medium level of vehicular access. The magnitude of change is considered to be minor due to the likely limited reduction in accessibility. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on these terrestrial businesses.

14.8.68 In addition, construction activities within the River Yare, would have the potential to affect vessel transport and port operations. As shown in Table 1.2 in Chapter 2: Description of the Scheme, the western approach retaining structures would take approximately 57 weeks to construct, the eastern approach retaining structure approximately 55 weeks, the double-leaf bascule bridge approximately 87 weeks, and the vessel waiting facility approximately 6 weeks. For the purpose of this assessment, the period of closures has been assumed to be two to four weeks, this is considered to be a reasonable worst-case scenario.

14.8.69 The sensitivity of the marine businesses is considered to be high as these businesses depend on a consistent and regular level of marine access. The magnitude of change prior to mitigation is considered to be moderate, as there would be a moderate reduction in accessibility of the river for marine businesses. Therefore, there is likely to be a direct, temporary, short-term, **moderate adverse (significant)** effect on marine businesses prior to the implementation of mitigation measures.

Mitigation

14.8.70 No additional mitigation would be implemented as part of the Scheme.

Residual Effect

14.8.71 Given that no additional mitigation is proposed in relation to effects on terrestrial and marine businesses, there would be no change in the residual findings.

Construction Phase: Recreational Activities

Terrestrial Recreational Activities

14.8.72 Temporary road blockades / partial closures and diversions would be required during the construction of the Scheme, as outlined in paragraphs 14.8.1, 14.8.2, 14.8.8 and 14.8.8. In addition, as described in the outline CoCP, advance notice of any road or footpath closures and/or diversions would be communicated to the local community. In addition, inclusive access (including for people with reduced mobility) would be maintained to community facilities, which are also considered as recreational facilities for

this assessment, where they have been temporarily disrupted during construction. If additional measures or reasonable adjustments are identified through the community liaison process to ensure accessibility by persons with a disability or reduced mobility, routes and / or diversions should be reviewed.

14.8.73 It is anticipated that these diversions could, temporarily, increase delays for vehicular users and disrupt access to the Kingsgate Community Centre, the MIND Centre and Grounds, reallocated allotment gardens, Southtown Common Recreation Ground, Claydon Pavilion Community Centre, East Coast Blackbelt School and Peggotty Community Centre. It should be noted that the receptors have been included within this assessment based on their location in relation to the Principal Application Site and temporary vehicular and pedestrian diversion routes during construction (see paragraphs 14.8.1, 14.8.2, 14.8.8 and 14.8.9 for further details), with receptors not being assessed if they are unlikely to be affected by the Scheme. The loss of accessibility to the allotment gardens and green space adjoining Kingsgate Community Centre during the construction period is assessed below, whilst the permanent change in community assets is assessed in the 'community assets' assessment.

14.8.74 The sensitivity of Kingsgate Community Centre is considered to be medium as it was noted as being moderately well used during the site visit. There would be a minor reduction in vehicular access to the Kingsgate Community Centre. However, the green space that is understood to be used by the Kingsgate Community Church would be used as a construction site compound during the construction period. Therefore, the magnitude of change on the Kingsgate Community Church is considered to be moderate. There is therefore likely to be a direct, temporary, short-term, **moderate adverse (significant)** effect on Kingsgate Community Centre.

14.8.75 The sensitivity of East Coast Blackbelt School is considered to be moderate as a number of classes take place each week. The magnitude of change prior to mitigation is considered to be minor due to the limited reduction in accessibility via Suffolk Road. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on access to East Coast Blackbelt School.

14.8.76 The footprint of the MIND Centre and Grounds would be reduced during construction and an additional site provided to the east of the proposed roundabout (assessed in the community assets section below). Access to the MIND Centre and Grounds would be maintained throughout the construction period via the Queen Anne's Road and Southtown Road junction, which would be constructed during the first phase of the construction works. The sensitivity of the MIND Centre and Grounds is considered to be high as the site is used by vulnerable users and there is limited alternative mental health resources within Great Yarmouth. The magnitude of change is considered to be minor as there would be a limited change in accessibility to the MIND Centre and Grounds. Therefore, there is

likely to be a direct, permanent, short-term, **slight adverse (not significant)** effect on access to the MIND Centre and Grounds.

14.8.77 As shown on Figure 14.4, two allotment gardens to the north-east of Suffolk Road and Queen Anne's Road junction would be lost as a result of the constructions works, and replacement allotment gardens provided to the north of Queen Anne's Road. It is assumed, based on a worst-case scenario, that the allotment gardens (existing and replacement) would not be available for the duration of the construction period which would last approximately two years. The sensitivity of the allotment gardens is considered to be medium due to the limited availability of alternatives within the locality. The magnitude of change is considered to be moderate as there would be a temporary reduction in accessibility to the allotment gardens during construction. Therefore, there is likely to be a direct, permanent, short-term **moderate adverse (significant)** effect on access to the allotment gardens.

14.8.78 Claydon Pavilion Community Centre is located to the east of Southtown Common Recreation Ground. It is anticipated that this facility is most frequently accessed by users via vehicular routes and the footbridge over William Adams Way at present. It is anticipated that users of the facilities would need to travel along William Adams Way or Southtown Road to access the facility during the construction period due to closures. However, it is anticipated that closures of Southtown Road and William Adams Way would be limited. In addition, temporary diversions would be put in place for pedestrians and cyclists as described in paragraph 14.8.1, including NMUs crossing Williams Adam Way. The sensitivity of Claydon Pavilion Community Centre is considered to be medium as it is anticipated that a moderate number of people currently use the facility. The magnitude of change prior to any additional mitigation is considered to be minor as there would be a limited reduction in accessibility. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on access to Claydon Pavilion Community Centre.

14.8.79 Peggotty Community Centre is located immediately east of the Principal Application Site, along Peggotty Road. It is anticipated that the users of Peggotty Community Centre most commonly access the facility from the east and north at present, as industrial storage areas are located to the west and south of the facility. As outlined in paragraph 14.8.8. there would be temporary road closures and diversions implemented during the construction period. The sensitivity of Peggotty Community Centre is considered to be high as the facility caters for vulnerable users. The magnitude of change prior to mitigation is considered to be minor due to the limited reduction in accessibility to this facility. There is anticipated to be a limited reduction in accessibility due to the location of the Principal Application Site in relation to the facility and users of the facility, which are anticipated to be to the east and north of the Principal Application Site Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on access to Peggotty Community Centre.

14.8.80 It is anticipated that Southtown Common Recreation Ground is currently frequently accessed via the footbridge over William Adams Way, and therefore pedestrian / cyclist access could be affected during the construction of the Scheme. During construction, temporary diversions would be put in place for pedestrian and cyclists as described in paragraph 14.8.1.

14.8.81 The sensitivity of Southtown Common Recreation Ground is considered to be medium, as based on the site visit, it is considered that a moderate number of people currently use the recreation ground. The magnitude of change prior to mitigation is considered to be minor as there would be no significant increase in journey time in accessing the recreation ground. Therefore, there is likely to be a direct, temporary, short-term, **slight adverse (not significant)** effect on Southtown Common Recreation Ground.

Mitigation

14.8.82 No additional mitigation would be implemented as part of the Scheme.

Residual Effects

14.8.83 Given that no additional mitigation is proposed in relation to effects on recreational facilities, there would be no change in the residual findings.

Marine Recreational Activities

14.8.84 As described in paragraph 14.8.68, construction activities would affect vessel movements along the River Yare within the locality of the Principal Application Site. All the construction works, however, would be planned and undertaken with the strategy of minimising impact and disruption to marine stakeholders and users. The Contractor would implement measures to minimise the impact on vessel movements. It is anticipated that there would be approximately 800 recreational movements per annum with the Scheme in place, which provides an indication of the number of movements that are anticipated during the construction period.

14.8.85 The sensitivity of the recreational vessels is considered to be medium as they have the ability to use and access the navigable length of the river rather than just the affected area. The magnitude of change is considered to be moderate as there would be reduced accessibility and likely waiting times (where there are currently none) during the construction period. Therefore, there is likely to be a direct, permanent, short-term, **moderate adverse (significant)** effect on recreational vessels prior to the implementation of mitigation measures.

14.8.86 Following consultation with the Great Yarmouth and Norfolk County Angling Association (GYNCAA) it is known that the club does not fish within the vicinity of the Principal Application Site but a number of anglers do fish in the harbour near the Principal Application Site. These anglers could be affected by reduced access to the angling sites within the harbour. The sensitivity of the anglers is considered to be low as there are a number of alternative sites

to fish in the area. The magnitude of change is considered to be minor as there would be a limited impact on access to the angling sites. Therefore, there is likely to be a direct, permanent, short-term, **slight adverse (not significant)** effect on anglers.

Mitigation

14.8.87 No additional mitigation would be implemented as part of the Scheme.

Residual Effects

14.8.88 Given that no additional mitigation is proposed in relation to effects on marine recreational facilities, there would be no change in the residual findings.

Operation Phase: Effect on Travellers

Non-motorised Users

14.8.89 The Scheme includes changes to NMU facilities as shown on Figure 14.3 and described below in Table 14.22.

Table 14.22: Changes to Non-Motorised User Facilities

NMU Facility	Existing Facilities	Proposed Facilities
Proposed Bridge	N/A	Proposed footway along the westbound carriageway of the bridge. Segregated footway and cycleway along the eastbound carriageway of the proposed bridge. Controlled crossings for pedestrians and cyclists on the approaches to the west side of the bridge. The crossing would be signal-controlled and staggered with a waiting area in the central reservation. See below for description of the proposed junction to the east of the bridge.
East of River Yare	Footway along A1243 South Denes Road and Sutton Road	New signal-controlled NMU crossings as part of the new junction between the proposed bridge, A1243 South Denes Road, and Sutton Road.

NMU Facility	Existing Facilities	Proposed Facilities
		The crossings on both approaches from the A1243 South Denes Rd would be a pedestrian-only puffin crossing, and a crossing would also be located on the bridge approach. All controlled crossings would be staggered and a waiting area in the central reservation would be provided
William Adams Way	Footbridge over Williams Adam Way. Footway along westbound carriageway of Williams Adam Way.	Footbridge over Williams Adam Way to be demolished as part of the Scheme. The Scheme includes a footway along westbound carriageway of Williams Adam Way. Signal-controlled crossings for pedestrians and cyclists would be provided across the William Adams Way eastern arm of the roundabout and across the arm connecting the new crossing to the roundabout. Both would be staggered with a waiting area in the central reservation.
National Cycle Network (NCN) 517 / Hopton-on-Sea to Sea Palling (Southtown Road) / NCC proposals to improve cycle facilities along Southtown Road	Footway along northbound carriageway of Southtown Road. Cycle lane along the majority of the northbound and southbound carriageway of Southtown Road.	An uncontrolled crossing across Southtown Road for pedestrians and cyclists would be provided. The footway, cycle lanes would not change as part of the Scheme.
Suffolk Road	There is an existing separated footway and cycleway along Suffolk Road.	A new signal-controlled crossing would be located on Suffolk Road, north of the new roundabout. The existing segregated footway and cycleway would not change as part of the Scheme.

14.8.90 As shown in Table 14.22, the Scheme includes additional NMU facilities which would be accessible to users once the Scheme is complete and operational. The proposed footways and cycleway along the proposed bridge would enable pedestrian and cyclists to safely cross the River Yare, linking the communities either side of the river. The sensitivity of the additional NMU facilities across the River Yare is considered to be medium as they are likely to be moderately used by NMU for commuting, recreational and leisure purposes. The magnitude of change is also considered to be moderate, as there would be a significant decrease in journey length / time for NMUs. Therefore, there is likely to be a direct, permanent, long-term, **moderate beneficial (significant)** effect on NMUs crossing the River Yare.

14.8.91 The proposed removal of the William Adams Way footbridge would mean that NMUs travelling from the north to south of William Adams Way would have travel a slightly longer distance and use at-grade crossings rather than a segregated footbridge. The sensitivity of NMUs is considered to be medium as the footbridge was observed to be moderately used by NMU (likely for commuting, recreational and leisure purposes). The magnitude of change is considered to be minor, as there would not be a significant increase in journey time for NMUs. Therefore, there is likely to be a direct, permanent, long-term, **slight adverse (not significant)** effect on NMUs crossing Williams Adams Way.

Mitigation

14.8.92 As no significant adverse effects have been identified, no additional mitigation is proposed as part of the Scheme.

Residual Effects

14.8.93 Given that no additional mitigation is proposed in relation to effects on NMUs, there would be no change in the residual findings

Vehicle Travellers

14.8.94 Appendix 14E provides detail of the driver stress calculations undertaken for the Scheme. A summary of the driver stress calculations is provided in Table 14.23 below. As shown, driver stress for the ‘do minimum scenario’ would be high and moderate, whilst driver stress for the ‘do something scenario’ would be predominantly moderate.

Table 14.23: Summary of Driver Stress Calculations

Location	AM Driver Stress	PM Driver Stress
Opening Year (2023) – Do Minimum Scenario		
Principal Application Site	Moderate (46 links) High (11 links)	Moderate (49 links) High (8 links)

Location	AM Driver Stress	PM Driver Stress
Satellite Application Site - A47 / New Road	Moderate (4 links) High (1 links)	Moderate (3 links) High (2 links)
Satellite Application Site - A47 (south of Principal Application Site)	Moderate (1 links) High (1 links)	Moderate (1 links) High (1 links)
Satellite Application Site - Fullers Hill	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - Gapton Hall Rd	Moderate (4 links)	Moderate (3 links) High (1 links)
Satellite Application Site - North Quay	Moderate (3 links) High (1 links)	Moderate (3 links) High (1 links)
Satellite Application Site - Yarmouth Way	Moderate (4 links)	Moderate (4 links)
Opening Year (2023) – Do Something Scenario		
Principal Application Site	Moderate (60 links)	Moderate (60 links)
Satellite Application Site - A47 / New Road	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - A47 (south of Principal Application Site)	Moderate (2 links)	Moderate (2 links)
Satellite Application Site - Fullers Hill	Moderate (6 links)	Moderate (6 links)
Satellite Application Site - Gapton Hall Rd	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - North Quay	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - Yarmouth Way	Moderate (4 links)	Moderate (4 links)
Design Year (2038) – Do Minimum Scenario		
Principal Application Site	Moderate (45 links) High (12 links)	Moderate (49 links) High (8 links)
Satellite Application Site - A47 / New Road	Moderate (4 links) High (1 link)	Moderate (3 links) High (2 links)

Location	AM Driver Stress	PM Driver Stress
Satellite Application Site - A47 (south of Principal Application Site)	High (2 links)	High (2 links)
Satellite Application Site - Fullers Hill	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - Gapton Hall Rd	Moderate (2 links) High (2 links)	Moderate (2 links) High (2 links)
Satellite Application Site - North Quay	Moderate (1 link) High (3 links)	Moderate (3 links) High (1 link)
Satellite Application Site - Yarmouth Way	Moderate (3 links) High (1 link)	Moderate (4 links)
Design Year (2038) – Do Something Scenario		
Principal Application Site	Moderate (61 links)	Moderate (61 links)
Satellite Application Site - A47 / New Road	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - A47 (south of Principal Application Site)	Moderate (2 links)	Moderate (2 links)
Satellite Application Site - Fullers Hill	Moderate (6 links)	Moderate (6 links)
Satellite Application Site - Gapton Hall Rd	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - North Quay	Moderate (4 links)	Moderate (4 links)
Satellite Application Site - Yarmouth Way	Moderate (4 links)	Moderate (4 links)

14.8.95 The sensitivity of vehicle travellers is considered to be medium due to the results of the baseline driver stress assessment. The magnitude of change is considered to be moderate as there would be a minor reduction in driver stress and provision of a new vehicular link across the river. Therefore, there is likely to be a direct, permanent, long-term, **moderate beneficial** (**significant**) effect on vehicle travellers.

Mitigation

14.8.96 The effect of the Scheme on the vehicle travellers would be positive and therefore no mitigation measures or further enhancement measures are considered necessary.

Residual Effects

14.8.97 Given that no additional mitigation is proposed in relation to effects on vehicle travellers, there would be no change in the residual findings.

Operation Phase: Effects on Communities

Community Severance

14.8.98 The Scheme would enhance connectivity for users of community resources as it would provide a link across the River Yare. The Transport Assessment (TA) (document reference 7.2) demonstrates that the overall impact of the Scheme would be to reduce average vehicular journey times on all routes considered within the TA study area. The greatest saving forecast is for the vehicular trips between locations on the peninsula such as the Outer Harbour and Pleasure Beach, where savings of up to six minutes are forecast. In addition, walking and cycling routes and NMU journey times between destinations on either side of the river would be improved due to the Scheme. For example, it is anticipated that a pedestrian walking from Peggotty Road Community Centre and Southtown Common Recreation Ground would save 36 minutes (45 minutes without the Scheme and 9 minutes with the Scheme). A cyclist undertaking the same journey would save 11 minutes (13 minutes without the Scheme and 2 minutes with the Scheme).

14.8.99 In general, the sensitivity of community facilities is considered to be medium due to the moderate availability of the majority of facilities. The magnitude of change is considered to be moderate as there would be a moderate improvement in vehicular and NMU journey times across the River Yare and associated accessibility to the community facilities. Therefore, there is likely to be a direct, permanent, long-term, **moderate beneficial** (**significant**) effect on community severance.

Mitigation

14.8.100 The effect of the Scheme on the community severance would be positive and therefore no mitigation measures or further enhancement measures are considered necessary.

Residual Effects

14.8.101 Given that no additional mitigation is proposed in relation to effects on community severance, there would be no change in the residual findings.

Operational Phase: Effects on People

Terrestrial Businesses and Associated Activities

14.8.102 During operation, the Scheme would provide a vehicular link across the River Yare, with the current crossing located approximately 1.5km north

of the Principal Application Site. The Scheme would provide a third crossing over the River Yare, creating a new, more direct link between the western and eastern areas of Great Yarmouth.

14.8.103 An economic appraisal was undertaken for the Scheme and presented in the Economic Assessment Report (document reference 7.6). The economic appraisal estimated that the Scheme would save £219,300,000 per annum due to travel time benefits. The benefits associated with business users and providers includes £42,650,000 for commutes, £14,986,000 for business car journeys, and £63,281,000 for freight journeys. The cost savings per annum would be due to improved journey times and the associated cost of operating business vehicles.

14.8.104 The sensitivity of terrestrial businesses is considered to be medium as it is anticipated that the businesses depend on a low level of footfall due to their location and a medium level of vehicular access. The magnitude of change is considered to be minor as there would be a minor economic improvement in the context of the wider Great Yarmouth economy. Therefore, there is likely to be a direct, permanent, long-term, **slight beneficial (not significant)** effect on terrestrial businesses.

Mitigation

14.8.105 The effect of the Scheme on the local economy would be positive and therefore no mitigation measures or further enhancement measures are considered necessary.

Residual Effects

14.8.106 Given that no additional mitigation is proposed in relation to effects on the local economy, there would be no change in the residual findings.

Marine Businesses and Associated Activities

14.8.107 Once complete, the placement and opening of the proposed bridge have the potential to affect vessel transport and port operations. A pNRA (document reference 6.14) was undertaken for the Scheme. The pNRA concluded that it is estimated that the future average vessel movements at the proposed bridge location could increase to 20 movements per day from an average of 11 vessel movements per day at present; a 25% increase on the maximum annual average daily movements currently.

14.8.108 The Vessel Simulation Report (as an appendix to the pNRA) for the Scheme details the navigation simulation that was undertaken to assess the effects of the Scheme on vessel movements. The simulation involved the development of a computer model of the approaches to the location of the Scheme and allowed a variety of vessel passages to be attempted in various weather conditions. The simulations show that the Scheme would be unlikely to create an unacceptable level of hazard to navigation, nor require the

imposition of excessive restrictions on navigation within the Port of Great Yarmouth.

14.8.109 For commercial vessels the bridge opening would be on demand, limiting disruption to commercial businesses that rely on port operations.

14.8.110 The sensitivity of marine businesses is considered to be high as the businesses depend on a consistent and regular level of marine access. The magnitude of change is considered to be minor due to the results of the Vessel Simulation Report and the feedback from consultees outlined in Appendix 14B. Therefore, there is likely to be a direct, permanent, long-term, **slight adverse (not significant)** effect on marine businesses

Mitigation

14.8.111 No additional mitigation is proposed as part of the Scheme.

Residual Effects

14.8.112 Given that no additional mitigation is proposed in relation to effects on marine businesses, there would be no change in the residual findings.

Operation Phase: Recreational Activities

Terrestrial Recreational Activities

14.8.113 The Scheme would enhance connectivity for recreational resources as it would provide a link across the River Yare. The Transport Assessment (TA) (document reference 7.2) demonstrates that the overall impact of the Scheme would be to reduce average vehicular journey times on all routes considered within the TA study area. The greatest saving forecast is for the vehicular trips between locations on the peninsula such as the Outer Harbour and Pleasure Beach, where savings of up to six minutes are forecast. In addition, walking and cycling routes and NMU journey times between destinations on either side of the river would be improved due to the Scheme. For example, it is anticipated that a pedestrian walking from Peggotty Road Community Centre and Southtown Common Recreation Ground would save 36 minutes (45 minutes without the Scheme and 9 minutes with the Scheme). A cyclist undertaking the same journey would save 11 minutes (13 minutes without the Scheme and 2 minutes with the Scheme).

14.8.114 In general, the sensitivity of recreational activities is considered to be medium due to the moderate availability of the majority of the activities. The magnitude of change is considered to be moderate as there would be a moderate improvement in vehicular and NMU journey times across the River Yare and accessibility of the recreational activities. Therefore, there is likely to be a direct, permanent, long-term **moderate beneficial** (**significant**) effect on recreational activities.

Mitigation

14.8.115 The effect of the Scheme on the terrestrial recreational activities would be positive and therefore no mitigation measures or further enhancement measures are considered necessary.

Residual Effects

14.8.116 Given that no additional mitigation is proposed in relation to effects on recreational activities, there would be no change in the residual findings.

Marine Recreational Activities

14.8.117 The pNRA (document reference 6.14) considers recreational vessels with the assessment indicating that the anticipated annual number of vessel passages through the new bridge would be around 8,000. In total around 90% of movements are anticipated to be commercial traffic with the remaining 10% recreational vessel movements.

14.8.118 The 'Existing and Future Navigation Requirements of Peel Ports Great Yarmouth and other Port Users' report forms an appendix of the pNRA. The report considers the movements of recreational vessels from within the Norfolk Broads to the North Sea, via the River Yare, and vice versa. The report indicates that the number of movements of the recreational vessels is limited and they are currently controlled due to the timings at which their passage through the port can occur.

14.8.119 It is anticipated that for recreational vessels, bridge openings would be agreed in advance with the bridge operator. Based on demand from commercial vessel traffic however, the bridge operator has the ability to adjust the proposed opening time for recreational vessels. If recreational vessels arrive outside of the agreed opening time they would have to wait for the bridge opening for other users. In order for vessels to wait safely, provision of vessel waiting facilities to the north and south of the new crossing would be provided as part of the Scheme, delivery of which is secured through the DCO.

14.8.120 The sensitivity of recreational vessels is considered to be medium as the facilities are understood to be moderately used. The magnitude of change is considered to be minor as there would be a limited reduction in accessibility due to the bridge, taking into consideration the port operations described above, vessel waiting facilities, and dredging. Therefore, there is likely to be a direct, permanent, long-term, **slight adverse** (**not significant**) effect on marine recreational activities.

14.8.121 During operation, the Scheme could cause sediment and hydromorphological changes to the River Yare and the wider Norfolk coast, which could have an adverse effect on off-site recreational resources (e.g. beaches). A sediment assessment has been undertaken and presented in

Chapter 11: Road Drainage and the Water Environment. The assessment indicates that:

- The water level within the study area would be similar to the existing water level;
- There would be riverbed scour between the bridge piers; and
- There would be a change in sediment levels of the riverbed within the study area. However, this should be seen in the context that the riverbed between Haven Bridge and the river mouth which would continue to be dredged ever year as part of the harbour authority's regular activities.

14.8.122 The sensitivity of the off-site recreational resources is considered to be medium as the resources are understood to be moderately used. The magnitude of change is considered to be minor as there would be a limited change to water levels, sediment levels and hydromorphology when considering the dredging which would be undertaken on an annual basis. Therefore, there is likely to be a direct, permanent, long-term, **slight adverse** (**not significant**) effect on marine recreational activities.

Mitigation

14.8.123 As no significant effects have been identified, no additional mitigation is proposed in relation to these effects.

Residual Effects

14.8.124 Given that no additional mitigation is proposed in relation to effects on marine recreational activities, there would be no change in the residual findings.

14.9 Monitoring

14.9.1 No monitoring is considered to be required over and above that which is included in the Outline CoCP (document reference 6.16) and Framework TCMP, and that would be included in its subsequent development into the full CoCP and CTMP respectively. The full CoCP and CTMP, once detailed, will provide a review, monitoring and audit mechanism to determine the effectiveness of and compliance with environmental control measures.

14.10 Limitations and Assumptions

14.10.1 Assumptions used for the assessment of effects related to employment are as follows:

- For the purposes of this assessment, it is assumed that one job is equal to one Full-Time Equivalent (FTE) employee; and

- For the purposes of the assessment, the evaluation for the local and regional levels is not mutually exclusive i.e. the number of FTE / jobs is considered in relation to the total employees at both the local and regional levels.

14.11 Summary

14.11.1 The key baseline features are the receptors that are located within the Principal Application Site. For the people and communities assessment, these receptors include the MIND Centre and Grounds, the allotment gardens situated immediately north-east of the Queen's Anne Road and Suffolk Road junction, recreational vessels that use the River Yare, and commercial and residential properties and their associated land.

14.11.2 Table 14.24 provides a summary of the effects of the Scheme on people and communities. The majority of the effects on people and communities would be slight adverse, meaning they would not be significant. However, there would be residual adverse effects of moderate significance (significant) during the construction phase, as follows:

- Access and functionality of Kingsgate Community Centre and the two allotment gardens to the north-east of Suffolk Road and Queen Anne's Road junction during construction. This effect has been assessed under both the community severance and terrestrial recreational activities sub-assessments;
- The tenants of privately owned residential properties that would be lost as part of the Scheme;
- The long-term changes to the MIND Centre and Grounds;
- Severance and disruption to marine businesses and associated activities during construction; and
- Access and disruption to marine recreational activities during construction.

14.11.3 There would also be moderate (significant) beneficial effects during the operation of the Scheme, as follows:

- Additional NMU facilities proposed as part of the Scheme;
- Beneficial changes to driver stress;
- Beneficial changes to community severance; and
- Beneficial changes to access to terrestrial recreational activities.

Table 14.24: Summary of Effects Table for People and Communities

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Changes to NMU facilities	NMUs, including non-designated footways adjacent to the Satellite Application Site, NCN route 517, Hopton-on-Sea to Sea Palling and proposed cycle route are located along Southtown Road	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T / ST
Changes to vehicular journeys	Vehicle travellers	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T / ST
Changes to community severance	MIND Centre and Grounds, East Coast Blackbelt School, Claydon Pavilion Community Centre, Great Yarmouth	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T / ST

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	Community Hub, Nova Training Great Yarmouth, Shine, Peggotty Community Centre and Southtown Common Recreation Ground			
	Kingsgate Community Centre and two allotment gardens to the north-east of Suffolk Road and Queen Anne's Road junction	Moderate significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Moderate significance – D / T / ST
Increased demand for local services due to influx of construction workers	Local services	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T / ST
Changes to physical assets – Residential Properties	NCC owned residential properties - Tenants	Slight significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / P / LT

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	NCC owned residential properties – Housing Stock	Slight significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / P / LT
	Privately owned residential properties - Tenants	Moderate significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Moderate significance – D / P / LT
	Privately owned residential properties - Homeowners	Slight significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / P / LT
	Access to private properties	Slight significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / P / LT
Changes to physical assets – Commercial Properties	Commercial premises - Tenants	Slight significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / P / LT
	Commercial premises - Owners	Slight significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / P / LT
	Temporary land take - Tenants	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T /ST

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	Permanent land take - Tenants	Slight significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / P / LT
	Permanent land take – Landowners	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T /ST
Changes to community assets	Two allotments gardens to the north-east of Suffolk Road and Queen Anne's Road junction	Neutral D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Neutral D / P / LT
	MIND Centre and Grounds	Moderate significance – D / P / LT	No additional mitigation would be implemented as part of the Scheme.	Moderate significance – D / P / LT
Changes to economy and employment	Economic receptors at a local scale	Slight significance + D / T / ST	N/A	Slight significance + D / T /ST
Changes to economy and employment	Economic receptors at a regional scale	Slight significance + D / T / ST	N/A	Slight significance + D / T /ST
Severance and disruption to terrestrial	Terrestrial businesses	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T / ST

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
and marine businesses and associated activities	Marine businesses	Moderate significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme	Moderate significance – D / T / ST
Changes to recreational activities	East Coast Blackbelt School, MIND Centre and Grounds, Claydon Pavilion Community Centre, Peggotty Community Centre and Southtown Common Recreation Ground	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T / ST
	Kingsgate Community Centre and two allotments gardens to the north-east of Suffolk Road and Queen Anne's Road	Moderate significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Moderate significance – D / T / ST
	Marine recreational activities including	Moderate significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme	Moderate significance – D / T / ST

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
	recreational vessels			
	Anglers	Slight significance – D / T / ST	No additional mitigation would be implemented as part of the Scheme.	Slight significance – D / T / ST
Operational Phase				
Additional NMU facilities proposed as part of the Scheme	NMUs	Moderate significance + D / P / LT	N/A	Moderate significance + D / P / LT
Removal of William Adams Way footbridge	NMUs	Slight significance – D / P / LT	N/A	Slight significance – D / P / LT
Changes to driver stress	Vehicle travellers	Moderate significance + D / P / LT	N/A	Moderate significance + D / P / LT
Changes to community severance	Community receptors	Moderate significance + D / P / LT	N/A	Moderate significance + D / P / LT
Changes to terrestrial businesses and associated activities	Terrestrial businesses	Slight significance + D / P / LT	N/A	Slight significance + D / P / LT
Changes to marine businesses and associated activities	Marine businesses	Slight significance – D / P / LT	N/A	Slight significance – D / P / LT

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Changes to recreational activities	Terrestrial recreational activities	Moderate significance + D / P / LT	N/A	Moderate significance + D / P / LT
	Marine recreational vessel movements	Slight significance – D / P / LT	N/A	Slight significance – D / P / LT
	Marine off-site recreational resources	Slight significance – D / P / LT	N/A	Slight significance – D / P / LT

Key to table:

+ / – = Positive or Negative; P / T = Permanent or Temporary; D / I = Direct or Indirect; ST / MT / LT = Short-Term, Medium-Term or Long-Term; N/A = Not Applicable

14.12 References

Ref 14.1: Highways England (2015). Interim Advice Note 125/15 Supplementary guidance for users of Design Manual for Roads and Bridges Volume 11 'Environmental Assessment'.

Ref 14.2: Department for Transport (2014). National Policy Statement for National Networks.

Ref 14.3: Department for Transport (2012). National Policy Statement for Ports.

Ref 14.4: Ministry of Housing, Communities & Local Government (2019). National Planning Policy Framework.

Ref 14.5: Great Yarmouth Borough Council (2015). Great Yarmouth Local Plan: Core Strategy 2013 – 2030.

Ref 14.6: HM Government (2014). East Inshore and East Offshore Marine Plans

Ref 14.7: Highways England (2001). Design Manual for Roads and Bridges Volume 11, Section 3, Part 6 (Land Use).

Ref 14.8: Highways England (1993). Design Manual for Roads and Bridges Volume 11, Section 3, Part 8 (Pedestrians, Cyclists, Equestrians and Community Effects).

Ref 14.9: Highways England (1993). Design Manual for Roads and Bridges Volume 11, Section 3, Part 9 (Vehicle Travellers).

Ref 14.10: Homes and Community Agency (2015). Employment Density Guide 3rd Edition.

Ref 14.11: English Partnerships (2014). Additionality Guide 4th Edition.

Ref 14.12: Office of National Statistics (no date). 2011 Census (online) (Accessed August 2018).

Ref 14.13: Office of National Statistics (no date). NOMIS (online) (Accessed August 2018).

Ref 14.14 Department for Communities and Local Government (2015). The English Indices of Deprivation 2015 (online) (Accessed August 2018).

Ref 14.15 Great Yarmouth Borough Council (2015). Great Yarmouth Local Plan Core Strategy 2013 - 2030 (online) (Accessed August 2018).

Ref 14.16: Great Yarmouth Borough Council (2015). Local Plan Policies Map (online) (Accessed August 2018).

Ref 14.17: Great Yarmouth Borough Council (2018). A replacement Local Plan (2021-2036) Development Plan Document.

Ref 14.18: Great Yarmouth Borough Council (2013). Open Space Study (online) (Accessed August 2018).

Ref 14.19: Highways England (no date). WebTRIS (online) (Accessed August 2018).

Ref 14.20: Mouchel (2017). Great Yarmouth Third River Crossing: Outline Business Case.

Ref 14.21: Department for Environmental and Rural Affairs, Natural England, Environmental Agency, Historic England, Forestry Commission and Marine Management Organisation (2018). Magic (online) (Accessed August 2018).

Ref 14.22: Buchanan Computing (2017). Collison Map (online) (Accessed August 2018).

Ref 14.23: Great Yarmouth and Waveney (no date). Who We Are (online) (Accessed March 2019).

Ref 14.24: Department for Transport (2018). Port and Domestic Waterborne Freight Statistics Port (online) (Accessed August 2018).

15 Materials

15.1 Introduction

15.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Scheme upon the consumption of material resources (which includes recovered site arisings), and the generation and disposal of waste.

15.1.2 The chapter details the methodology used to assess significance of effects for the Scheme. To provide context to which the EIA has been undertaken, the baseline conditions of the Scheme and the surrounding administration region have been provided. The Satellite Application Site, containing the Variable Messaging Signs, has not been included in this assessment as professional judgement has predicted the outcome to be negligible due to the size and nature of these locations. Embedded mitigation measures adopted by the Scheme have been taken into account as part of the assessment. Additional mitigation measures required to prevent, reduce or offset any significant negative effects (following embedded mitigation) have been described for consideration.

15.1.3 The assessment methodology used in this chapter is based on guidance set out in IAN 153/11 (Highways Agency, 2011) *Environmental Assessment of Material Resources* (Ref 15.1). IAN 153/11 (Ref 15.1) sets out the process and information required for the assessment of significant effects from the use of material resources and production of waste.

15.1.4 Materials resources are defined in Section 2.1.1, IAN 153/11 (Ref 15.1) as:

"the materials and construction products required for the construction, improvement and maintenance of the road network. Materials resources include primary raw materials such as aggregates and minerals, and manufactured construction products. Many material resources will originate off site, purchased as construction products, and some will arise on site such as excavated soils or recycled road planings".

15.1.5 IAN 153/11 (Ref 15.1) does not include a definition of waste, however the EU Waste Framework Directive Definitions (1) (Ref 15.2) defines it as *"… any substance or object that the holder discards or intends or is required to discard"*.

15.1.6 This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES.

15.2 Competent Expert

15.2.1 Table 15.1 demonstrates that the professionals contributing to the production of this Materials chapter have sufficient expertise to ensure the ES is completed to the expected technical and professional quality.

Table 15.1: Material Professional Competence

Name	Role	Qualifications and Professional Membership	Experience
Alice Berry	Co-Author	MSc Environmental Policy and Management BSc (Hons) Geography	Alice has experience as a lead or co-author of several materials and waste chapters for environmental impact assessments on roads and bridges, for a range of clients including a number of local authorities.
Jean-Louis Bartlett	Co-Author	MSc Environmental Consultancy BSc (Hons) Applied Biology	Jean-Louis has been the lead or co-author of several materials chapters for environmental impact assessments, for a range of Highways England developments as well as for various local authorities and private sector clients. Jean-Louis has also supported the development of industry guidance on the environmental assessment of materials and waste, including the new DMRB Part and IEMA guidance.
Tim Danson	Reviewer	MSc (Dist.) Environmental Diagnostics BSc (Hons) Environmental Biology & Ecology IEMA Associate Member of the Chartered Institution Water and	Tim is currently leading on the production of materials and waste chapters for nearly twenty Environmental Impact Assessments, for a variety of public and private sector clients. Tim was also WSP's lead author for a new DMRB Part on assessing the impact of materials and waste within EIA, for Highways England. Tim is working with IEMA to produce industry guidance on the

Name	Role	Qualifications and Professional Membership	Experience
		Environmental Management Chartered Scientist	environmental assessment of materials and waste.

15.3 Legislation, Policy and Guidance Summary

15.3.1 Table 15.2 provides a summary of the key policy and guidance for this assessment.

15.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 15A (document reference 6.2).

Table 15.2: Summary of Key Legislation, Policy and Guidance

Policy / Guidance	Summary	Chapter Compliance
The NPS for National Networks (NPS NN)	NPS NN re-iterates the waste hierarchy as a method of achieving sustainable waste management (para 5.40). It also contains guidance for the Applicant: • 5.19: that an applicant should provide *"Evidence of appropriate mitigation measures (incorporating …. use of materials) in both design and construction…. to ensure that, in relation to design and construction, the carbon footprint is not unnecessarily high."* • 5.42: that the applicant should *"set out the arrangements that are proposed for managing any waste produces"* and *"seek to minimise the volume of waste produced and the volume of waste sent for disposal"*.	This chapter accords with the NPS NN and complies with the policies by promoting management of resources in accordance with the principles of the Waste Hierarchy. Evidence is set out in Paragraph 15.7.5 and the mitigation sections of this chapter. The Monitoring section of this chapter (paragraph 15.8.18) outlines how a SWMP will be developed by the contractor following the Outline CoCP (document reference 6.16), and how the SWMP will be used to comply with this policy by minimising the volume of waste

Policy / Guidance	Summary	Chapter Compliance
	It also provides guidance for the decision maker regarding the consideration of proper management of on-site and off-site waste, that waste infrastructure is available and that *"adequate steps have been taken to minimise the volume of waste arisings, and of the volume of waste arisings sent to disposal, except where an alternative is the most sustainable outcome overall"* (5.43).	produced and sent for disposal.
National Policy Statement for Ports (NPS for Ports)	NPS for Ports also mentions the use of the waste hierarchy to attain sustainable waste management as well as providing information on dredging and disposal of waste at sea.	This chapter accords with the NPS for Ports by complying with the policies concerning the promotion of resource management in accordance with the principles of the Waste Hierarchy. Evidence is set out in Paragraph 15.7.5 and the mitigation sections of this chapter.
The National Planning Policy Framework (NPPF) 2019	This NPPF sets out policies for national construction minerals supply. It aims to facilitate the sustainable use of minerals (Chapter 17), which are a finite natural resource, and can only be worked where they are found, as best use needs to be made of them to secure their long-term conservation. *"Planning policies should:* *a) provide for the extraction of mineral resources of local and national importance, but not identify new sites or extensions to existing sites for peat extraction;*	This chapter promotes the sustainable use and conservation of minerals. Evidence is set out in Paragraph 15.7.5 and the mitigation sections of this chapter. This chapter considers impacts on peat extraction and Mineral Safeguarding Areas in the Baseline Conditions (Section 15.5) as part of the methodology to

Policy / Guidance	Summary	Chapter Compliance
	b) *so far as practicable, take account of the contribution that substitute or secondary and recycled materials and minerals waste would make to the supply of materials, before considering extraction of primary materials, whilst aiming to source minerals supplies indigenously;*	determine significance of effects. In Section 15.8, the cut and fill balance, and the diversion of arisings from landfill for reuse consider the contribution of secondary and recycled materials.
IAN 153/11 Guidance on the Environmental Assessment of Material Resources (Ref *15.1*)	IAN 153/11 provides a framework for the assessment of the impacts and effects associated with the use of materials in new construction, improvement and maintenance projects. The guidance outlines the consideration of material resource use and waste as part of an EIA process. Section 2.1.1 provides the following definition of materials resources: "*The materials and construction products required for the construction, improvement and maintenance of the road network. Materials resources include primary raw materials such as aggregates and minerals, and manufactured construction products. Many material resources will originate off site, purchased as construction products, and some will arise on site such as excavated soils or recycled road planings*".	The content of IAN 153/11 has been interpreted and applied within this chapter. It has been integrated into the overall approach in the Assessment Methodology.
Highways England's Major Projects' Instructions MPI-	The significance criteria used for assessing sensitivity and magnitude are based on MPI-57, but also include other information	The content of Highways England's instruction has been interpreted and applied

Policy / Guidance	Summary	Chapter Compliance
57-052017(Rev1) (Ref 15.3);	and criteria that – in the professional judgement of the author – refine and improve robustness of the assessment process.	within this chapter. It has been integrated into the overall approach in the Assessment Methodology.

15.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

15.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

15.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

15.4.3 Table 15.2 and 15.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 15.3: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
4.10 Materials: ID 1, Ref Paragraph 6.11.30 (and Table 43). Operational phase consumption of material resources and waste generation: "*The Scoping Report states that operational impacts are anticipated to be negligible and have been scoped out of the assessment of environmental effects. It is noted at Table 43 of the Scoping Report that the ES will include an assessment of the consumption of resources for the first year of operation, where they can be forecast. Although it is also stated in Table 43 that whilst the extent of*	PINS	Impacts arising during operation have been scoped out of this assessment. This includes the assessment of effects in the first year of operation as agreed in the Scoping Opinion, it has not been possible to forecast materials information during this lifecycle phase as it is expected to be minor repairs and maintenance and the impacts are expected (through professional judgement) to be negligible.

Scoping Opinion Item	Consultee	Response
changes is currently unknown, they are unlikely to result in significant effects. *The SoS accepts that material consumption and waste generation during operation is unlikely to generate significant effects and is content that this matter can be scoped out of the assessment."*		
4.10 Materials: ID 2, Ref Paragraph 6.11.32. Effects associated with transportation of materials; and issues associated with land contamination: *"The Inspectorate notes the information within the other aspect chapters listed (Air Quality, Peoples and Communities, Noise, Water Environment, Flooding, and Climate Change aspect chapters with respect to transportation of materials; and the Geology and Soils aspect chapter with respect to contaminated land) and is content that it is appropriate to assess the environmental effects of these two matters as set out in the above aspect chapters. The Inspectorate also understands from Scoping Report Section 6.13 that transportation of materials will be considered in the Traffic and Transport aspect chapter. Therefore, the Inspectorate agrees to scope these matters out of the Materials assessment of the ES. The ES should include clear cross-references in aspects chapters to where relevant matters have been assessed elsewhere in the ES."*	PINS	Effects associated with transportation of materials (including waste) are assessed in Chapter 6: Air Quality, Chapter 14: Peoples and Communities, Chapter 7: Noise and Vibration, and Chapter 13: Climate Change chapters. Effects associated with land contamination are assessed in Chapter 16: Geology and Soils chapter.
4.10 Materials: ID 3, Ref Paragraph 6.11.10 and 6.11.14.	PINS	Descriptions of the current (anticipated) consumption of materials resources associated with the Scheme

Scoping Opinion Item	Consultee	Response
Baseline: *"The Scoping Report states that the current consumption of material resources within the site (with reference to the scoping boundary provided in Appendix B of the Scoping Report) and the current anticipated site waste arisings are deemed to be negligible. However, the Scoping Report does not provide any more detailed information to support these statements. The ES must include the baseline information on which the assessment is based presented in the ES, with estimated quantities, where available."*		have been included in this chapter in Paragraph 15.5.9. Baseline information on which the assessment is based has been included in Section 15.5.
4.10 Materials: ID 4, Ref Paragraph 6.11.17 to 6.11.18. Baseline: *"The Scoping Report includes contradictory information and the available regional data for transfer, material recovery, and metal recycling rates applied to the baseline. The Scoping Report states that there is currently no regional data available for construction, demolition and excavation production or recovery rates for the East of England. Figure 7 of the Scoping Report shows transfer, material recovery and metal recycling rates for 2016 but is titled both 'East of England' and 'North of England'. It is unclear if the graph relates to rates for the East of England or North of England.* *The information on which the assessment is based should be clearly presented in the ES. Where data is unavailable and proxy data is applied this should be clearly explained and justified in the ES."*	PINS	There is no regional data available for construction, demolition and excavation production. Plate 15.1 shows rates of material transfer, recovery and metal recycling but the data included all waste types and therefore does not specify between construction, demolition and excavation arisings. The title of the graph has been edited in the PEIR, Appendix 5.1, Figure 15.2. It has also been addressed in this ES chapter by clearly stating that the graph relates to the East of England, Plate 15.1. Available baseline information is clearly presented in Section 15.5.
4.10 Materials: ID 5, Ref Paragraph 6.11.19.	PINS	Addressed in Section 15.5: Table 15.10: Non-Hazardous

Scoping Opinion Item	Consultee	Response
Baseline: *"This paragraph states that data indicates that there is likely to be regional infrastructure and capacity for the anticipated transfer and recovery of materials associated with the Scheme, based on trends in national rates of recovery. However, no information about regional infrastructure is presented. The paragraph also refers the reader to Table 36 of the Scoping Report; however, Table 36 does not correspond to the statement made here.* *The ES should include information on the availability of regional waste management infrastructure including the available capacity."*		Construction and Demolition Arisings and Recovery in England shows the construction and demolition recovery trends across England and Plate 15.2 shows the remaining landfill capacity in the East of England.
4.10 Materials: ID 6, Ref Paragraph Table 43, 6.11.41. Construction effects: *"Table 43 of the Scoping Report makes a commitment to estimate the volume of material resources required for the Proposed Development. The ES should include the estimated quantities of materials and waste and explain how these are derived. The information should be used to inform the assessment of likely significant effects in the ES."*	PINS	Estimated quantities of materials and arisings have been received from the design team and have been included in this ES chapter (Table 15.13, Table 15.14 and Table 15.15).
4.10 Materials: ID 7, Ref Paragraph Table 43. Construction effects: *"Table 43 of the Scoping Report states that it is expected that a commitment will be made to reuse and recycle waste arisings from the Proposed Development. If this forms part of the proposed mitigation this should be clearly set out in the ES. The ES must*	PINS	Materials resource efficiency and waste minimisation measures are included in the Outline CoCP (document reference 6.16). Including these measures will lead to the development of the (post-consent) CoCP, the SWMP and the MMP. Wherever possible, the extent to which mitigation measures reduce associated

Scoping Opinion Item	Consultee	Response
demonstrate how any mitigation measures on which the assessment has relied will be secured."		adverse impacts will be stated and justified.
4.10 Materials: ID 8, Ref Paragraph N/A. Impacts – marine sediments: *"It is not clear from the description of the development and Section 6.11 (Materials) of the Scoping Report whether the Proposed Development will require the removal, dredging and disposal of sediment from the marine environment. If this is required, the ES must provide information regarding the likely quantities and method of disposal, together with an assessment of impacts. The ES should make clear whether removal of marine sediment would be required during construction and/or operation/maintenance."*	PINS	It is estimated that 4,500 tonnes of sediment from the dewatered cofferdam will be removed; this datum is included in Table 15.14 of this ES chapter, alongside the likely management method.

Table 15.4: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
Hazardous Substances Consent would be required to store or use any of the Named Hazardous Substances of Categories of Substances at or above the controlled quantities set out in schedule 1 of these Regulations.	Health and Safety Executive	Addressed in Appendix 15A. The regulation is summarised and the Hazardous Substances Consent is mentioned in Table 15A.1 and it is then stated how this has been addressed in the Materials chapter, through the development of an Outline CoCP (document reference 6.16) which will be followed by the development of an MMP and SWMP.
If you are consulting on a mineral/waste plan or local aggregate assessment, the MMO recommend reference to marine aggregates and to the documents below: • The Marine Policy Statement (MPS), section	MMO	Addressed in Appendix 15A. The documents are summarised and cross references are stated to show how the key points have been addressed in the Materials chapter.

Section 42 Item	Consultee	Response
3.5 which highlights the importance of marine aggregates and its supply to England's (and the UK) construction industry. • The National Planning Policy Framework (NPPF) which sets out policies for national (England) construction minerals supply. • The Managed Aggregate Supply System (MASS) • The National and regional guidelines for aggregates provision in England 2005-2020.		

15.4.4 No further consultation activity has been undertaken in support of the preparation of this chapter.

15.4.5 Details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Likely Significant Effects

Construction Phase

15.4.6 The following likely significant effects that have been assessed in this chapter:

- The consumption of material resources (from primary, recycled or secondary, and renewable sources) including the generation and use of arisings recovered from the Scheme; and
- The production and disposal of waste to landfill (cognisant of the fact that waste sent for regional treatment and recovery has the potential to reduce adverse impacts on void capacity).

Extent of the Study Area

15.4.7 The primary study area comprises the Principal Application Site, including all construction and laydown areas. The Satellite Application Site has not been included in this assessment as professional judgement has been used to predict a negligible, and insignificant effect.

15.4.8 The secondary study area extends to the availability of construction and recovered material resources within the East of England region (Hertfordshire, Bedfordshire, Cambridgeshire, Essex, Norfolk and Suffolk) and - where appropriate - the UK, and the capacity of recovery and waste management facilities in the East of England region.

Method of Baseline Data Collation

Desk Study

15.4.9 The baseline data collected and presented in this chapter were obtained by desk study.

15.4.10 The data acquired during the desk study describe the regional and national availability of materials that would typically be required, and the capacity of regional facilities to recover and dispose of waste generated.

15.4.11 Data relating to the volumes of materials (including their source and recycled content) and waste (including their management method, including disposal) have been obtained from design estimates and information provided by the Design Team.

Assessment Methodology

15.4.12 As set out in the Scoping Report for the Scheme, the primary guidance that has been used to inform the assessment process is IAN 153/11 (Ref 15.1).

15.4.13 As the proposed works comprise demolition works, highway alterations and the generation of a new river crossing with associated infrastructure, the Scheme is classed as a large local major scheme; this aligns with the IAN 153/11 (Ref 15.1, Section 3.3.3) guidance definition of 'complex improvement and large new construction works'. In accordance with the requirements for complex works set out in the guidance, a detailed assessment of material resources has been undertaken.

15.4.14 As part of the assessment, the following tasks were carried out:

- Relevant waste legislation, policies and guidance have been reviewed to identify material use and waste management objectives, commitments and targets (Appendix 15A);

- The likely types of material resources (including site arisings) and waste have been identified, and quantities estimated for the Scheme, for waste, inert and non-inert forecasts, have been made;
- Impacts have been evaluated against the regional and national materials markets and the capacity of regional (or if appropriate, national) landfills;
- Opportunities to eliminate, reduce, reuse, recycle or recover material resources, site arisings and (potential) waste, have been identified through a review of the Scheme (including proposed building materials, construction methods and design, where available) and in accordance with industry good practice; and
- Identification of viable circular economy opportunities in design and construction have been made.

15.4.15 This ES considers the nature of impacts (adverse/beneficial, permanent/temporary, direct/indirect) from the use of material resources and production of waste. Significance of effects have been determined in accordance with Highways England MPI/57/052017 (Rev 1) (Table 15.5, Table 15.6 and Table 15.7) and by applying Table 2.4 of DMRB Volume 11 Section 2 Part 5 HA 205/08 (Ref 15.4), whilst also taking account of the requirements of the national and local policy documents.

15.4.16 The main outputs from the detailed assessment are:

- Estimates of material resource consumption and waste arisings; and
- Identification of measures which will eliminate and / or mitigate the potential for significant adverse environmental effects, and that will fulfil resource efficiency and circular economy opportunities.

Materials

15.4.17 An assessment of the impacts of consuming materials required during site construction has been undertaken by considering the origins and sources of materials, including their general availability (production, stock, sales) and the proportion of recovered (reused or recycled) materials they contain.

15.4.18 The reuse of excavated and other site arisings has been evaluated as part of the assessment of materials, to determine whether the adverse effects associated with the consumption of virgin materials can be reduced.

Landfill Capacity

15.4.19 An assessment of the remaining landfill capacity in the East of England has been used to determine the impacts and effects of waste generated during site construction of the Scheme.

15.4.20 The assessment considers the volume of waste (inert, non-hazardous and hazardous) anticipated to be generated by the Scheme and determines the potential impact of each on remaining landfill capacity in the region. Wherever waste is recovered (diverted from landfill) the influence of this has been taken into account in the assessment of significance of effect.

Significance Criteria

15.4.21 The assessment of potential effects from the Scheme has taken into account the construction process, which comprises the Scheme's site preparation works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme. The significance level attributed to each effect has been determined by comparing the magnitude of change due to the Scheme, with the sensitivity of the affected receptor.

15.4.22 In accordance with Highways England MPI/57/052017 (Rev 1), the sensitivity of the affected receptor is assessed on a scale of very high, high, medium, low and negligible (Table 15.5), and the magnitude of change is assessed on a scale of major, moderate, minor, negligible and no change (Table 15.6). The significance of an effect can then be derived by comparing the magnitude of change with the sensitivity of the receptor (Table 15.7).

Table 15.5: Sensitivity Criteria

Sensitivity	Materials	Waste
Very High *	• Comprises no reused/recycled aggregate (alternative materials) and/or • Are forecast (through trend analysis and other information) to suffer from known issues regarding supply and stock or are known to be insufficient regarding supply and stock and/or • Offer little or no sustainable features and benefits compared to traditional materials	• A project will require new (permanent) waste infrastructure to be constructed to accommodate waste.
High *		• >50% of a project's waste requires disposal outside of the region
Medium	• Comprises reused/recycled aggregate (alternative materials) below the lower of the relevant regional or national percentage target (refer to the Notes in the final row of this table) and/or • Are forecast (through trend analysis and other information) to suffer from some potential issues regarding supply and stock and/or • Offer some sustainable features and benefits compared to traditional materials	• 1-50% of a project's waste requires disposal outside of the region
Low	• Comprises reused/recycled aggregate (alternative materials) above the higher of the relevant regional or national percentage target (refer to Notes below) and/or	• Waste infrastructure has sufficient capacity to accommodate waste from a proposed project, without compromising integrity of the receiving infrastructure (design life or capacity) within the region

Sensitivity	Materials	Waste
	• Are forecast (through trend analysis and other information) to be generally free from known issues regarding supply and stock, and/or • Offer sustainable features and benefits compared to traditional materials	
Negligible	• No reduction or alteration in the availability of material assets at a regional scale in relation to the resources the Scheme will use	• No reduction or alteration in the capacity of waste infrastructure at a regional scale

Notes:

Recycled aggregate targets 2005 – 2020 (Ref 14.20).

The higher target for recycled aggregate between the national average or region shall apply. Where a project is located in more than one region, the regions target where the majority of the materials are to be sourced shall apply.

Region	Recycled content target (alternative materials)	Total aggregate provision (million tonnes)
East	31%	382
England Average	25%	434

** note that materials sensitivity criteria for 'very high' and 'high' are – as per IAN 153/11 – identical.*

Table 15.6: Magnitude Criteria

Magnitude	Materials	Waste
Major *	• >50% of primary materials to be sourced internationally and/or • Sterilises ≥1 mineral safeguarding site and/or peat resource	• >1% reduction or alteration in **national** capacity of waste infrastructure, as a result of accommodating waste from a project
Moderate *		• >1% reduction or alteration in the **regional** capacity of waste infrastructure as a result of accommodating waste from a project
Minor	• >50% of primary materials to be sourced nationally (with other primary materials sourced at a lower geographic scale)	• >1% reduction or alteration in the **regional** capacity of waste infrastructure as a result of accommodating waste from a project
Negligible	• Requires ≤50% of primary materials to be sourced nationally (with other primary materials sourced at a lower geographic scale)	• ≤1% reduction or alteration in the regional capacity of waste infrastructure
No change	• No reduction or alteration in the availability of material assets at a regional scale in relation to the resources a project will use	• No reduction or alteration in the capacity of waste infrastructure at a regional scale

Notes:

For materials: magnitude of impact may be reduced wherever non-renewable / virgin / primary material consumption is reduced e.g. through use of recycled / secondary content, or where materials with sustainable features are committed to.

** note that materials magnitude criteria for 'very high' and 'high' are – as per IAN 153/11 – identical.*

Table 15.7: Matrix used to Determine the Significance of Effects

Environmental Value (Sensitivity)	Magnitude of Impact (Degree of Change)					
		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	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

Effect Significance

15.4.23 In accordance with guidance provided in MPI-57-052017, Table 15.8 is used to determine whether effect is considered significant, or not.

Table 15.8: Effect Thresholds and Significance of Effect (Materials, Waste)

Effect Threshold	Significance of Effects	
	Materials	**Waste**
Negligible / Neutral	Not significant	Not significant
Slight		
Moderate		Significant
Large	Significant	
Very Large		

15.4.24 As materials extraction, processing and manufacture is closely regulated (though this does depend on the source country), for the purpose of this assessment, the effects of a Scheme are not considered significant unless it can be demonstrated that there are either: clear, detrimental impacts on the production, stocks or sales of construction materials in one or more regions, and/or recycled / secondary content is notably absent, and/or products with clear sustainability credentials have not been identified for use.

15.4.25 As waste management facilities and landfills in the UK are subject to an effective system of environmental regulation and permitting, for the purpose of this assessment, effects are not considered significant unless it can be demonstrated that there are clear and detrimental impacts on the capacity of landfill sites in one or more regions.

15.4.26 It should be acknowledged that whilst materials and waste management facilities are (certainly in the UK) regulated, the principle inherent to this assessment is that by consuming construction and other materials, and producing and disposing of waste, Schemes incentivise or 'draw' negative effects in the supply chain, and hence must take full and proportional responsibility for their contributions.

15.5 Baseline Conditions

15.5.1 The following sections describe baseline material consumption and waste disposal for any assets currently present and provide regional and national information in the context of which environmental assessment has been undertaken.

Material Resources

Materials Currently Required

15.5.2 The current infrastructural assets within include: a highway network; residential and business properties; allotments; quays and a pedestrian bridge.

15.5.3 The operation and maintenance of the assets are likely to require a small number of specialist components (for example light bulbs, signage steelwork and kerbstones for the roads) as well as some bulk products (asphalt for minor re-surfacing of roads) for routine works and repairs. The current consumption of construction and other material resources is, therefore, deemed negligible.

15.5.4 The baseline scenario (no Scheme pursued) is not expected to change the current consumption of material resources.

UK and regional perspective: availability of construction materials

15.5.5 Table 15.9 (Ref 15.5, Ref 15.6, Ref 15.7, Ref 15.8) provides a summary of the most recent available data from the Department of Business, Energy and Industrial Strategy, the East of England Aggregates Working Party, the Mineral Products Association, and the House of Commons on the availability of the main construction materials in the East of England and the UK (comprising, in combination, the secondary study area), as required to deliver typical highways and bridge schemes. The overview provides a context in which the assessment of impacts and significant effects from material consumption on the Scheme can be undertaken.

Table 15.9: Construction Material Available in the East of England and the UK

Material Type		Availability (2017 data unless otherwise stated)	
		East of England	UK
Aggregate	Sand and gravel *	13.5Mt	61.7Mt
	Permitted crushed rock *	0.4 Mt	144.5Mt
Recycled and secondary aggregate (as part of 'Aggregate', above) *		(no data)	74Mt
Ready-mix concrete +		1.4M m^3	25.9M m^3
Asphalt *		2.4Mt	27.3Mt
Concrete blocks #		1.7Mt (Midlands)	6.8Mm^2
Steel +		(no data)	8Mt (2016)

Key:
stocks
+ production
* sales

15.5.6 The Norfolk Minerals and Waste Core Strategy and Development Framework (Ref 15.9) identifies mineral safeguarding areas. The Scheme is partially underlain by a sand and gravel Mineral Safeguarding Areas. However, the Scheme is already sterilised due to development. Furthermore, there are no known peat resources or active peat extractions within the primary study area.

15.5.7 Currently, data for the East of England regarding materials typically required for highways and bridge construction, are incomplete. For example, information on aggregate sales and steel production are not currently

available for the region. Accordingly, a full picture of resource availability in the secondary study area cannot be obtained.

15.5.8 However, the availability of construction materials across the UK indicates that national stocks, production and sales remain buoyant. Using UK data as a proxy, in combination with information that is available for the East of England, the sensitivity of materials availability for the Scheme is assessed to be **low**.

Site Arisings

Existing Site Arisings

15.5.9 Current routine operation and maintenance works on existing infrastructural assets (roads, roundabouts, junctions) are likely to generate negligible volumes of site arisings.

15.5.10 The baseline scenario (no Scheme pursued) is not expected to change the volume or type of site arisings generated within the footprint of the Scheme.

National and Regional Perspective: Transfer, Recovery and Recycling

15.5.11 Defra data (Table 15.10: Non-Hazardous Construction and Demolition Arisings and Recovery in England) show that, according to the most recent available data, within England, the recovery rate for non-hazardous construction and demolition arisings has remained above 90% since 2010. This exceeds the EU target of 70%, which the UK must meet by 2020 (Ref 15.10).

Table 15.10: Non-Hazardous Construction and Demolition Arisings and Recovery in England

Year	Generation (Mt)	Recovery (Mt)	Recovery rate (%)
2010	53.6	49.4	92.2%
2011	54.9	50.8	92.5%
2012	50.5	46.4	92.0%
2013	51.7	47.6	92.0%
2014	55.9	51.7	92.4%
2015	57.7	53.3	92.3. %
2016	66.2	55.0	92.1%

15.5.12 Plate 15.1 shows that rates of material transfer (non-civic), recovery and metal recycling within the East of England continue to rise steadily (Ref 15.11). Since 2011, rates for material recovery have increased notably. Data

provided include all waste types in the region and hence will include, but are not specific to, construction, demolition and excavation arisings.

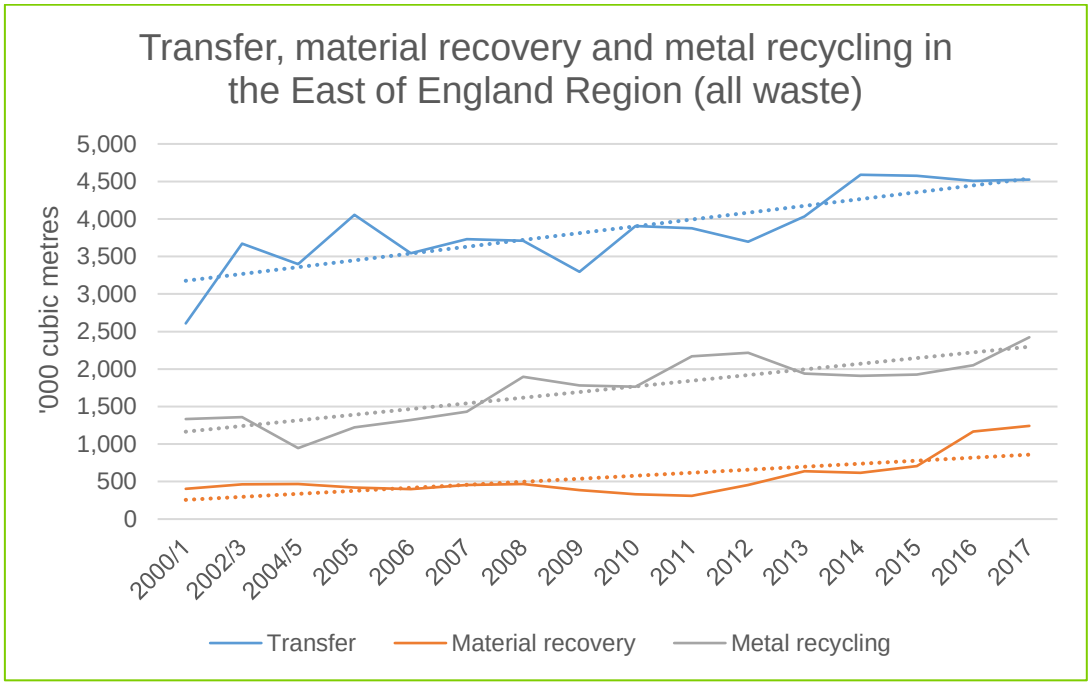


Plate 15.1: Transfer, material recovery and metal recycling in the East of England

15.5.13 Available data demonstrate that the upward trends for transfer, recovery and metal recycling within the East of England (the secondary study area) remain consistent. Data indicate that there is likely to be regional infrastructure and capacity for the transfer and recovery for construction, demolition and excavation arisings from the Scheme. Construction and demolition recovery trends across England (Table 15.10: Non-Hazardous Construction and Demolition Arisings and Recovery in England) demonstrate further capacity in this context.

15.5.14 The availability of materials recovery infrastructure in the East, and across England, suggests that there is strong potential to divert from landfill site arisings generated by the Scheme. Both the importance (positive value) of this infrastructure indicates there is strong potential to maximise the reuse and recycling value of site arisings. This has the potential to materially influence the assessment of materials and waste.

Waste Generation and Disposal

Waste currently generated and disposed of

15.5.15 The operation and maintenance of the existing infrastructural assets is likely to generate small volumes of waste from routine highway maintenance, in combination with littering, light replacement, signage replacement, and

replacement of reflective road studs (cats' eyes). The anticipated effects of disposing of this waste are deemed negligible in the context of available regional capacity.

Regional perspective: remaining landfill capacity

15.5.16 At the end of 2017, the East of England had 51 active landfill sites with 51.6Mm^3 of remaining capacity (Ref 15.12). Table 15.11 summarises Environment Agency data relating to these landfill types.

Table 15.11: Landfill Capacity in the East of England (2017)

Landfill Type		Number of Sites	Remaining Capacity (Mm^3, end of 2017)
Inert		29	18.5
Non-hazardous	Non-Hazardous	18	27.2
	Non-Hazardous with Stable Non-Reactive Hazardous Waste Cell	4	5.9
Hazardous		0	0.0
Total remaining capacity		51	51.6

15.5.17 Environment Agency data confirm that at the end of 2017, remaining landfill capacity in the East of England was: 18.5Mm^3 for inert (down 14.5Mm^3 from 2016) and 33.1Mm^3 for non-hazardous (2.4Mm^3 down from 2016). No regional remaining capacity for hazardous waste was recorded.

15.5.18 Statistical forecasting (using the Microsoft Excel forecasting function) has been used to demonstrate long term void capacity to the year of planned Scheme completion (2023) in the absence of future provision; trends for baseline regional landfill capacity are detailed in Plate 15.2.

15.5.19 Baseline data indicates that in the absence of future provision, total and non-inert landfill capacity are likely to become increasingly sensitive receptors over the life of the Scheme to the completion of construction (2023). Data e only available up to 2017, and an increase in inert landfill capacity between 2013 and 2016 limits the extent to which forecasting trends can be applied. Plate 15.2 shows that waste capacity in the East of England is forecast to reduce by as much as 69% (non-inert), and 10% (total) from 2016 to 2023, in the absence of future provision. This is considered the worst-case scenario as it is presumed that no new provision for landfills in the region will be made.

15.5.20 Individually, the sensitivity of different landfill capacity types over the lifetime of the Scheme is assessed to be inert (**low**), non-inert (**high** - taking into account the absence of capacity for hazardous waste) and total (**medium**). On average, the sensitivity of landfill capacity is assessed to be **medium**.

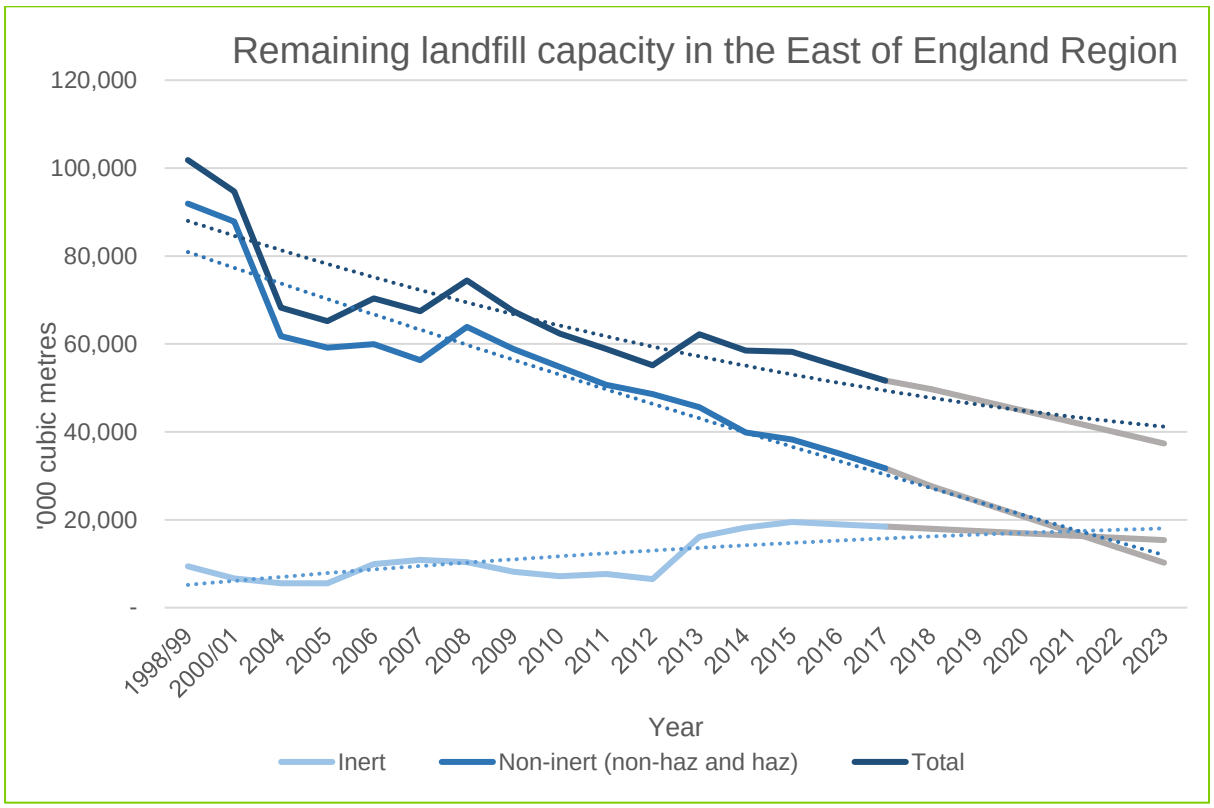


Plate 15.2: East of England Remaining Landfill Capacity (2000/1-2016) and Non-hazardous Landfill Capacity Forecast (2023)

15.6 Sensitive Receptors

15.6.1 Construction materials (resource use) has been identified as a sensitive receptor. The potential for significant effects from the consumption of material resources is associated with the depletion of these natural resources and any indirect environmental effects associated with the extraction and transportation of primary raw materials, and the manufacture and transport of products for use in construction.

15.6.2 Whilst the sensitivity of materials is assessed as low, the potential magnitude of impact (and the way that mitigation measures are applied) could give rise to significant effects.

15.6.3 Landfill capacity is increasingly considered a sensitive receptor in the UK. The potential for significant effects from waste disposal is associated with a

commensurate reduction in landfill capacity, and any indirect effects that result (greenhouse gas emissions, water consumption, water pollution – among others).

15.6.4 Non-inert landfill capacity is likely to become an increasingly sensitive receptor over the life of the Scheme, as the forecast shows a consistent, downward trend. Inert landfill capacity trends shows a slight increase over time; this is the result of additional capacity provision made between 2013 and 2016. Inert landfill is therefore considered to be less sensitive to change.

15.6.5 No hazardous waste landfill capacity was recorded in the baseline data, and is thus considered a very sensitive receptor. Any hazardous waste generated by the Scheme would need to be disposed of outside the region.

15.7 Establishing the Scenario for Assessment

Construction

15.7.1 The Scheme has the potential to consume material resources (including those recovered from site arisings), and produce and dispose of waste during the demolition, site preparation, and construction stages of delivery.

15.7.2 The associated potential environmental impacts (both direct and indirect) will occur throughout construction until 2023, and will be associated with the production, processing, consumption and disposal of material resources.

15.7.3 The impacts of the Scheme on material resources (including recovered site arisings) and waste generation and disposal, are likely to occur on-site, off-site within the UK and, potentially, internationally.

15.7.4 It is not possible at this stage to estimate the percentage of reused, recycled and secondary materials and so it has been assumed that all materials are from primary sources to give a reasonable worst-case assessment.

Embedded Mitigation

Materials

15.7.5 Committing to the use of off-site manufacture and prefabrication of materials and products, for example bascule leaves–sections as road transportable sections.

15.7.6 Ensuring reuse of all suitable uncontaminated excavated materials. Where material requires improvement to allow its use, this will be undertaken.

15.7.7 Excavated materials taken off-site may be restricted to earthworks, topsoil (made ground), organic peats and contaminated materials which cannot be stabilised.

15.7.8 These measures form part of the Outline CoCP (document reference 6.16) which is secured by DCO requirement. The MMP will be developed by the contractor later in the process.

Waste

15.7.9 Non-hazardous waste: The Outline CoCP, (document reference 6.16) which is secured by DCO requirement, and the following SWMP will be implemented to encourage the reduction and recovery of waste. Measures are as follows:

- Reduction of materials wastage through good storage and handling;
- Use of modern methods of construction and logistics, encouraging waste reduction and improved materials resource efficiency;
- Entering into agreements with waste contractors to maximise the recovery of segregated site wastes (e.g. timber, brick, plasterboard, metal);
- Ensuring that all suppliers of materials provide returnable or practicably recyclable packaging;
- Providing waste minimisation inductions and tool box talks throughout the construction phase;
- Ensuring adequate storage facilities are provided for raw materials and waste streams; and
- Contaminated arisings and hazardous waste: a SWMP will be implemented by the Contractor to ensure all hazardous wastes are collected, transported, stored and disposed of in a manner that protects the environment, noting that region capacity is currently zero.

Operational

15.7.10 As stated previously in this chapter, potential operational lifecycle environmental impacts within and beyond the first year of operation are expected to be minor repair and maintenance and are expected to be negligible and cannot be forecast, and have therefore been scoped out of this chapter.

15.8 Assessment of Effects, Mitigation and Residual Effects

Potential Impacts

15.8.1 In response to the assessment requirements set out in IAN 153/11 (Ref 15.1), a summary of the potential impacts from material resource consumption and waste generation and disposal, is provided in Table 15.12; where appropriate, the potential influence of recovering (reusing or recycling) site arisings is also included.

Table 15.12: Potential Impacts of Consuming Material Resources and Disposing of Waste

Element	Use of Materials Resources	Production and Disposal of Waste
Demolition	No potential impacts identified with regards to the consumption of material resources during demolition.	• Waste from the demolition of a number of existing residential and commercial/business properties; • Demolition waste would also be generated in the breaking out of highways and junctions and the demolition of the existing footbridge on William Adams Way. Wastes generated during demolition are likely to include: • Brick, mortar, concrete, steel, timber, tiles and glass; • Broken out concrete, cut steel and road surface planings; • Hazardous or contaminated material found on or beneath the Scheme; and • Other demolition wastes. The demolition of buildings, highways and associated assets is likely to result in a volume of arisings, a proportion of which (after the potential for reuse and recycling has been maximised) may need to be disposed of.
Site remediation	• Timber and steel products will be required for the erection of perimeter fencing and	Wastes likely to be generated during site preparation include:

Element	Use of Materials Resources	Production and Disposal of Waste
and preparation	temporary barriers as part of the site preparation for the Scheme. • It is also expected that material resources (concrete, steel, formwork, other) will be required during the stabilisation, laying out and making safe of areas adjacent to the River Yare, ready for construction of the new river embankments, retaining walls and bridge. • Temporary stockpile and construction areas may also be required, and could necessitate the consumption of aggregate and stone for ground improvements prior to use by heavy plant and equipment.	• Vegetation and other above ground materials produced by site clearance; • Paving, kerbing, bitumen and sub-base material; • Surplus non-highway subsoil material; • Hazardous or contaminated material found during site preparation.
Scheme construction	• Material resources will be required for the construction of the Scheme, including (but not limited to): local road realignment and development; alterations to roundabouts and junctions; the construction of the new embankments and retaining walls on either side of the River Yare; and the construction of the double leaf bascule bridge and control tower. Construction materials required are anticipated to include:	• Waste is anticipated to be generated during the construction of the Scheme, particularly during the construction of new roads, roundabouts and junctions, and in the digging out and construction of the new river embankments. It is anticipated that the following wastes would be generated: • Timber and steel from formwork and fencing;

Element	Use of Materials Resources	Production and Disposal of Waste
	• Bulk materials for earthworks and landscaping (to be imported, though volumes will be dependent on the cut and fill balance); • Road and pedestrian paving and kerbing materials, including sub-base and bituminous materials; • Steel for bridge structures and sheet piling; • Concrete; • Bricks, sand and aggregate; • Timber and steel for fencing and formwork; • New street furniture, signage and lighting; • Cabling; • Specialist mechanical and engineering (M&E) components or technologies; and • Other general construction materials.	• Concrete, bricks, aggregate and steel waste; • Road paving materials including sub-base and bituminous materials; • Hazardous or contaminated material found or generated on site; • Surplus cabling; • Redundant street furniture, signage and lighting; • General construction waste e.g. packaging, ducting, damaged goods.
Operation and maintenance of asset	During the first year of operation, maintenance of the Scheme assets may be required. The extent of these activities is expected to be minimal, and the potential to consume material resources or produce and dispose of waste to landfill, commensurately limited. Additionally, minor changes or amendments to the Scheme may be necessary. However, it is not possible to forecast these at this time, and the extent of these activities is expected to be minimal. The potential to consume material resources or produce and dispose of waste during minor Scheme changes is expected to be extremely limited.	

Element	Use of Materials Resources	Production and Disposal of Waste
	No further detailed assessment is necessary for the operation and maintenance of the asset, as agreed in the Scoping Opinion dated May 2018 (document reference 6.7, 6.11.30 and Table 43).	

Construction Phase

Materials

15.8.2 The consumption of materials during demolition works is considered negligible.

15.8.3 The materials set out in Table 15.13 are those which are likely to be consumed during the site remediation, preparation and construction of the Scheme. Primary and secondary materials will be utilised.

15.8.4 The Satellite Application Site (signage, hardstands, laybys and parking spaces) have not been included in this assessment as the effects are – due to the small size and nature of these locations – expected to be negligible.

15.8.5 The information in Table 15.13 has been gathered from the Design Team and consolidated to show the main materials types required. A more detailed breakdown showing the material application can be found in Appendix 15B. Where possible, quantities provided have been converted into tonnes using Waste and Resources Action Programme (WRAP) conversion factors (Ref 15.12).

Table 15.13: Materials Imported to Site during Construction

Materials	Approximate Quantity (tonnes unless otherwise stated)	Likely Source
Concrete (Structural and ST1-ST4)	15,000	Source expected to be local Tarmac depots.
Precast concrete (piles, drainage and kerbs)	8,600	Source unknown but expected to be regional or national.
Steel	4,800	Source expected to be regional or national.
Topsoil	400	Source unknown but expected to be regional or national.
Aggregate	83,500	Primary aggregate, sourced from international quarries.
Asphalt	17,300	Source expected to be local Tarmac depots.

Materials	Approximate Quantity (tonnes unless otherwise stated)	Likely Source
Rubber	45	Source unknown but expected to be regional or national.
Plastic (drainage)	20	Drainage pipework is likely to be sourced from within the UK or regionally.
Timber	110	Expected to be locally sourced.
Packaging	170	Source unknown but expected to be regional or national.
Other general construction materials (including road lighting accessories, LEDs)	No data available	Source unknown but expected to be regional or national.

15.8.6 Primary materials required for the Scheme are a finite resource and whilst some will be available through local and regional supply, national or wider sourcing is also likely to be required. The consumption of construction materials is likely to have an adverse impact on the regional and national market for resources. However, as per the methodology described in Table 15.6, it is anticipated that over 50% of the primary materials will be sourced internationally, making the magnitude of impact moderate.

15.8.7 The sensitivity of construction materials is considered **low** as forecast excavated arisings that will be reused comprises 36% (13,500 tonnes) of the total fill required (37,500 tonnes), and the materials quantities required are forecast to be free from known issues relating to production, stock and supply. The magnitude of change is considered **moderate**, as, despite mitigation, it is still planned that 83,500 tonnes of aggregate is expected to be imported from Norwegian quarries i.e. 55% of primary materials will be sourced internationally.

15.8.8 Post embedded mitigation effects from the construction stage of the Scheme are assessed to be **slight (not significant)**.

Waste

15.8.9 During demolition, enabling and earthworks and construction, it is expected that a proportion of the waste generated will be suitable for recovery (processing, reuse and recycling) at an off-site facility. Excavated and other

materials, as presented in Table 15.14 and Appendix 15C, that comply with an appropriate waste exemption, or reuse criteria set out in the MMP, which will be developed following the Outline CoCP (document reference 6.16) which is secured by DCO requirement, are expected to be redeployed on the Scheme.

15.8.10 Forecasts for waste recovery (diverted from landfill) from the Scheme are given in Table 15.14. The information has been gathered from the from the design team together with professional judgement based on knowledge from other similar schemes, and consolidated to show the forecast site arisings. Quantities provided have been converted into tonnes using WRAP conversion factors (Ref 15.13).

Table 15.14: Forecast Site Arisings that can be Recovered and Hence Diverted from Landfill

Excavated and other Materials	Approximate Quantity (tonnes unless otherwise stated)	Reuse Process
Steel (Demolition)	50	100% diversion from landfill, expected to be transferred to waste transfer station in Great Yarmouth
Demolition wastes (brick, timber, glass etc)	4,000	95% diversion from landfill, expected to be transferred to waste transfer station in Great Yarmouth
Topsoil (Excavation)	5,000	98% diversion from landfill, expected to be transferred to waste transfer station in Great Yarmouth
Earthworks (Excavation)	13,500	85% diversion from landfill, expected to be transferred to waste transfer station in Great Yarmouth
Road paving (Excavation)	5,500	85% diversion from landfill, expected to be transferred to waste transfer station in Great Yarmouth
Concrete (Excavation)	3,500	95% diversion from landfill, expected to be transferred to waste transfer station in Great Yarmouth

Excavated and other Materials	Approximate Quantity (tonnes unless otherwise stated)	Reuse Process
Material from dewatered cofferdam (Excavation)	4,500	0% diversion from landfill
Hazardous materials	30	0% diversion from landfill, expected to be removed to contaminated waste facility in Peterborough
Contaminated land	Unknown quantity	0% diversion from landfill
Construction waste (surplus materials)	6,460	95% diversion from landfill, expected to be transferred to waste transfer station in Great Yarmouth

15.8.11 Forecasts for any waste which cannot be diverted from landfill, or which have been identified for disposal to landfill are listed in Table 15.15. The information has been gathered from estimates provided by the design team; data have been consolidated to show the key waste types. A more detailed breakdown showing the source of the waste (e.g. from demolition of structures, drainage) can be found in Appendix 15C. Quantities provided have been converted to tonnes using WRAP conversion factors (15.19).

Table 15.15: Forecast Site Arisings that have been Identified for Disposal to Landfill

Waste	Quantity (tonnes) Forecast for Disposal
Steel	0
Demolition wastes (brick, timber, glass etc)	200
Topsoil	100
Earthworks	2,100
Road pavings	900
Concrete	200
Excavated material from dewatered cofferdam	4,500
Hazardous materials	30
Contaminated land	Unknown Quantity
Construction waste (surplus materials)	350

15.8.12 The majority of known arisings are anticipated from earthworks during the demolition of existing residential buildings and structures and from the breaking out of highways and junctions, site remediation and preparation. As described in Table 15.14 and Table 15.15, available information suggests that the 85% of the waste from earthworks will be reused on-site or recovered and diverted from landfill. Waste to landfill is currently expected to comprise any unusable (contaminated) earthworks and topsoil, as identified by the ground investigation and the contractor, road paving and concrete.

15.8.13 Due to the different rates of landfill capacity change (-69% for non-inert and +51% for inert), the impact of non-inert waste being landfilled is expected to be greater than the impact of inert waste. The sensitivity of landfill capacity is (on balance, and in accordance with the criteria set out in the assessment methodology) considered to be **low** for inert and **high** for non-inert. Post embedded mitigation, the magnitude of change is considered **negligible** for inert and non-inert waste, as it is expected around 90% of total arisings will be diverted from landfill and (as a result) regional landfill capacity will decrease by less than 1%.

15.8.14 Construction and demolition waste has been assessed to have an adverse, permanent and direct impact on landfill capacity. Post embedded mitigation, and based on the anticipated quantities of waste to be sent to landfill and the capacity of regional sites to accept the waste, the effect for both inert and non-inert waste is considered **slight (not significant).**

Additional Measures

15.8.15 The following are additional measures which may be implemented at construction phase but are not necessary for the purposes of assessment. These measures should be reviewed and (where appropriate) implemented to encourage the iterative management and further reduction of impacts, in the ongoing aspiration to achieve best practice on the Scheme.

Table 15.16: Additional Design, Mitigation or Enhancement Measures

Element	Description	Timing/ Process
Materials	Identification and specification of material resources that can be acquired responsibly, in accordance with BES 6001 Responsible Sourcing of Construction Products.	Design and construction
	Design for resource optimisation: simplifying layout and form, using standard sizes, balancing cut and fill, maximising the use of renewable materials, and materials with recycled or	Design

Element	Description	Timing/ Process
	secondary content, and setting net importation as a scheme goal.	
	Design for off-site construction: maximising the use of pre-fabricated structures and components, encouraging a process of assembly rather than construction.	Design
	Design for the future: considering how materials can be designed to be more easily adapted over an asset lifetime, and how deconstructability and demountability of elements can be maximised at end-of-first-life.	Design
	Identify opportunities to minimise the export and import of material resources.	Design and construction
Waste	Engage early with contractors to identify possible enhancement and mitigation measures (for example, waste exemption licenses), and to identify opportunities to reduce waste through collaboration and regional synergies.	Design and Procurement

Operation

Materials

15.8.16 Effects from materials arising either within or beyond the first year of operation have been scoped out of this assessment. The reason for this is that the extent of operational and maintenance activities is expected (using professional judgement based on experience of similar schemes) to be minimal, and the potential to consume material resources, commensurately limited. In summary, it is expected that all associated operational effects are expected to be insignificant.

Waste

15.8.17 Effects from waste generation and disposal arising either within or beyond the first year of operation have been scoped out of this assessment. The extent of operational and maintenance activities that could give rise to waste is expected to be minimal, and therefore the potential to dispose of waste to landfill, equally limited. Accordingly, all associated effects are expected to be insignificant.

Monitoring

15.8.18 All requirements for monitoring are included in the Outline CoCP (document reference 6.16) which is secured by DCO requirement and will be subsequently developed by the Contractor into a full CoCP. The full CoCP, once detailed, will provide a review, monitoring and audit mechanism to determine the effectiveness of and compliance with environmental control measures, which includes the preparation and subsequent review of an SWMP and an MMP.

15.8.19 The SWMP shall be used to monitor site waste effectively to reduce potential harm to the sensitive receptors during the design and construction stages of the Scheme. SWMPs typically monitor aspects relating to:

- Responsibility for resource management;
- The types and volumes of waste generated;
- The management of waste – the reduction, reuse and recycling;
- The use of contractors to ensure waste is correctly recycled or disposed of responsibly and legally;
- The measurement and monitoring of the quantity of waste generated by the Scheme; and
- The use of a reporting and recoding tool.

15.8.20 The MMP will be a mechanism which can enable the reuse of natural soils and arisings including made-ground (contaminated or otherwise) on a development site. The MMP requires answers to a series of questions regarding excavated materials on:

- The parties involved;
- Suitability for use criteria;
- Certainty of use;
- Quantity of use;
- Contingency arrangements;
- Tracking and document control; and
- Verification plan.

15.9 Limitations and Assumptions

15.9.1 The assessment of materials is based upon the validity of the collated information, regarding the anticipated materials to be used and waste generated and disposed of.

15.9.2 This ES chapter has been completed based on the currently available information regarding the scale and nature of the Scheme. Type and quantities of material and waste provided at this stage are indicative, and limited due to the constraints of working with preliminary designs and associated descriptions.

15.9.3 The estimates provided by the Design Team do not account for the components of the Satellite Application Site and ancillary items such as signage (including Variable Message Signs) and lighting. However, the adverse environmental effects associated these assets are expected to be negligible, and not significant.

15.9.4 Information on the source and recycled content of materials, and the intended destination for any waste, has not been provided. As such, it is anticipated that best practice will be used to maximise waste recovery and diversion from landfill.

15.9.5 Baseline data and information for the assessment are (unless otherwise stated) only available to 2017.

15.9.6 UK landfill operators can claim commercial confidentiality for their data at time of submission; data for sites with a commercial confidentiality in place are therefore unavailable for the analyses presented in this chapter. This is not, however, expected to affect the overall conclusions made in this chapter.

15.9.7 The Department of the Environment, Food and Rural Affairs (Defra) has been consulted to determine whether generation and recovery rates for Construction, Demolition and Excavation (CDE) arisings were available by region.

15.9.8 Defra confirmed that it does not publish CDE figures at a regional level, and only national (England) data are accessible through the publicly available Waste Data Interrogator Database; the database is held and operated by the Environment Agency. Defra responded:

"*The methodology used to generate these figures is complex, in order to take into account the inherent double-counting and data gaps that are present within waste system data, and it would not be feasible to reproduce these on a regional basis*."

15.9.9 Until such a time that CDE generation and recovery rates by region are available, transfer (non-civic), recovery and metal recycling data (available through the Waste Data Interrogator Database) has been used as the closest possible proxy.

15.10 Summary

15.10.1 A review of baseline material consumption and waste disposal in the East of England has provided regional and national data, and a context in which the assessment has been undertaken.

15.10.2 During demolition, site remediation and preparation, and construction (the 'construction stage'), materials consumption and disposal of waste is likely to have adverse environmental impacts. Prior to mitigation, the consumption of materials would be expected to have an adverse impact on the regional and national market resources. Equally, prior to mitigation, the generation and disposal of waste would be expected to have an adverse impact on landfill capacity.

15.10.3 The implementation of planned design, mitigation and enhancement measures, have been set out for the Scheme and is considered in the assessment.

Materials in Construction

15.10.4 Following embedded mitigation, the assessment of effects from the consumption of materials (including those potentially from international sources) during the construction stage of the Scheme indicates that the sensitivity would remain **low** (unaffected) and the magnitude of change is **moderate**. Material resources from international sources has increased magnitude of impact. Therefore, the effects are expected to be **slight (not significant).**

Waste in Construction

15.10.5 Following mitigation, the assessment of likely significance of effects from the generation and disposal of waste during the construction stage of the Scheme indicates that the sensitivity is likely to be ***low*** for inert and ***high*** for non-inert and the magnitude of change is ***negligible*** for inert and ***minor*** for non-inert. Therefore, the effects are expected to be ***slight*** and therefore not significant.

Operational Effects

15.10.6 Effects from materials arising either within or beyond the first year of operation have been scoped out of this assessment. The reason for this is

that the extent of operational and maintenance activities is expected (using professional judgement) to be minimal, and the potential to consume material resources, commensurately limited. In summary, it is expected that all associated operational effects are expected to be insignificant.

Waste

15.10.7 Effects from waste generation and disposal arising either within or beyond the first year of operation have been scoped out of this assessment. The extent of operational and maintenance activities that could give rise to waste is expected to be minimal, and therefore the potential to dispose of waste to landfill, equally limited. Accordingly, all associated effects are expected to be insignificant.

Table 15.17: Summary of Effects Table for Materials

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Consumption of material resources	Construction materials (resource use)	Effects are expected to be slight (not significant). - / P / D / LT	The following are additional measures which may be implemented at construction phase but are not necessary for the purposes of assessment. • Identification and specification of material resources that can be acquired responsibly. • Design for resource optimisation. • Design for off-site construction, encouraging a process of assembly rather than construction. • Design for the future: considering how materials can be designed to be more easily adapted over an asset lifetime, and how deconstructability and demountability of elements can be maximised at end-of-first-life.	Not significant. - / P / D / LT

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
			• Identify opportunities to minimise the export and import of material resources.	
Production and disposal of waste to landfill	Landfill capacity	Effects are expected to be slight (not significant). - / P / D / LT	The following are additional measures which may be implemented at construction phase but are not necessary for the purposes of assessment. • Engage early with contractors to identify possible enhancement and mitigation measures (for example, waste exemption licenses), and to identify opportunities to reduce waste through collaboration and regional synergies.	Not significant. - / P / D / LT

Key to table:

+ / - = Positive or Negative P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short-Term, Medium-Term or Long-Term N/A = Not Applicable

15.11 References

Ref 15.1: Highways Agency (2011) Interim Advice Note (IAN) 153/11 – Guidance on the Environmental Assessment of Material Resources.

Ref 15.2: The EU Waste Framework Directive, European Directive 2006/12/EC, as amended by Directive 2008/98/EC.

Ref 15.3: Highways England (2018) Major Projects' Instructions MPI-57-052017 (Rev1).

Ref 15.4: Design Manual for Roads and Bridges Volume 11, Section 2, Part 5: H205/08, former Highways Agency, August 2008.

Ref 15.5: Department for Business, Energy & Industrial Strategy, Monthly Bulletin of Building Materials and Components - June 2018.

Ref 15.6: East of England Aggregates Working Party Annual Monitoring Report (2017).

Ref 15.7: Mineral Products Association, Profile of the UK Mineral Products Industry, 2018 Edition.

Ref 15.8: House of Commons Library UK Steel Industry: Statistics and Policy (2018).

Ref 15.9: Norfolk County Council (2011) Core Strategy and Minerals and Waste Development Management Policies. Development Plan Document 2010-2026.

Ref 15.10: Defra (2019) UK Statistics on Waste.

Ref 15.11: Environment Agency, Waste Data Interrogator (2017) Waste Management Information 2017: East England.

Ref 15.12: Environment Agency, Remaining Landfill Capacity, England (2017).

Ref 15.13: Waste and Resources Action Programme (WRAP) Waste Recording and Reporting Guidance.

16 Geology and Soils

16.1 Introduction

16.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Scheme on geology and soils.

16.1.2 The assessment of this topic area considers potential impacts relating to the following receptors:

- Effects on geology and soils;
- Effects on human health (site users and adjacent site users including construction workers);
- The disturbance of potentially contaminated soils (including river sediments) and the potential for construction to establish pathways between contaminants and receptors are also discussed;
- Effects on infrastructure in the operational phase (including new buildings and foundations); and
- Effects on controlled waters, specifically from the mobilisation of contaminants is discussed and considered. Reference should also be made to Chapter 11: Road Drainage and the Water Environment which covers wider hydrogeological issues including road drainage and the water environment.

16.1.3 Effects on ecological receptors are reported in Chapter 8: Nature Conservation.

16.1.4 This chapter describes the assessment methodology, the baseline conditions at the Principal Application Site and in the surrounding area and mitigation adopted for the purposes of the assessment. It includes a summary of the likely significant effects taking into account national legislation, and describes the further mitigation measures required to prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

16.1.5 This chapter (and its associated figure and appendices) is intended to be read as part of the wider ES with particular reference to Chapter 8: Nature Conservation and Chapter 11: Road Drainage and the Water Environment and the following Appendices and Figure:

- Appendix 16A Legislation, Policy and Guidance;
- Appendix16B Interpretative Environmental Desk Study Report;
- Appendix 16C Interpretative Environmental Ground Investigation Report;
- Appendix 16D – Piling Works Risk Assessment Report;
- Figure 16.1.

16.2 Competent Expert

16.2.1 The geology and soil lead, Neil Balderstone is a Senior Environmental Consultant who holds a BSc (Hons) degree in Geology from Royal Holloway College, University of London and a MSc degree in Mining Geology from Camborne School of Mines. He has in excess of 18 years experience in geology, soils and contaminated land assessment.

16.2.2 He has experience of giving technical advice and liaising with stakeholders including clients, Local Authority Environmental Health Officers and Environment Agency officers regarding contaminated land assessments, liability, determinations under the Part 2A regulatory process, remediation, waste issues and the discharge of planning conditions associated with contaminated land.

16.2.3 He has recently prepared Geology and Soils Chapters for EIA for a number of large infrastructure / highway schemes including Lake Lothing third river crossing in Lowestoft, Oxon Link Road near Shrewsbury and A338 Wessex Fields near Bournemouth.

16.3 Legislation, Policy and Guidance Summary

16.3.1 Table 16.1 provides a summary of the key legislation, policy and guidance for this assessment.

16.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 16A.

Table 16.1: Summary of Key Legislation, Policy and Guidance

Legislation	Summary	Chapter Reference
National Networks National Policy Statement (Ref 16.14)	The NPS NN provides some guidance on assessing geology, soils and contamination and	This Chapter conforms with the policy statement by assessing the likely significant effects on designated geological

Legislation	Summary	Chapter Reference
	sets out how the impacts should be considered. Paragraph 5.22 of the NPS NN states: "*Where the project is subject to EIA the applicant should ensure that the environmental statement clearly sets out any likely significant effects on internationally, nationally and locally designated sites of ecological or geological conservation importance....*" Paragraph 5.168 of the NPS NN states: *For developments on previously developed land, applicants should ensure that they have considered the risk posed by land contamination and how it is proposed to address this".* *The NPS NN also provides some guidance on land stability in paragraphs 5.116 to 5.119.*	sites. It also assesses risks posed by land contamination (ground investigation and human health and controlled waters risk assessments) and includes remedial options for addressing the identified contamination. Land stability is also assessed. See Sections 16.6, 16.7 16.8, 16.9 and 16.11
National Policy Statement for Ports (Ref 16.15)	The NPS for Ports, in Paragraph 5.13.8, likewise advises that developments on: "… *previously developed land……should ensure that they have considered the risk posed by land contamination"*.	This Chapter conforms with the policy statement by considering the risk posed by land contamination through ground investigation and human health and controlled waters risk assessments. See Sections 16.6, 16.7, 16.8, 16.9 and 16.11
National Planning Policy Framework (Ref 16.13)	The NPPF Section 15 provides guidance on conserving and enhancing the natural environment	This Chapter conforms to the policy framework by assessing soil and water pollution and land

Legislation	Summary	Chapter Reference
	and paragraphs 170 and 178 to 180 specifically reference contaminated land. Sub-sections (e) and (f) of Paragraph 170 of the NPPF states that: *"Planning policies and decisions should contribute to and enhance the natural and local environment by:* *e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and* *f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate".* Paragraph 178 of the NPPF states that: *"Planning policies and decisions should ensure that:* *a) site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability*	instability and proposing remediation / mitigation where appropriate. This Chapter assess whether the Principal Application Site is suitable for the proposed use (in the context of this chapter) and the remediation proposed will result in the site not being capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990. Adequate site investigation is available and has been used to inform these assessments. The Chapter assesses the likely effects of pollution on health and the natural environment and also assesses the impacts to the site and wider area from the development. See Sections 16.6, 16.7, 16.8, 16.9 and 16.11

Legislation	Summary	Chapter Reference
	and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation); *b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and* *c) adequate site investigation information, prepared by a competent person, is available to inform these assessments".* Paragraph 179 of the NPPF states that: *"Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner".* Paragraph 180 of the NPPF states that: *"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living*	

Legislation	Summary	Chapter Reference
	conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development".	
The Environmental Protection Act 1990 (Ref 16.12)	The Environmental Protection Act 1990 defines, within England, Wales and Scotland, the fundamental structure and authority for waste management and control of emissions into the environment. The Environmental Protection Act 1990 was intended to strengthen pollution controls and support enforcement with heavier penalties. Part 2A of the Environmental Protection Act 1990 was inserted into that Act by s57 of the Environment Act 1995 and contains a regulatory regime for the identification and remediation of contaminated land. In addition to the requirements contained in the primary legislation, operation of the regime is subject to regulations and statutory guidance. The main objective underlying the introduction of the Part 2A contaminated land regime was to provide an improved system for the identification and remediation of land where	This Chapter addresses the needs of the Environmental Protection Act through the ground investigation, human health and controlled waters risk assessments and preparation of a conceptual site model to assess sources of contamination, receptors and pathways, culminating in an assessment of contaminant linkages. See Sections 16.6, 16.7 and16.8.

Legislation	Summary	Chapter Reference
	contamination is causing unacceptable risks to human health or the wider environment, assessed in the context of the current use and circumstances of the land. It also works alongside planning rules to help ensure that this land is made suitable for use following development. Development of land will have to take into account Part 2A because a change in the use of the land may bring the development inside the statutory definition of contaminated land by creating new or different receptors and/or pathways, resulting in new contaminant linkages.	

16.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

16.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

16.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

16.4.3 Table 16.2 and 16.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 16.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
"The Scoping Report indicates a search area for designated sites up to 500m from the 'proposed scheme'. The Scoping Report does not explicitly scope out assessment of impacts on designated sites but states that they are unlikely, given that none were found within the study area. The Inspectorate advises that the study area for the assessment must be based on the potential geographical extent of the anticipated impacts and justified accordingly. *The Scoping Report does not state if the term 'proposed scheme' refers to the area shown on Drawing 62240375-GYTRC-Scoping Report Boundary – 20188219 (provided in Appendix B of the Scoping Report). The ES should clearly set out the study area applied, in relation to the proposed DCO boundary."*	PINS ref - 4.11 - ID 2	Topics scoped into the EIA and associated study area are outlined in Section 16.1 and 16.4 respectively. The study area for the assessment has been clarified to incorporate the potential geographical extent of the anticipated impacts. The ES now sets out clearly the study area applied in relation to the proposed DCO boundary. See Section 16.4.
"The results of the ground investigations should be fully reported in the ES, by way of an appendix if appropriate, where this information has been used to inform the assessment of environmental effects."	PINS ref - 4.11 - ID 3	The results of the ground investigation are summarised in Sections 16.4, 16.5 and 16.6 of this chapter and Appendix 16C presents the Interpretative Environmental Ground Investigation Report.
"The proposed ground investigations should also include consideration of the		Appendix 16B presents an assessment of waste classification and soil re-

Scoping Opinion Item	Consultee	Response
available minerals resource to determine whether any onsite material extracted as part of the construction of the Proposed Development could be suitable for reuse."		use suitability and this is summarised in the ES.
"Where relevant, cross-reference should be made to the Materials aspect chapter."		References to Chapter 15: Materials included.
"The assessment of potential impacts to the River Yare pSPA (potential Special Protection Area) (NB. this has been formally designated as the Outer Thames Estuary SPA) described in the Geology and Soils aspect chapter is likely to inform the assessment of ecological effects for the Proposed Development, and the ES should take into account interrelationships between these environmental aspects. Information and assessments contained within the Geology and Soils will also be applicable to the Water Environment chapter. The Inspectorate expects to see cross-referencing between the Geology and Soils and relevant aspect chapters in the ES, as appropriate."	PINS ref - 4.11 – ID 4	Cross-references included throughout this chapter including to Chapter 8: Nature Conservation and Chapter 11: Road Drainage and the Water Environment (document reference 6.1).
"Inspectorate acknowledges the statement regarding an absence of specific methods of assessment for the geology and soils impact assessment, and the intention to use assessment procedures contained within BS10175:2011 and CLR11, including CIRIA C552, in a	PINS ref – 4.11 – ID 5	Noted. See Section 16.4 for more information on the assessment methodology.

Scoping Opinion Item	Consultee	Response
phased approach together with professional judgement".		
"The ES should clearly describe the assessment methodology applied to the aspect chapter. The ES must state whether residual effects are significant. Where professional judgement has been used in the assessment, this should be stated in the ES."		Residual effects have been assessed and professional judgement highlighted when used throughout this chapter. Assessment of significance is presented in Section 16.10.
"The intention to produce a remediation strategy (where contaminant linkages are present) is noted and the Inspectorate advises that the ES should clearly set out where mitigation has been applied to the assessment and the implications for residual effects. The ES must demonstrate how any mitigation measures on which the assessment has relied will be secured."	PINS ref – 4.11 – ID 6.	A remediation strategy is presented in Appendix 16C and is also detailed in Section 16.10 of this Chapter including the assessment of implications for residual effects and how the mitigation will be secured.

Table 16.3: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
"The current submission does not include a specific section summarising the potential public health impacts. We understand that the promoter will wish to avoid unnecessary duplication and that many issues including air quality, emissions to water, waste, contaminated land etc. will be covered elsewhere in the ES, but we believe that the summation of relevant issues into a specific section of the	Public Health England 4th May 2018 ref 43557	Health impacts are discussed in Chapter 4: Approach to EIA and where appropriate this chapter includes the summation of the identified contaminated land issues, mitigation and residual impacts (Sections 16.7 and 16.10, and Table 16.9).

Section 42 Item	Consultee	Response
report provides a focus which ensures that public health is given adequate consideration and due weight in the planning process. Such a section should summarise key information, risk assessments, outline any proposed mitigation, and identify any residual impacts or uncertainties. Compliance with the requirements of National Policy Statements and relevant guidance and standards should also be highlighted."		

16.4.4 Table 16.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

16.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 16.4: Summary of Consultation Undertaken to Date

Body / Organisation	Individual	Meeting Dates and Other Forms of Consultation	Summary of Outcome of Discussions
Environment Agency	Contaminated Land Team via Sustainable Places Planning Advisor.	Online submission of Appendix 16C Interpretative Ground Investigation Report on 19th February 2019.	Comments received by email on 11th March 2019.

Insignificant Effects

16.4.6 No insignificant effects have been identified in the preparation of this chapter.

Likely Significant Effects

Construction Phase

16.4.7 Likely significant effects identified and assessed in this chapter comprise:

- Disturbance of contaminated ground during earthworks resulting in mobilisation of contaminants impacting controlled waters or human health receptors;
- Disturbance of contaminated ground during earthworks resulting in release of contaminated dust during periods of dry weather;
- Disturbance of geological strata resulting in changes to the groundwater regime and soil drainage including creation of new pathways for migration of mobile contaminants;
- Potential for ground instability and potential effects on construction workers and infrastructure; and
- The construction works and plant causing pollution through spillages or leaks from fuel storage bowsers or equipment.

Operation Phase

16.4.8 Likely significant effects identified and assessed in this chapter comprise:

- Potential exposure of future site users and third parties to surface contamination and associated effects on human health;
- Potential build-up of ground gas or landfill gas within operation building / kiosk, exposing staff to risk of asphyxiation or explosion; and
- Potential for mobile contaminants to be released from contaminated soils to impact controlled waters.

Extent of the Study Area

16.4.9 The study area covers an area of approximately 43ha, centred at National Grid Reference 652320, 306005 and this is shown on Figure 16.1.

16.4.10 The assessment for the construction phase and operational phase considers the Principal Application Site only. The Satellite Application Sites have not been considered as works here are considered to be negligible in duration and extent. The Satellite Application Sites do not include any significant excavation or interaction with geology, soils or contamination and no ground investigation was undertaken in these areas. In this chapter and the accompanying appendices, for simplicity, the Principal Application Site has

been split into two – eastern site area and western site area, divided by the River Yare.

16.4.11 The Study Area was defined early in the process and incorporated a larger area than the Principal Application Site in order to inform the ground investigation design.

Method of Baseline Data Collation

Desk Study

16.4.12 An Interpretative Environmental Desk Study Report is presented as Appendix 16B. The objective of the desk study was to assess the potential environmental risks, constraints and liabilities associated with the Scheme and includes: an interpretation of the information obtained from a GroundSure Report; a preliminary assessment of potential geo-environmental risks following the methodology of CLR11 (Ref 16.3).

16.4.13 The boundary of the assessment is the Principal Application Site boundary, although a 1,500m search area from the boundary for sites of geological interest is used together with a 250m search area for sites such as gasworks, landfills, dye works and bleach works, which can be particularly contaminated and from which contamination could have migrated into the Principal Application Site.

16.4.14 The Interpretative Environmental Desk Study Report (Appendix 16B) used information from historical Ordnance Survey maps and environmental data reports together with published and internet based information sources.

16.4.15 An understanding of the likely existing environmental setting in terms of geology, soils and contamination has been established with reference to the following sources of information:

- British Geological Survey (BGS) – geological mapping including bedrock and superficial geology information;
- Environment Agency – aquifer designation information; and
- CentremapsLive - GroundSure report comprising historical Ordnance Survey maps and environmental data reports obtained from GroundSure.

16.4.16 The assessment has been based upon the guidance presented in DMRB Volume 11 Section 3 Part 11 Geology and Soils (Ref 16.1) and has been supplemented by the assessment procedures contained within BS10175:2011 (Ref 16.2) and CLR11 (Ref 16.3).

Site Visit

16.4.17 A site visit was undertaken on 12th July 2017 for the purposes of the Interpretative Environmental Desk Study Report (Appendix 16B). A competent expert also had a part-time presence on site during the Ground Investigation.

Ground Investigation Surveys

16.4.18 The Ground Investigation commenced on 18th September 2017 and was completed on 14th July 2018 and comprised:

- 25 onshore cable percussion boreholes;
- 16 window samples;
- Soil and groundwater sampling and chemical testing;
- Construction of gas and groundwater monitoring wells in selected boreholes;
- Gas and groundwater monitoring; and
- 10 offshore cable percussion boreholes (including sediment sampling within the River Yare for contamination testing).

16.4.19 An Interpretative Environmental Ground Investigation Report (Appendix 16.C) has been prepared using the information gathered from the ground investigation. This includes: human health; controlled waters and ground gas risk assessments undertaken in accordance with:

- CLR and SR (SC050021 series) (DEFRA) guidance (Ref 16.10) as well as CL:AIRE guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008 (Ref 16.11);
- Environment Agency Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, 2006 (Ref 16.5); and
- Assessing Risked Posed by Hazardous Ground Gases to Buildings (CIRIA) C665, dated 2007 (Ref 16.7).

16.4.20 A waste classification and re-use assessment has also been undertaken to assess potential disposal routes for soils excavated during construction. Chapter 15: Materials further discusses re-use of site won materials during construction of the Scheme.

16.4.21 The human health, controlled waters and ground gas risk assessments have assessed the potential contaminant linkages identified in the Interpretative

Environmental Desk Study Report (Appendix 16B). This has resulted in the development of an updated conceptual site model (CSM) (presented in Appendix 16C Interpretative Environmental Ground Investigation Report) including potential source-pathway-receptor contaminant linkages, and to assist with the assessment of potential impacts on human health and controlled waters.

16.4.22 A Piling Works Risk Assessment (presented as Appendix 16D) has been prepared to assess the likely impact on controlled waters and underlying geology from any piling works.

Assessment Methodology

16.4.23 In terms of geological and geomorphological resources as well as contaminated land, DMRB Volume 11 Section 3, part 11: Geology and Soils (Ref 16.1) does not provide any specific methods of assessment or scales of measurement for either the value and sensitivity of the receptor, or the magnitude of the impact. Assessment has therefore been based on the assessment procedures detailed in CLR11 (Ref 16.3) using a phased approach and taking into account professional judgement and knowledge of similar schemes (including Lake Lothing in Lowestoft, A338 Wessex Fields near Bournemouth and Oxon Link Road near Shrewsbury), to inform a quantitative risk assessment.

16.4.24 CLR11 (Model Procedures for the Management of Land Contamination) (Ref 16.3) outlines the framework to be followed for contaminated land risk assessment in the UK. The framework is designed to be consistent with UK legislation and policies including planning. Under CLR11, three stages of contaminated land assessment exist: preliminary, generic quantitative and detailed quantitative.

16.4.25 Preliminary Risk Assessment: The desk study report (Appendix 16B) forms the preliminary risk assessment where the Study Area is assessed for its environmental status including geological setting, hydrogeological and hydrological setting, historical site uses and current site uses. An outline conceptual model is developed at the preliminary risk assessment stage which collates all the existing information pertaining to a site in a tabular form. The outline conceptual site model identifies potentially complete (termed possible) pollutant linkages (source–pathway–receptor) and is used as the basis for the design of the site investigation. The outline conceptual site model is updated as further information becomes available, for example as a result of the site investigation. Production of a conceptual model requires an assessment of risk to be made. Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, both the likelihood and the consequences of an event must be taken into account when assessing risk. CIRIA C552 (Ref 16.9) provides the guidance for producing conceptual site models.

16.4.26 The likelihood of an event can be classified on a four-point system using the following terms and definitions based on CIRIA C552 (Ref 16.9):

- highly likely: the event appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution
- likely: it is probable that an event will occur or circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term
- low likelihood: circumstances are possible under which an event could occur, but it is not certain even in the long term that an event would occur and it is less likely in the short term
- unlikely: circumstances are such that it is improbable the event would occur even in the long term.

16.4.27 The severity can be classified using a similar system also based on CIRIA C552.

16.4.28 Once the likelihood of an event occurring and its severity have been classified, a risk category is assigned.

16.4.29 Once the preliminary conceptual site model has been developed, it informs the design of the ground investigation and the potentially significant contaminant linkages are targeted. Human health and controlled waters risk assessments are undertaken using data gathered during the ground investigation and the results are used to further develop the conceptual site model. Detailed quantitative risk assessment (DQRA) is used where it is considered necessary to further assess potentially significant contaminant linkages. The developed conceptual site model is then used to inform the design of remedial measures that will reduce the risk category of the contaminant linkage to acceptable levels (ie low or very low).

16.4.30 Without each of the three fundamental elements (source, pathway and receptor), there can be no risk from contamination. Thus, the presence of a contamination source does not necessarily imply the existence of associated risks.

Sensitivity of Receptors

16.4.31 In the absence of any specific methods of assessment or scales of measurement for either the value and sensitivity of the receptor, or the magnitude of the impact in DMRB Volume 11 Section 3, part 11: Geology and Soils (Ref 16.1), the sensitivity of the affected receptor is assessed on a scale of high, medium, low and negligible, and the magnitude of change is assessed on a scale of major, moderate, minor, negligible and no change.

This deviates slightly from the method detailed in Chapter 4: Approach to EIA.

16.4.32 The sensitivity of the receptors is determined through a combination of professional judgement and the environmental value of receptors, as recognised or determined by various criteria. For example:

- Environment Agency water quality ratings and groundwater vulnerability in the case of controlled water receptors, e.g. Principal Aquifers are widely used for drinking water abstraction and are therefore more sensitive than a Secondary (B) aquifer where drinking water abstraction is minimal;

- Ecological / scientific designation in the case of geological, hydrological or habitat features such as SSSI or RIGS, e.g. SSSI are of national interest and are therefore more sensitive than regionally important sites such as RIGS and peat soils and associated high soil moisture levels, particularly in extensive areas as found in blanket bog, are considered to be of high sensitivity compared to soils in urban environments; and

- Use of the site in the case of human health, e.g residential properties with gardens are likely to have children present 24hours a day who could ingest contaminated soil and vegetables may be grown in the soils which could uptake contaminants to the food chain. These are therefore more sensitive than industrial properties where only hard standing or minimal landscaping is present, there are no children and very little if any interaction with soils occur.

16.4.33 Guidance and examples of the sensitivity of the receptors are outlined in Table 16.5.

Impact Magnitude

16.4.34 The criteria for assessing the magnitude of potential impacts (Table 16.6) reflects the extent of the change produced. The assessment of impact magnitude is based on technical judgement and, where possible, scientific quantification such as exceedance of controlled waters or human health risk assessment screening values. For example:

- Following human health and / or controlled waters risk assessments, identification of a source of contamination and an active contaminant linkage within the conceptual site model that is likely to result in a possible designation of the site as ‘contaminated land’ under Part 2A of

the Environmental Protection Act would be classified as a major adverse magnitude; and

- Loss of a designated geological SSSI e.g. construction of a highway over part of a quarry where an exposed rock face was a SSSI would also be classified as a major adverse magnitude.

Impact Significance

16.4.35 The significance of an impact is defined by the sensitivity of identified receptor and the magnitude of the impact, as shown in Table 16.7. The table provides a guide to assist in decision making. However, it should not be considered as a substitute for professional judgement and interpretation. For example:

- A sensitive receptor such as a residential property where vegetables are grown (high sensitivity) would be considered to have a very large significance should gross contamination be present. However, a low sensitivity receptor such as a highway where hard standing prevents interaction between the human receptor and the gross contamination may only have a moderate sensitivity.

- A Principal Aquifer underlying a site may be of high sensitivity due to numerous drinking water abstractions and a small deterioration due to downward migration of contamination could represent a very large (significant) effect. However, a Principal Aquifer underlying an industrial coastal environment may have poor water quality due to saline intrusion due to the coastal environment and previous impacts due to the overlying industrial heritage. Downward migration of contamination in this case may not impact the water quality and could represent only a slight (not significant) effect.

Significance Criteria

16.4.36 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Scheme and the sensitivity of the affected receptor, as well as a number of other factors that are outlined in more detail in Chapter 4: Approach to EIA.

16.4.37 The likely significant environmental effects are assessed based on consideration of receptors and the predicted magnitude of the potential effects. The magnitude of the affected receptor / receiving environment is assessed as substantial, moderate, minor or negligible and the sensitivity is

assessed on a scale of high, medium, low and negligible. Example receptor sensitivity and magnitude of impact scenarios based on professional judgement and experience are provided in Tables 16.5 and 16.6 below. This has informed a matrix of determining significance in Table 16.7, effects that are deemed moderate, large or very large are deemed significant.

Table 16.5: Sensitivity Criteria

Sensitivity	Description
High	• Areas containing geological, hydrological or habitat features considered to be of national interest, for example Sites of Special Scientific Interest (SSSI). • Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. • Study area located within a Source Protection Zone (SPZ) 1 or 2. • Underlying Principal Aquifer. • Wetland/watercourse of Good Ecological and or Chemical Potential (Water Framework Directive (WFD)). • Residential end uses.
Medium	• Areas containing features of designated regional importance, for example Regionally Important Geological and Geomorphological Sites (RIGS), considered worthy of protection for their educational, research, historical or aesthetic importance. • Study area located within an SPZ Zone 3. • Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. • Underlying Secondary (A) Aquifer. • Wetland/watercourse of Moderate Ecological and / or Chemical Potential (WFD). • Commercial buildings including foundations.
Low	• Geological features not currently protected and not considered worthy of protection.

Sensitivity	Description
	• Low permeability superficial deposits likely to inhibit the transport of contaminants. • Underlying Secondary (B) Aquifer. • Study area not located within an SPZ. • Wetland/watercourse of Poor Ecological and/or Chemical Potential or no WFD classification. • Highways and pedestrian footpaths.
Negligible	• No sensitive environmental receptors identified.

Table 16.6: Magnitude Impact Criteria

Magnitude	Description
Major	Adverse: • Greater than 50% loss of a study area of recognised geological importance. • Significant contamination identified – screening values for protection of Controlled Waters or human health exceeded by more than one order of magnitude in more than 50% of samples. Possible designation of the Principal Application Site as 'contaminated land' under Part 2A of the Environmental Protection Act 1990. • Greater than 50% partial damage or loss of building or infrastructure.
	Beneficial: • Improved access / protection for a study area of recognised geological importance. • Remediation of Part 2A site, breaking a pathway that was resulting in SPOSH (Significant Possibility of Significant Harm). Resulting in improved protection to human health and controlled water receptors.
Moderate	Adverse: • Partial loss (between approximately 25% to 50%) of a study area of recognised geological importance.

Magnitude	Description
	• Exceedance of one order of magnitude or less of human health or controlled water screening value in between 25% and 50% of samples. Localised or marginal contamination resulting in the need for some localised remediation. • 25% to 50% partial damage of buildings and infrastructure.
	Beneficial: • Remediation of potential Part 2A site resulting in improved protection to human health or controlled water receptors.
Minor	Adverse: • Minor effect (a loss of between 10% and 25%) on a study area of recognised geological importance. • Minor contamination identified – between 10% and 25% of samples exhibit exceedance of less than one order of magnitude of human health or controlled water screening values. • 10% to 25%) partial damage of buildings and infrastructure.
	Beneficial: • Remediation of localised contamination resulting in improvement to soil and groundwater quality.
Negligible	Adverse: • Minimal contamination identified – up to 10% of samples exhibit exceedances of less than one order of magnitude of human health or controlled water screening values. • Minimal effect (partial damage of less than 10% of buildings and infrastructure.
	Beneficial: • Remediation of localised contamination resulting in improvement to soil or groundwater quality.
No Change	• No change from baseline conditions. • No contamination above relevant thresholds identified. • No damage or loss of buildings and infrastructure.

Table 16.7: Matrix for Determining Significance

		Magnitude of Impact				
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
Importance / Sensitivity / Value	**High**	Neutral	Slight	Moderate	Large	Very Large
	Medium	Neutral	Neutral	Slight	Moderate	Large
	Low	Neutral	Neutral	Neutral	Slight	Moderate
	Negligible	Neutral	Neutral	Neutral	Neutral	Slight

16.5 Baseline Conditions

Designated Sites

16.5.1 No geological designated sites exist within 1,500m of the Principal Application Site.

Bedrock Geology

16.5.2 As indicated on the BGS website the bedrock geology within the Principal Application Site comprises the Crag Group (sands, gravels, silts and clays) with London Clay underlying this at depth.

16.5.3 The EA designates the Crag Group as a Principal Aquifer. However, the British Geological Survey designates the Crag Group as a Secondary A Aquifer in the area of Great Yarmouth. For the purposes of this ES, to be conservative, the Crag Group is considered a Principal Aquifer. Further information is presented in Chapter 11: Road Drainage and the Water Environment.

16.5.4 The London Clay is considered to be unproductive.

16.5.5 Chalk underlies the London Clay at depth and forms the deep regional bedrock aquifer.

Superficial Geology

16.5.6 The BGS website indicates that the superficial deposits immediately underlying the Principal Application Site varies as follows:

- South west – peat of the Breydon Formation;
- North – clay and silt of the Breydon Formation;
- Eastern part beyond the River Yare – sand and gravel of the North Denes Formation; and
- Within the River Yare – clay and silt Tidal River or Creek deposits.

16.5.7 The superficial geological units are generally classified as Secondary A aquifers.

Land Stability

16.5.8 The GroundSure Report presented as Annex B to the Interpretative Environmental Desk Study Report (Appendix 16B), provides the following details on land stability. The Principal Application Site is not underlain by historical mining, coal mining activities, non-coal mining activities, non-coal mining cavities, natural cavities, brine extraction, gypsum extraction, tin mining, kaolin or ball clay and none are recorded within 1,000m of the study area.

16.5.9 The GroundSure Report also provides the following information on natural ground subsidence:

- Shrink-swell clay: Negligible to low risk;
- Ground dissolution of soluble rocks: Negligible risk;
- Compressible deposits: Negligible to high risk;
- Collapsible deposits: Negligible to very low; and
- Running sands: Very low to moderate risk.

16.5.10 The Scheme involves significant earthworks and infrastructure to be constructed close to a river and quay wall. The potential loadings are high and could lead to land stability issues close to the quay wall if the foundations are insufficient. Piled foundations are therefore proposed for both the highway embankments and the bridge structure / cofferdam and therefore land stability issues are not considered likely to exist with suitable foundation design and construction working practices and are not considered further.

Soils and Sediment

16.5.11 The Soilscapes website (Ref 16.4) indicates the soils to the Principal Application Site to the west of the River Yare comprise loamy and clayey soils of coastal flats with naturally high groundwater. To the east of the River Yare, the majority of the Principal Application Site is underlain by freely draining slightly acid sandy soils but a thin sliver of loamy and clayey soils of coastal flats with naturally high groundwater is present immediately adjacent to the river.

16.5.12 Due to previous development within the Principal Application Site, naturally occurring soils were only occasionally encountered at the surface during the Ground Investigation and made ground is more prevalent at the surface.

Potentially Contaminated Sites

16.5.13 The Interpretative Environmental Desk Study Report (Appendix 16B) includes a review of information from a GroundSure Report. This records that no locations within the Principal Application Site are determined as contaminated land under Part 2A of the Environmental Protection Act 1990. However, a number of historical ground workings are recorded, all associated with the River Yare quay and wharf area, all of which may have introduced contaminated material into the study area. In addition, historical railway sidings are recorded in the eastern part of the study area.

16.5.14 There is one record relating to an Environment Agency licensed landfill in the south west corner of the study area. GroundSure Report records this as a household, commercial and industrial waste transfer station accepting between 25,000 tonnes and 75,000 tonnes annually.

2017/2018 Scheme-Specific Ground Investigation

16.5.15 A ground investigation was undertaken by Norfolk Partnership Laboratory (contracted to the Applicant) between the 18th September 2017 and 14th July 2018 with the purpose of assessing ground conditions within the Principal Application Site. The works undertaken are detailed in 16.3.17 and the Interpretative Environmental Ground Investigation Report (Appendix 16.C).

16.5.16 Engineer's logs and chemical test results are presented in Annex D of the Interpretative Environmental Ground Investigation Report (Appendix 16C).

16.5.17 Figure 16.1 presents the exploratory hole locations. Engineer's logs and chemical test results are presented in Annex C of the Interpretative Environmental Ground Investigation Report (Appendix 16C).

16.5.18 The Interpretative Environmental Ground Investigation Report (Appendix 16C) includes human health and controlled waters risk assessments, gas risk assessments and waste classification or re-use assessments, which have informed the need for mitigation measures.

Made Ground – Eastern Area

16.5.19 In the eastern area, made ground was recorded at almost all exploratory hole locations (absent from BH15) and varied in thickness from 0.55m to 4.8m. The thickness of made ground varied across the Principal Application Site with the thicker made ground generally recorded close to the quay wall.

16.5.20 The made ground was generally granular and heterogenous in nature and included detritus comprising; brick, wood, concrete, porcelain, asphalt, ceramics and metal. However, BH12A and BH13A both recorded brick and concrete within natural strata at depth (5.9m and 3.5m respectively), indicating this material may be reworked rather than being in-situ natural strata.

Made Ground – Western Area

16.5.21 In the western area, made ground was recorded at almost all exploratory hole locations (absent from WS8) and varied in thickness from 0.4m to at least 4.2m (BH4D towards the south west corner of the Principal Application Site), although the base of the made ground was not encountered in WS2 at 2m depth and therefore may be deeper.

16.5.22 The thickness of made ground varied across the western Principal Application Site area and although thick made ground was recorded close to the quay wall, the thickest made ground was not recorded in this area.

16.5.23 The made ground was generally granular and heterogenous in nature and included detritus comprising concrete, asphalt, tile, brick, ceramic, pottery, wood, ash, leather, metal, glass, plastic, mortar and slag. BH5A at 2.0 m recorded brick gravel within the Breydon Formation indicating this layer is likely to be made ground rather than in-situ natural strata.

Concrete, Tarmac and Structures

16.5.24 Solid concrete was recorded at most locations in the east area of the Principal Application Site and was recorded up to 0.65m thick. However, only a few locations in the west area of the Principal Application Site recorded concrete, up to 0.5m thick.

16.5.25 Tarmac up to 0.2m thick was recorded at five locations in the western Principal Application Site area but was absent from the eastern Principal Application Site area.

16.5.26 No pipes or underground structures were recorded during the ground investigation.

Tidal River or Creek Deposits

16.5.27 Tidal River or Creek Deposits cannot always be differentiated from the underlying Breydon Formation. Those that can be differentiated are located in the eastern area and typically comprised a dark grey to black, silty, variably organic clay, and a sandy, clayey silt interbedded with light brown to black, fine to coarse Sand with occasional flint gravel and pockets of organic material.

North Denes Formation

16.5.28 The North Denes Formation was only encountered in the eastern site area and was typically described as a very loose to dense yellowish-brown fine to course sand with some rare gravels described as angular to sub-rounded fine to gravel of flint and quartz and some rare thin silt and clay bands.

Breydon Formation

16.5.29 The Breydon Formation was encountered in most boreholes in both the western and eastern areas. In the west the Breydon Formation was encountered as either granular, cohesive or peat material. The Breydon Formation peat was encountered predominantly towards the west and south of the study area but was also found in thinner layers close to the river. The cohesive and granular materials were encountered as interbedded layers of varying thicknesses across the Principal Application Site.

16.5.30 Some strata within the Breydon Formation was encountered as quartz and quartzite gravels within a granular matrix. This material was encountered across both the western and eastern Principal Application Site areas and was typically described as a loose to medium dense, grey, slightly silty sand and gravel, where the gravels are fine to medium, angular to rounded flint and quartz with some rare limestone gravels and shells.

Happisburg Glacigenic Formation

16.5.31 The Happisburg Glacigenic Formation was found to underlay the Breydon Formation in the east of the Principal Application Site but in the western part of the Principal Application Site, it was occasionally absent, partly replaced by the granular and cohesive layers of the Breydon Formation.

16.5.32 The Happisburg Glaciogenic Formation was typically described as a loose to medium dense, light brown to orange-brown, fine to coarse though predominantly medium, variably silty sand with rare fine gravels. The Sand

contains variable amounts of angular to rounded, fine to coarse flint gravel. Some cohesive deposits were encountered within the strata as firm to stiff orange-brown laminated sandy silt and clay, with olive grey clay banding.

Crag Group

16.5.33 The Crag Group was encountered across the entire study area underlying the Happisburg Glacigenic Formation as dense to very dense, grey to dark grey, fine to medium grained silty sand with frequent white shell fragments, with some fine gravel and occasional soft to firm silty clay layers.

London Clay

16.5.34 London Clay was encountered at depth (approximately 45m below ground level) underlying the Crag Formation as a stiff to very stiff, brown grey, sometimes laminated silty clay. Some rare flint gravels and gypsum crystals were encountered.

Saline Intrusion

16.5.35 An assessment of saline intrusion concludes that the most recent two sets of groundwater test results included electrical conductivity results which suggests some influence from seawater across the study area, particularly in BH4, BH4D (shallow), BH4D (deep), BH7, BH11 and BH12B. This is discussed further in Chapter 11: Road Drainage and the Water Environment.

Hydraulic Connectivity

16.5.36 The superficial deposits are considered to be in hydraulic continuity with the Crag Group due to the absence of any low permeable strata separating these aquifers. The mixing of groundwater between the hydrogeological units is considered likely from the similar groundwater quality characteristics and the proximity to the River Yare.

16.5.37 The regional Chalk Group aquifer (not encountered during the ground investigation) is considered to be protected by the overlying London Clay Formation within the study area, which significantly reduces the potential for groundwater pollution of the chalk.

16.5.38 Further details on the hydraulic connectivity are presented in Chapter 11: Road Drainage and the Water Environment.

16.6 Preliminary Conceptual Site Model

16.6.1 In accordance with the CIRIA C552 (Ref 16.9) guidance, the Desk Study Report (Appendix 16B) presents a preliminary conceptual site model

including potential source-pathway-receptor contaminant linkages which is then used to inform the ground investigation.

Potential Contamination Sources

16.6.2 Potential sources of contamination relate to historical uses of the Principal Application Site.

16.6.3 Made ground (and possibly also natural ground) may contain contaminants at concentrations that could pose a risk to human health and controlled waters. Made ground can also generate gases including carbon dioxide and methane that could pose a risk to buildings and human health.

Potential Pathways

16.6.4 Potential pathways which may exist or become apparent during construction and / or once the Scheme is constructed and operational are as follows:

- Human health – ingestion of or dermal contact with contaminated soils or inhalation of contaminated dust, organic vapours or ground / landfill gas; and
- Controlled waters – vertical and lateral migration of mobile contaminants into groundwater and / or surface water, surface run off and direct spills. This includes the potential for piling works to create new migration pathways which is discussed in more detail in Appendix 16D Piling Works Risk Assessment.

Potential Sensitive Receptors

16.6.5 Table 16.8 below summarises the sensitive receptors which have been assessed. The sensitivity has been derived from the matrix in Table 16.7.

Table 16.8: Matrix for Determining Significance

Aspect	Sensitive Receptor	Sensitivity
Human Health	Site users (including children) Adjacent site users Construction and maintenance workers	Medium
Controlled Waters	River Yare surface watercourse Principal Aquifer	High
	Secondary A Aquifer	Medium
Infrastructure	Piled foundations	Medium
	Bridge Control Room / Kiosk	Medium

16.7 Ground Investigation Contaminated Land Risk Assessment

16.7.1 This Section summarises the findings of the human health and controlled waters risk assessment to inform the Environmental Statement of how contamination could be affected /mobilised by the Scheme and the knock-on effect on humans and the environment. It forms part of the baseline assessment and sets out the baseline contamination status of the Principal Application Site. From this, remedial measures can be developed to be protective of human health, controlled waters and the environment.

Risk Assessment Methodologies

16.7.2 A human health risk assessment was undertaken to identify potential risks to site users and adjacent site users from contamination within the study area and is presented in the Interpretative Environmental Ground Investigation Report presented in Appendix 16C.

16.7.3 The presence of contamination within soil or groundwater at a site is generally only of concern if an actual or potentially unacceptable risk to a receptor exists.

16.7.4 The risk assessment process begins with screening chemical concentrations in soil or groundwater against conservative screening values to identify the presence of contaminants of concern (CoC), which may require further, more detailed assessment. An exceedance of the screening values does not necessarily mean that a risk is present until a contaminant linkage is identified with a viable pathway and receptor.

16.7.5 This Section summarises the Generic Qualitative Risk Assessment of those contaminant linkages that were determined to be plausible in the refined Conceptual Site Model (CSM).

Human Health

16.7.6 The soil chemical test results have been assessed against screening values for both commercial / industrial and public open space land use scenarios. Further details of the methodologies adopted in this assessment are provided in Annex D of Appendix 16C. These land use scenarios are also defined in the Environment Agency document 'Updated Technical Background to the CLEA Model' Report SC050021/SR3, January 2009 (Ref 16.10).

16.7.7 These two scenarios are most appropriate for the proposed highway and landscaping end uses, although both are considered to be reasonably conservative for most of the Principal Application Site as it is unlikely human receptors would be on-site for the duration that either scenario assumes.

The exception being the landscaping areas within the MIND Site area where exposure duration is likely to be longer than elsewhere.

16.7.8 The chemical test data has been split into made ground and natural ground and then split again into eastern area and western area.

16.7.9 For some CoC, direct contact will be the dominant pathway for exposure. Due to the unknown nature of soil excavation and reuse at this stage of the design, it is possible that materials from any depth could be excavated and placed at or near the surface in the final design.

Controlled Waters

16.7.10 The generic controlled waters risk assessment was conducted in accordance with the principles of the Environment Agency publication 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination' 2006 (Ref16.5) and the 'prevent and limit' approach of the Water Framework Directive (Ref16.6). Generic controlled waters risk assessments compare directly measured concentrations with standard assessment criteria.

16.7.11 Appropriate Water Quality Standards (WQS) are selected based on both a hierarchy of relevance to England and Wales and the receptor. In this case, the controlled water receptors identified in the CSM are:

- River Yare surface watercourse; and
- The underlying Secondary (A) and Principal Aquifers within the superficial and bedrock strata.

Human Health Risk Assessment Summary

16.7.12 The following CoC were identified:

- Asbestos recorded by the chemical testing laboratory in four samples;
- Exceedances of the public open space screening values have been recorded for pH (ten locations), lead (one location) and benzo-a-pyrene (two locations); and
- Exceedances of the commercial / industrial screening values have been recorded for pH (ten locations) and benzo-a-pyrene (one location).

Controlled Waters Risk Assessment – Soil Leachate Testing Summary

16.7.13 The following CoC were identified within soil leachate:

- Risks to River Yare surface water body – metals and speciated polyaromatic hydrocarbons, with one or two exceedances for phthalate, phenol, and petroleum hydrocarbon speciation.

- Risks to underlying aquifers - pH, ammoniacal nitrogen, metals, benzo(a)pyrene and total polyaromatic hydrocarbons.

Controlled Waters Risk Assessment – Groundwater Testing Summary

16.7.14 The following CoC were identified within groundwater.

- pH, ammoniacal nitrogen, sulphate, cyanide, arsenic, boron, benzo(a)pyrene and total polyaromatic hydrocarbons were recorded at concentrations in excess of the UK Drinking Water Standards screening values indicating the groundwater has the potential to impact the underlying aquifer water quality.

- Cyanide, arsenic, copper, zinc, anthracene, benzo(a)pyrene, fluoranthese, phenol, trichloroethene and aromatic hydrocarbons C10-C12 and C12-C16 were recorded at concentrations in excess of the Environmental Quality Standards indicating groundwater has the potential to impact the surface waters of the River Yare.

16.7.15 There does not appear to be any discernible differences between the chemistry of the shallow and deep groundwater or from one side of the River Yare to the other.

Groundwater Discussion

16.7.16 The ground investigation recorded some olfactory evidence of hydrocarbons in WS21, BH14 and BH6.

16.7.17 Sampling of groundwater from monitoring well installations (adopting best practice of purging) identified some exceedances of groundwater screening values for metals, inorganics and hydrocarbons. Most of these exceedances are less than one order of magnitude greater than the screening values and are therefore not considered to be indicative of significant contamination.

16.7.18 However, there is some evidence of organic contamination (polyaromatic hydrocarbons, volatile organic compounds and petroleum hydrocarbons) and to a lesser extent metals and non-metals in the groundwater across the Principal Application Site indicating the groundwater has been impacted previously and has the potential to impact the surface water of the River Yare.

16.7.19 The soil leachate WQS exceedances are generally marginal exceedances less than one order of magnitude above the screening values and indicate

that there is a theoretical potential for an impact to occur but the concentrations recorded suggest this would not pose a significant risk given the existing water quality.

16.7.20 Notwithstanding the above, the screening values are very conservative and in the absence of test results that consistently exceed the screening values at each monitoring visit indicates that there is unlikely to be contamination present that is likely to result in an unacceptable risk to the identified receptors. It is considered that there is unlikely to be a need for specific remediation to occur to target existing groundwater exceedances and there are not considered to be any sources of leachable contamination present within the study area that could lead to further groundwater or surface water pollution in either the long term or the short term.

Ground Gas Monitoring

16.7.21 Norfolk Partnership Laboratory undertook gas monitoring of the fourteen installed monitoring wells on 14 occasions between 1st June 2018 and 20th December 2018. It should be noted that not all of the monitoring wells were monitored on each occasion. Full details of the groundwater monitoring is presented in Annex B of Appendix 16C.

16.7.22 This comprised measuring the following parameters from each monitoring well:

- Methane concentration;
- Carbon dioxide concentration;
- Oxygen concentration;
- Atmospheric pressure; and
- Water level.

16.7.23 Methane was recorded up to 1.1% and carbon dioxide up to 10.6%. Flow rates varied with initial flows up to 1.1 litres per hour.

16.7.24 The ground gas risk assessment undertaken in accordance with CIRIA C665 (Ref 16.7) recorded ground gas across most of the study area at concentrations that are unlikely to require specific gas protection measures to be incorporated into the floor slab of any new commercial buildings.

16.7.25 However, one exploratory hole, BH4, recorded gas concentrations that may require specific gas protection up to characteristic situation 2 for a commercial building.

16.7.26 The control kiosk and plant room are designed to be cantilevered from the side of the bridge abutments at approximately first floor level and are therefore not in contact with the ground. As a result, there is no gas migration pathway and therefore no gas risk is considered to exist. Ground gas is therefore not considered further in the assessment below.

Waste Classification and Soil Re-Use Assessment

16.7.27 A waste classification hazardous properties assessment in accordance with the WM3 Technical Guidance (Ref 16.8) has been carried out on 85 soil samples. The chemical test results have been assessed and identified hazardous properties in six samples and a further 42 samples that are potentially hazardous. There is therefore material present on site that may not be suitable for reuse within the Principal Application Site and could require offsite disposal as hazardous waste at a suitable permitted facility.

16.7.28 Waste acceptance criteria (WAC) analysis has been carried out on 28 samples in order to assess the acceptability to landfill should offsite disposal be required. Two samples recording hazardous or potentially hazardous properties and subjected to WAC testing failed the WAC criteria for hazardous disposal as a result of loss on ignition (LOI) and total organic carbon (TOC). The other WAC test results indicate that most of the samples meet the criteria for inert waste disposal but two samples fail the inert criteria and will require disposal as non-hazardous waste.

16.7.29 Soils excavated from behind the quay wall to facilitate construction of the bridge abutments are likely to be saturated and of very poor quality geotechnically. It is therefore likely that this material will be disposed of by the Contractor to a suitably licensed facility rather than reused within the Principal Application Site.

16.7.30 It is understood that no dredging of the river bed is required to facilitate construction and therefore disposal at sea is unlikely to be required. Chapter 15: Materials discusses consumption of material resources including recovered site arisings, and the generation and disposal of waste.

Future baseline

16.7.31 No change in the baseline geology and soils are anticipated.

16.8 Sensitive Receptors

16.8.1 The following are the sensitive receptors which have been assessed. These are also detailed in Table 16.8 above:

- Human Health including site users, adjacent site users and construction and maintenance workers;
- Controlled Waters including the River Yare surface water course and the underlying Principal and Secondary A Aquifers; and
- Infrastructure including piled foundations.

16.9 Establishing the Scenario for Assessment

Construction Phase

16.9.1 Chapter 2: Description of the Scheme details the construction phase of the Scheme.

16.9.2 The key aspects of the construction phase of the Scheme which inform this geology and soils chapter are:

- Earthworks;
- Piled foundations; and
- Landscaping.

16.9.3 Embedded mitigation during construction comprises the following which will be included as part of the Outline CoCP (document reference 6.16) and will be secured by DCO requirement:

- Risks to human health from contamination will be managed through the CDM Regulations and will include the development of method statements and risk assessments for the various construction activities and use of good construction practices.
- Good working practices and housekeeping during construction such as sealing or covering stockpiles of contaminated soils to minimise the risk of generating dust.
- The Scheme will adhere to pollution prevention guidance and good practice during the construction phase.
- Discharges to watercourses from dewatering activities will be controlled via existing pollution control legislation.
- Temporary shoring to be used in excavations where there is a risk of collapse of excavations.

- Construction workers to wear appropriate personal protective equipment (PPE), monitoring equipment and Respiratory Protective Equipment (RPE) where required to mitigate the potential risk of exposure to hazardous gas / vapour and / or depleted oxygen levels when working in excavations or confined spaces.

- Areas with a greater risk of spillage (e.g. vehicle maintenance and storage areas for hazardous materials) would be carefully sited (e.g. away from drains or areas where surface waters may pond);

- Measures would be put in place to prevent pollution from construction plant, vehicles and machinery including refuelling in designated areas, on an impermeable surface, away from drains and watercourses; plant to be maintained in a good condition with wheel washing in place, all refuelling would be supervised and carried out in a designated area;

- Concrete wash out would only take place at designated concrete washout areas;

- Surface water run-off and excavation dewatering would be captured and settled out prior to disposal to sewer as appropriate. Any contaminants would be removed prior to disposal; and

- All fuel, oil and chemicals would be stored in a designated secure area, with secondary containment provided.

Operational Phase

16.9.4 Chapter 2: Description of the Scheme details the operational phase of the Scheme.

16.9.5 The key aspects of the operational phase of the scheme which inform this geology and soils chapter are:

- Site users and their interaction with the landscaped areas;

- Piled foundations and their interaction with the geology, soils and groundwater.

16.9.6 Embedded mitigation comprises the following and will be included as part of the Outline CoCP (document reference 6.16) and will be secured by DCO requirement):

- The concrete for all foundations will be designed to an appropriate concrete class for the sulphate and groundwater regimes.

16.10 Assessment of Effects, Mitigation and Residual Effects

Construction Phase

16.10.1 Impacts on geology and soils are considered likely to be most significant during the construction phase of the Scheme which will include major earthworks.

Detriment to Human Health

16.10.2 If human health receptors (site users (including children)), adjacent site users, construction workers and maintenance workers) are exposed to contaminants above the screening value concentrations there is potential for both temporary and permanent health problems to arise. These are dependent on a number of factors including type of potential contaminant (e.g. physical contaminants such as asbestos, or chemical contaminants such as arsenic or hydrocarbons), characteristics of the receptor and duration of the exposure. The length of exposure will also depend on a number of factors such as the amount of time workers spend in the construction area or for site users and adjacent site users, the actual duration of the construction works.

16.10.3 Excavation of potentially contaminated soils could pose a health risk to the public in the immediate vicinity of the study area during the construction period, through inhalation of contaminated dusts and particulate matter generated by excavation activities.

16.10.4 Construction workers are susceptible to exposure to hazardous gases (primarily methane, hydrogen sulphide, carbon monoxide and carbon dioxide) and/or depleted oxygen levels associated within excavations or confined spaces associated with the earthworks and installation of any below ground infrastructure (e.g. drainage chambers).

16.10.5 The use of machinery and plant associated with Scheme preparation, earthworks and construction activities (including the establishment of a site compound) could give rise to contamination risk to soils, through accidental fuel/oil spills and leaks, and storage of chemicals or fuels. Soils impacted by fuel/oil spills and leaks may represent a future source of contamination to human health.

16.10.6 Risks of ground collapse during excavation in made ground or loose natural soils resulting in risks to construction workers within excavations.

16.10.7 The sensitivity of human health is considered to be medium, and the magnitude of change prior to additional mitigation, is considered to be moderate. Therefore, there is likely to be a direct, temporary short-term **moderate (significant)** effect on human health prior to the implementation of additional mitigation measures.

Mitigation

16.10.8 In addition to the embedded mitigation detailed above in 16.9, the following additional mitigation measures would be implemented during the construction phase to mitigate risks to human health (site users, adjacent site users and construction workers, surroundings site visitor/occupants). These will be included as part of the Outline CoCP (document reference 6.16) which will be secured by DCO requirement and agreed following consultation with the Environment Agency and Great Yarmouth Borough Council.

- Earthworks would be completed in accordance with a Materials Management Plan (MMP) or similar protocol to ensure re-used material does not present a risk to human health or the environment. This would ensure any contaminated materials are re-used suitably as part of the cut and fill earthworks associated with the Scheme.

- Earthworks to be undertaken in accordance with a suitable Remediation Strategy, which is to include the provision for a 'clean' validated topsoil / subsoil to be placed in landscaping areas.

16.10.9 The construction Contractor will have a watching brief during the works (excavation and piling in particular) to identify any unforeseen potential contamination. If encountered, the Local Authority Environmental Health Department (for soil contamination) and the Environment Agency (for water contamination) shall be contacted. Depending on the site operations occurring where the contamination is encountered, works may need to temporarily cease in that area and samples taken for chemical testing to inform a remediation strategy to deal with the issue. The remediation strategy shall be prepared by an appropriately qualified Environmental Consultant and agreed with the Regulator prior to implementation. This will be secured through Requirement 8 of the draft DCO (document reference 3.1).

Residual Effect

16.10.10 The sensitivity of human health is medium, and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a direct, temporary, short term residual **neutral (not significant)** effect on human health following the implementation of additional mitigation measures.

Pollution of Controlled Waters

16.10.11 The disturbance of contaminated ground and the storage of fuel/oils on study area during the construction phase have the potential to result in mobilisation and release of contaminants, increasing the potential to negatively impact controlled water bodies (primarily underlying aquifers and the River Yare).

16.10.12 Potential historical sources of contamination have been identified (detailed in Appendix 16B Desk Study Report). Earthworks associated with the construction of the Scheme could potentially disturb and release mobile historical contamination impacting controlled waters.

16.10.13 The use of machinery and plant associated with construction activities (including the establishment of a site compound and storage of any chemicals or fuels in the compound area) could give rise to a pollution risk to soils, groundwater and surface water features through accidental fuel / oil and chemical spills and leaks. Soils impacted by spills and leaks may also represent a source of contamination to controlled waters via leaching.

16.10.14 Water pumped from excavations may contain contaminants, which if not managed appropriately could result in discharge and contamination of surrounding surface watercourses.

16.10.15 During construction of piled foundations, new pathways for mobile contaminants to migrate downwards and impact the deeper aquifers could be created.

16.10.16 Contaminated runoff could be generated during the earthworks phase of the Scheme, including hydrocarbon contamination and high suspended solid loads, associated with the operation of vehicles. This has the potential to migrate and pollute surrounding surface water courses.

16.10.17 For the potential risks identified (excluding piling), the sensitivity of the River Yare and Principal Aquifer controlled waters is considered to be high and the sensitivity of the Secondary A Aquifer is medium. The magnitude of change prior to additional mitigation, is considered to be moderate. Therefore, there is likely to be a direct, temporary short-term **large (significant)** effect on the River Yare and / or the Principal Aquifer and a direct, temporary, short term **moderate (significant)** effect on the Secondary A Aquifer.

16.10.18 For the proposed piling, the sensitivity of the River Yare and Principal Aquifer controlled waters is considered to be high and the sensitivity of the Secondary A Aquifer is medium. The magnitude of change prior to additional mitigation, is considered to be no change due to the existing groundwater conditions. Therefore, there is likely to be a direct, permanent

long-term **neutral (not significant)** effect on the River Yare, the Principal Aquifer and the Secondary A Aquifer.

Mitigation

16.10.19 In addition to the embedded mitigation detailed in 16.9 above, the following additional mitigation measures (implemented during the construction phase to mitigate risks to controlled waters) will be included as part of the Outline CoCP (document reference 6.16) and secured by requirements.

- A temporary surface water drainage strategy will be prepared for the construction stage;
- All drains within the Principal Application Site would be identified and labelled and measures implemented to prevent polluting substances from entering them;
- All temporary stockpiles will be sealed and/or covered if comprising contaminated soils so as not to give rise to a significant increase in sediment load to the drainage network or dust generation risk to human health.

16.10.20 Sediment modelling has been undertaken and the results are detailed in Chapter 12: Flood Risk.

16.10.21 Appendix 16D Piling Works Risk Assessment Report discusses the different piling techniques although it is likely that driven piles will be used. Following an optioneering exercise undertaken by the Contractor, driven piles have been considered the most appropriate foundation solution throughout the Scheme. The primary reason is driven piles are the most efficient solution for the fine to medium dense sand ground conditions present across the Principal Application Site. The use of driven piles reduces the geotechnical risks associated with 'blowing sands' and the risks associated with containing and disposing of potentially contaminated arisings and bentonite associated with bored piles.

Residual Effect

16.10.22 For the potential effects, excluding piling, the sensitivity of risks to the River Yare and Principal Aquifer controlled waters is high and the sensitivity of the Secondary A Aquifer is medium. The magnitude of change, following additional mitigation, is negligible. Therefore, there is likely to be a direct, permanent, long term **slight (not significant)** residual effect on controlled waters to the River Yare and the Principal Aquifer and a direct residual **neutral (not significant)** effect on the Secondary A Aquifer following the implementation of additional mitigation measures.

16.10.23 For the proposed piling, the sensitivity of risks to the River Yare and Principal Aquifer controlled waters is high and the sensitivity of the Secondary A Aquifer is medium. The magnitude of change, following additional mitigation, is no change. Therefore, there is likely to be a direct, permanent long term **neutral (not significant)** residual effect on the River Yare, the Principal Aquifer and the Secondary A Aquifer.

Infrastructure

16.10.24 Excavations in any ground conditions have the potential to collapse resulting in risk to construction workers and infrastructure.

16.10.25 Potential for methane and / or carbon dioxide to migrate into excavations posing a risk of explosion or asphyxiation.

16.10.26 Mitigation of the above risks will be achieved through the embedded mitigation detailed 16.9 above; ie temporary shoring and appropriate PPE and RPE for construction workers.

16.10.27 The sensitivity of infrastructure is considered to be medium, and the magnitude of change following mitigation, is considered to be negligible. Therefore, there is likely to be a direct, temporary and / or permanent, short term and long term **neutral (not significant)** effect on infrastructure.

Mitigation

16.10.28 No additional mitigation will be required.

Residual Effect

16.10.29 No additional mitigation measures are required and therefore the residual effects are as reported above.

Monitoring

16.10.30 No monitoring is considered to be required during construction over and above that which would normally be carried out as part of any internal environmental audits undertaken by the Contractor and / or included in the Outline CoCP (document reference 6.16) and its subsequent development, the full CoCP.

Operational Phase

Human Health

16.10.31 Site users, adjacent site users and maintenance workers are potentially at risk from contaminated soils at or near the surface through dermal contact, ingestion, and / or inhalation of fugitive dust.

16.10.32 The sensitivity of human health is considered to be medium, and the magnitude of change prior to additional mitigation, is considered to be moderate. Therefore, there is likely to be a direct, temporary and / or permanent, short term and / or long-term **moderate (significant)** effect on human health prior to the implementation of mitigation measures.

Mitigation

16.10.33 Potential risks to human health from contamination during the operational phase can be mitigated through placement of an inert soil capping and geotextile membrane in landscaping areas, where necessary during the construction phase. This will be included as part of the Outline CoCP (document reference 6.16) and secured by requirements.

Residual Effect

16.10.34 The sensitivity of human health is medium, and the magnitude of change, following mitigation, is no change. Therefore, there is likely to be a direct, temporary and / or permanent, short term and / or long term **neutral (not significant)** effect on human health following the implementation of additional mitigation measures.

Controlled Waters

16.10.35 Potential for mobile contaminants to leach from contaminated soils and migrate vertically or horizontally to impact controlled waters.

16.10.36 Potential for piled foundations to have opened a new pathway for mobile contaminants to migrate and impact controlled waters.

16.10.37 For mobile contaminants, the sensitivity of the Principal Aquifer and the River Yare controlled waters is considered to be high, and the sensitivity of the Secondary A Aquifer controlled water is considered to be medium. The magnitude of change prior to mitigation, is considered to be negligible. Therefore, there is likely to be a direct, temporary and / or permanent, short term and / or long-term **slight (not significant)** effect on the Principal Aquifer and the River Yare and a **neutral (not significant)** effect on the Secondary A Aquifer prior to the implementation of mitigation measures.

16.10.38 For piled foundations, the sensitivity of the Principal Aquifer and the River Yare controlled waters is considered to be high, and the sensitivity of the Secondary A Aquifer controlled water is considered to be medium. The magnitude of change prior to mitigation, is considered to be negligible. Therefore, there is likely to be a direct, temporary and / or permanent, short term and / or long-term **slight (not significant)** effect on the Principal Aquifer and the River Yare and a **neutral (not significant)** effect on the Secondary A Aquifer prior to the implementation of mitigation measures.

Mitigation

16.10.39 Measures to mitigate spillage and leak impacts to controlled waters from the operational phase of the Scheme are discussed in detail in Chapter 11: Road Drainage and the Water Environment.

16.10.40 No unacceptable risks to controlled waters have been identified from the results of the ground investigation and no mitigation measures are considered necessary. No additional mitigation measures are considered necessary from the perspective of impacts to water from the geology and soils present within the study area as part of the operational phase of the Scheme.

16.10.41 The Scheme design does not reduce significantly the proportion of hard standing therefore the degree of rainfall percolation though the made ground will not increase significantly. Leaching of mobile contaminants will not increase and risks to controlled waters will not increase.

16.10.42 No additional mitigation will be required for the piled foundations assuming appropriate concrete sulphate classification design and appropriate disposal of arisings in accordance with current waste regulations and protocols.

Residual Effect

16.10.43 For potential leaks and spills, the sensitivity of the Principal Aquifer and the River Yare controlled waters is considered to be high, and the sensitivity of the Secondary A Aquifer controlled water is considered to be medium. The magnitude of change following mitigation, is considered to be negligible. Therefore, there is likely to be a direct, temporary and / or permanent, short term and / or long-term **slight (not significant**) effect on the Principal Aquifer, the River Yare and a **neutral (not significant)** effect on the Secondary A Aquifer following the implementation of mitigation measures.

16.10.44 For piled foundations, the sensitivity of the Principal Aquifer and the River Yare controlled waters is considered to be high, and the sensitivity of the Secondary A Aquifer controlled water is considered to be medium. The magnitude of change following mitigation, is considered to be negligible. Therefore, there is likely to be a direct, temporary and / or permanent, short term and / or long-term **neutral (not significant)** effect on the Principal Aquifer, the River Yare and a neutral (not significant) effect on the Secondary A Aquifer following the implementation of mitigation measures.

Infrastructure

16.10.45 Sulphates have the potential to impact the integrity of buried concrete.

16.10.46 Mitigation of the above risk will be achieved through embedded mitigation detailed in 16.9 above ie design of concrete to appropriate class for the sulphate and groundwater regimes. No additional mitigation will be required.

16.10.47 The sensitivity of infrastructure is considered to be medium and the magnitude of change following mitigation is considered to be no change. Therefore, there is likely to be a direct, permanent, long-term **neutral (not significant)** effect on infrastructure.

Mitigation

16.10.48 No additional mitigation will be required.

Residual Effect

16.10.49 No additional mitigation measures are required and therefore the residual effects are as reported above.

Monitoring

16.10.50 No additional monitoring is considered to be required over and above that which would normally be carried out as part of any internal environmental audits undertaken during the operational phase.

16.11 Limitations and Assumptions

16.11.1 There were no major limitations to the ground investigation. However, the following minor access constraints were experienced during the works and the scope amended accordingly.

- All trial pits were replaced with window samples due to insufficient space to undertake a trial pit.
- One borehole location (BH3) was cancelled before drilling was undertaken due to the lack of available verge space close to the Suffolk Road Junction. The depth of window sample WS7, located close to the junction, was increased to 8m from 5m to provide additional ground profile data.
- Access to the verge for a cable percussion rig at BH4ASU and BH4BU was not possible so window samples replaced these locations.
- Two additional borehole locations (BH4A and BH4D) were undertaken on William Adams Way to gain further information on the deeper ground conditions in this area.

- One location (BH12A) encountered obstructions during drilling and was terminated. The borehole was moved a short distance from the original location and re-drilled as BH12B.
- Borehole BH4 was relocated due to access restrictions.
- Three boreholes (BH4A, BH5 and BH7) were terminated at shallow depths due to high magnetometer readings during the UXO (unexploded ordnance) surveying.

16.11.2 It is not considered that any of these limitations have had a significant impact on the assessment or the conclusions.

16.11.3 The main assumption is regarding the Principal Aquifer designation for the Crag Group. As with the above limitations, it is not considered that this assumption has any impact on the assessment or conclusions.

16.11.4 Due to the lack of any observed impermeable layers thick enough to minimise movement of water, it is assumed that the aquifers within the shallower superficial deposits are in hydraulic connectivity with the deeper aquifers within the Crag Group.

16.12 Summary

16.12.1 An assessment has been undertaken of the impact of the Scheme on the geology and soils, including potentially contaminated soils and the subsequent impacts on human health, controlled waters and the environment.

16.12.2 The geology and soils baseline is not considered likely to change over the operational life of the Scheme.

16.12.3 Potential risks to construction workers during the construction phase will be managed through the CDM Regulations by the Contractor using developed Method Statements, Risk Assessments, the Outline CoCP (document reference 6.16) and the use of good construction practices.

16.12.4 Potential risks to human health from contamination during the operational phase can be mitigated through placement of an inert soil capping and geotextile membrane in landscaping areas.

16.12.5 Potential risks to controlled waters from piled foundations are not considered likely to occur.

16.12.6 There are not considered to be any significant effects upon geology, soils and contamination arising from the Scheme.

Table 16.9 – Summary of Effects Table for Geology and Soils

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Mitigation / Additional Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Detriment to human health	Construction workers and adjacent site users.	Moderate significance / - / D / T / ST.	Earthworks completed in accordance with MMP or similar re-use protocol; Contractor to manage risks from contamination through site specific risk assessment and method statements; Remediation strategy to include where necessary, geotextile membrane, clean validated topsoil and subsoil in landscaping areas; RAMS to be developed by the Contractor for dealing with unexpected contamination during excavation; Sealing and / or covering soil stockpiles to minimise	Neutral significance / + / D / T / ST.

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Mitigation / Additional Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
			generation of contaminated dust; Earthworks to adhere to pollution prevention guidance and good practice; Contractor to have a watching brief during the works to identify any unforeseen contamination;	
Pollution of Controlled Waters	River Yare and Principal Aquifer	Excluding piling Large significance / - / D / T / ST	Surface water drainage strategy; Refuelling areas to be located away from sensitive receptors; Refuelling areas to be located on impermeable hard standing; All drains to be identified and measures implemented to prevent polluting substances entering the drainage system'	Slight significance / - / D / P / LT
		Piling Neutral Significance / - / D / P / LT		Neutral significance / - / D / P / LT
	Secondary A Aquifer	Excluding piling Moderate significance / -/D / T / ST		Neutral significance / - / D / P / LT
		Piling		Neutral significance / - / D / P / LT

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Mitigation / Additional Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
		Neutral Significance / - / D / P / LT	All fuels and chemicals to be stored in a designated area with secondary containment; Concrete washout carried out in designated area; Surface water run-off and excavation dewatering to process water in accordance with required pollution control legislation and the required licence prior to discharge; Sealing and / or covering soil stockpiles to minimise contaminated runoff; Driven piles reduce the geotechnical risks from blowing sands and the risks associated with containing and disposing of contaminated arisings and bentonite.	

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Mitigation / Additional Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Infrastructure	Construction workers and infrastructure	Neutral significance / - / D / T and or P / ST and or LT	Temporary shoring in excavation to minimise the risk of collapse; PPE and respiratory equipment when working in excavations; No additional mitigation necessary.	Neutral significance / - / D / P and or T / ST and or LT.
Operational Phase				
Detriment to human health	Site user, adjacent site users, and maintenance workers.	Moderate significance / - / D / T and or P / ST and or LT.	Placement of an inert subsoil and topsoil capping where necessary within landscaping areas to break the pathway between the contaminants and the receptors. If made ground is present below the inert capping, a geotextile membrane shall be used where necessary to delineate the change of strata and to minimise mixing of the soils.	Neutral significance / + / D / T and or P / ST and or LT.

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Mitigation / Additional Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Pollution of controlled waters	River Yare and Principal Aquifer	Migration of mobile contaminants: Slight significance / - / D / T and or P / ST and or LT	None considered necessary.	Slight significance / - / D / T and or P / ST and or LT.
		Piled Foundations: Neutral significance / D / T and or P / ST and or LT		Neutral significant / - / D / T and or P / ST and or LT
	Secondary A Aquifer	Migration of mobile contaminants: Neutral / D / T and or P / ST and or LT.		
		Piled Foundations: Neutral significance / D / T and or P / ST and or LT		
Infrastructure	Piled foundations	Neutral significance / - / D / P / LT	Piles designed to appropriate concrete class for the ground conditions;	Neutral significance / + / D / P / LT

Key to table:

+ / - = Positive or Negative P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short-Term, Medium-Term or Long-Term N/A = Not Applicable

16.13 References

Ref 16.1: The Highways Agency et al, (1993), Design Manual for Roads and Bridges, Volume 11, Section 3, Part 11, Geology and Soils.

Ref 16.2: British Standards Institution (2011). BS 10175:2011 Code of Practice for the Investigation of Contaminated Land.

Ref 16.3: The Environment Agency (2004). Model Procedures for the Management of Land Contamination. Contaminated Land Report 11.

Ref 16.4: Soilscapes (online).

Ref 16.5: Environment Agency (2006) Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination.

Ref 16.6: Water Framework Directive (2000/60.EC).

Ref 16.7: CIRIA (2007). Assessing risks posed by hazardous ground gases to buildings. C665.

Ref 16.8: Technical Guidance WM3 (2018) Guidance on the classification and assessment of waste (1st Edition v1.1).

Ref 16.9: CIRIA (2001). Contaminated Land Risk Assessment – A guide to good practice. C552.

Ref 16.10: Environment Agency (2009). Updated Technical Background to the CLEA Model. Report SC050021/SR3.

Ref 16.11: CL:AIRE (2008). Comparing Soil Contamination Data with a Critical Concentration.

Ref 16.12: The Environment Protection Act (1990). The Stationary Office 1990 https://www.legislation.gov.uk/ukpga/1990/43/pdfs/ukpga_19900043_en.pdf

Ref 16.13: Ministry of Housing, Communities & Local Government (2019). National Planning Policy Framework.

Ref 16.14: Department for Transport (2015). National Policy Statement for National Networks.

Ref 16.15: Department for Transport (2012). National Policy Statement for Ports. Ref 16.1: The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

17 Traffic and Transport

17.1 Introduction

17.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the Scheme on Traffic and Transport. The assessment of the potential impacts of the Scheme on travellers, including pedestrians and cyclists, has been conducted in accordance with IEMA guidance (Ref 17.2).

17.1.2 This Chapter assesses the impacts of the Scheme against the following criteria:

- Effects on public transport users;
- Driver delay;
- Pedestrian and cyclist journey times and delay;
- Collisions and safety; and
- Fear and intimidation.

17.1.3 This chapter describes the assessment methodology, the baseline conditions at the Principal Application Site and in the surrounding area, any embedded mitigation adopted for the purposes of the assessment, a summary of the likely significant effects taking into account national legislation, the additional mitigation measures required to avoid, prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been deployed.

17.1.4 This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES (document reference 6.1), with particular reference to the Transport Assessment (TA) (document reference 7.2) and Outline Construction Code of Practice (Outline CoCP) (document reference 6.16) which incorporates a Framework Construction Traffic Management Plan (CTMP) and a Framework Construction Worker Travel Plan (CWTP) (both appendices to document reference 6.16).

17.2 Competent Expert

17.2.1 The traffic and transport lead, Amanda Fogg, is a Chartered Associate Director who holds a BEng (Hons) degree in Civil Engineering from The University of Leeds (1992) and an MSc degree in Transport Planning and Engineering from the University of Salford (1999). The traffic and transport lead has significant experience of leading all aspects of the traffic and

transportation elements of major infrastructure projects, supported by a team of technical specialists.

17.3 Legislation, Policy and Guidance Summary

17.3.1 Table 17.1 provides a summary of the key policy for this assessment.

17.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 17A (document reference 6.2).

17.3.3 A general assessment of the Scheme against national, regional and local policies can be found in the Case for the Scheme (document reference 7.1).

Table 17.1: Summary of Key Policy

Policy	Summary	Chapter Reference
National Planning Policy Framework (Ref 17.2)	The revised NPPF (Paragraph 148) states that: "The planning system …should help to shape places in ways that contribute to radical reductions in greenhouse gas emissions". With particular reference to transport, paragraph 111 of the NPPF states that: "All developments that will generate significant amounts of movement should be required to provide a travel plan, and the application should be supported by a transport statement or transport assessment so that the likely impacts of the proposal can be assessed".	The Scheme has a primary aim of reducing congestion, and will thereby support reduced greenhouse gases and pollutants. Whilst the Scheme is not 'development' which itself generates trips, it will cause traffic reassignment around the town which requires assessment. A TA (document reference 7.2) has been produced to inform the DCO submission. As this is an infrastructure project an operational travel plan is not required. A Framework Construction Worker Travel Plan and Framework Construction Traffic Management Plan have been produced and are presented as Appendix A and B to the Outline CoCP (document reference 6.16).
National Policy Statement for National Networks	The NPS NN highlights the need for development of the national road network in the context of Government policy	The Scheme objectives are in alignment with NPS NN objectives, and the Scheme is anticipated to improve

Policy	Summary	Chapter Reference
(Ref 17.3)	for economic performance, environment, safety, technology, sustainable transport, accessibility and journey reliability. The national road network connects towns, cities and regions and there is a critical need to address congestion issues to provide safe and resilient networks. The pressure on this network is predicted to increase as the long-term drivers for demand to travel, Gross Domestic Product (GDP) and population, are also forecast to increase.	network capacity and resilience, journey reliability and safety whilst reducing community severance and supporting growth of the offshore renewable energy industry. Further detail can be found in the TA (document reference 7.2)
National Policy Statement for Ports (Ref 17.4)	If a project is likely to have significant transport implications, the applicant's ES should include a transport assessment. Applicants should consult the relevant highway authority on the assessment and mitigation. The assessment should distinguish between the construction, operation and decommissioning stages as appropriate. Where appropriate, the applicant should prepare a travel plan including demand management measures and details of proposed measures to improve access by public transport, walking and cycling, to reduce the need for parking associated with the proposal and to mitigate transport impacts.	A TA has been produced to inform the DCO submission (document reference 7.2). The assessment of transport impacts during construction and operation has been undertaken in Section 17.8 of this Chapter. As this is an infrastructure project an operational travel plan is not required. A Framework Construction Worker Travel Plan and Framework Construction Traffic Management Plan have been produced and are presented as Appendix A and B to the Outline CoCP (document reference 6.16). As described in Chapter 2, decommissioning has been scoped out.

17.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

17.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document reference 5.2)).

Consultation

17.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

17.4.3 Table 17.2 and 17.3 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 17.2: Summary of Scoping Opinions Received

Scoping Opinion Item	Consultee	Response
No matters have been proposed to be scoped out of the assessment.	PINS ref1	No action required.
The Scoping Report contains limited information in respect of the nature, location, and quantum of any new development to be considered in the ES. Any assumptions made in relation to this assessment should be explained clearly in the ES. Inter-related impacts associated with the assumptions made regarding new developments should also be taken into account in other relevant aspect chapter assessments, including Air Quality, Acoustics, and Peoples and Communities.	PINS ref 2	Paragraph 17.4.28: Reference to uncertainty logs developed for modelling which contain details of the nature, location and quantum of new developments which have been included in the future baseline. Chapter 19: Cumulative Effects describes the cumulative assessment methodology and paragraph 17.4.30 sets out the relationship between the developments included in the uncertainty log and the cumulative assessment
The Scoping Report identifies disruption to pedestrians and cyclists during construction as	PINS ref 3	Paragraphs 17.7.1 and: Clarifies that pedestrian and cyclist amenity is considered in Chapter 14: People

Scoping Opinion Item	Consultee	Response
having a potential significant effect. The Inspectorate notes that change in accessibility to public routes/community severance is proposed for assessment within the Peoples and Communities aspect chapter. The Applicant should avoid duplication of assessment in the ES, and ensure clear cross-reference is provided between the two aspect chapters, where appropriate.		and Communities and that this chapter considers journey time and delays.
The Scoping Report states that traffic surveys will be undertaken depending on the availability of data. The ES should contain details of the traffic surveys (new or existing), including times, dates, weather, locations, and if any factors may have impacted the surveys. Consideration should be given to the age of available data (where used) and whether it will accurately reflect the baseline on which the assessment is to be undertaken.	PINS ref 4	Paragraph 17.4.13: References the Traffic Data Collection report (Appendix A of the TA (document reference 7.2A)), which contains the required detail including consideration of the age of available data and its suitability to reflect the baseline on which the assessment is undertaken.
The Significance of Effect matrix provided at Table 50 of the Scoping Report utilises differing terminology to the overall methodology presented in Table 3 and defined in Table 4 of the Scoping Report. The Inspectorate considers that the classification of significance of effects should use consistent terminology throughout the ES for ease of understanding. Where methodology is specific	PINS ref 5	It is the nature of the assessment in this Chapter that the topics considered are assessed based on the magnitude of change due to the Scheme and the sensitivity of each receptor. As a result, professional judgement is applied to each assessment to categorise the magnitude and sensitivity (and therefore by extension the significance) of effects. In the case of fear and intimidation, IEMA guidance is used as

Scoping Opinion Item	Consultee	Response
to an aspect chapter, this should be clearly stated in the ES.		described in Table 17.5.
The ES should clearly state and justify the Study Area selected for both the construction and operational phase in respect of traffic and transport. The Study Area for non-motorised users should also be identified and justified. The Study Area should be shown on a supporting figure and effort should be made to agree the approach with the relevant highways authorities and Highways England.	PINS ref 6	Paragraph 17.4.7: Justifies the Study Area selected for the operation phase, which applies to all users and is shown on Figure 17.2. This has been agreed with NCC at meetings with the Development Control Officer. The Study Area and methodology has also been discussed with Highways England, and NCC is in the process of agreeing a Statement of Common Ground with Highways England. For the construction phase, the same Study Area has been used, with particular focus on sub-areas within the Study Area as appropriate for each topic.
The Scoping Report does not make reference to any mitigation measures to address impacts from traffic. The ES should contain details of any mitigation measures proposed, including those for construction traffic mitigation. This should include justification for their need and anticipated efficacy of any measures. If plans are relied upon as a form of mitigation there should be sufficient detail provided with the application to give confidence to their efficacy. Any mitigation relied upon for the purposes of the assessment should be appropriately secured.	PINS ref 7	A framework CTMP and CWTP will be developed in liaison with the Contractor and the relevant highway authorities. Frameworks of both of these documents are appended to the Outline CoCP (document reference 6.16).

Scoping Opinion Item	Consultee	Response
The Applicant's mitigation proposals should include a Construction Worker Travel Plan. Effort should be made to agree any plans with the relevant local authority and be appropriately secured.		
The Scoping Report at paragraph 6.9.36 notes that road blockages and diversions would be required during construction of the Proposed Development. The ES should clearly describe the road blockages/diversions proposed and their duration, supported by figures. The ES should ensure it includes an assessment of potential effects as a result of such diversions. The Applicant's attention is drawn to the comments provided on the Peoples and Communities aspect section of the Scoping Report in respect of business severance. The ES should avoid duplication of assessment but include clear cross-referencing between relevant aspect chapters.	PINS ref 8	The Scheme Description (Chapter 2) includes a high-level summary of the proposed construction programme and main activities. The Framework CTMP, (Appendix A to document reference 6.16) sets out further detail of how the construction works will be managed in order to minimise the impact on all road users and NMUs. This document will be further developed and agreed in liaison with the relevant highway authorities before construction commences. Clear signposting has been included throughout this chapter.

Table 17.3: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
Highways England wishes to be included in the scoping of the TA. Section 6 of the PTA describes the methodology which will be used to assess the transport impacts of the scheme for the full TA. Highways England wishes to continue to be involved in agreeing the methodology.	Highways England	NCC has been in ongoing dialogue with Highways England and is in the process of agreeing a Statement of Common Ground.
it is suggested that the walking and cycling facilities should fully align with the DfT's active travel design principles of providing coherent, direct, safe and attractive facilities.	Norfolk County Council	NCC has reviewed the NMU facilities and considers them to be appropriate for anticipated demand.
Support the promoter's intent to provide provision for pedestrians and cyclists and encourage and increase the use of the most active modes of transport (walking and cycling).	Public Health England	Noted.

17.4.4 Table 17.4 provides a summary of the consultation activities undertaken in support of the preparation of this chapter.

17.4.5 Further details on the consultation responses received in both the statutory and non-statutory stages of consultation are presented in the Consultation Report (document reference 5.1).

Table 17.4: Summary of Specific Consultation to Date

Body/ Organisation	Individual / Stat Body / Organisation	Meeting Dates and other Forms of Consultation	Summary of Outcome of Discussions
Norfolk County Council (NCC)	Highways Development Control NCC	05/12/2017: Meeting at Norfolk County Hall 06/03/2019:	Agreed Scope and Methodology for Transport Assessment. Agreed content of 3rd draft TA and

Body/ Organisation	Individual / Stat Body / Organisation	Meeting Dates and other Forms of Consultation	Summary of Outcome of Discussions
		Meeting at Norfolk County Hall	some additional refinements relating to mitigation.
Highways England	PM and Project Sponsor, Regional Investment Programme (East)	Ongoing dialogue via emails, telecons and meetings from OBC stage and throughout the DCO pre-application stage.	Agreement of HE schemes to be included in GYTRC model. Ongoing collaboration between HE/NCC and WSP to investigate alternative HE schemes in context of the Scheme.
Department for Transport	Head of Local Transport Modelling	Email exchange	SATURN model and appraisal updated in response to DfT feedback.
Public Transport Operators	First Bus	05/03/19: Meeting at Norfolk County Hall	Discussed the proposed improvements to the Southtown Road bus stop and the likely impacts during construction. First Bus have advised that they are willing to enter into a Statement of Common Ground or provide a written response in support of the Scheme.

Insignificant Effects

17.4.6 The following effects have been considered on a qualitative basis and it has been concluded that any such effects arising from the Scheme would be insignificant and have therefore not been considered further in the assessment:

- The impact of the Scheme on rail users has not been assessed. The railway station in Great Yarmouth is located over a mile away from the Scheme. The Scheme comprises new highway infrastructure within a defined area remote from the railway station. Whilst the Scheme would affect motorised and non-motorised users of the local network, it is not designed nor anticipated to influence mode share between highway and rail, and this assumption is reflected in the scope of the modelling work which was agreed with DfT at Outline Business Case stage in 2017;

- The impact of the Scheme on equestrian users has not been assessed as there are no equestrian facilities within the immediate vicinity of the Principal Application Site and there are no bridleways within the main urban area of the town.

Extent of the Study Area

17.4.7 The Study Area has been informed by those junctions where traffic is expected to change significantly. This could be by way of an increase in traffic flow, decrease in traffic flow, or changes to the direction of flow of traffic. The Study Area is indicated by the extents of the Paramics microsimulation model area, as shown on Figure 17.2 in Volume III and described in more detail in section 6.2 of the TA (document reference 7.2).

17.4.8 This Study Area has also been used to assess the impacts on NMUs, with particular focus on existing ProWs.

17.4.9 It was agreed at the meetings with NCC Highways Development Control on 5 December 2017 and 6 March 2019 that this represents an appropriate Study Area to carry out a robust assessment of the transport impacts of the Scheme in the TA.

17.4.10 This Study Area has also been used in the assessment of construction impacts, with particular focus on the Principal Application Site. The construction at the Satellite Application Sites will involve short term, small scale works that are not anticipated to have a significant impact on the carriageway or pedestrian facilities. As such, the construction phase traffic effects associated with the Satellite Application Sites have not been the subject of further assessment.

Method of Baseline Data Collation

Desk Study

17.4.11 An extensive desk study exercise has been undertaken, including collation and review of the following:

- Traffic count data, including Highways England WebTRIS data, automatic traffic counts (ATC), manual classified counts (MCC), queues surveys, road side interview (RSI) and journey time data. This is detailed in the Traffic Data Collection Report (Document 7.2A);
- Literature review of relevant National, Regional and Local Policies and Guidance documentation;
- Ordnance Survey Mapping;
- Google maps (subsequently confirmed by site visits, see below);
- Traffic Signal Staging and Timing data provided by NCC;
- Public Transport Timetables;
- Video data from traffic surveys;
- STATS 19 injury accident data for five-year period;
- Port Authority data on river vessel movements for five-year period; and
- Watching brief on Great Yarmouth Wider Transport Strategy project, Highways England RIS scheme proposals for A47 junctions and Local Congestion Schemes.

Site Visit

17.4.12 Multiple site visits have been undertaken by members of the EIA Team to observe local traffic conditions, confirm status of on-site infrastructure and attend public consultation events. The public consultation events are described in further detail in Chapter 5: Consultation.

Surveys

17.4.13 Reference has been made to an extensive range of traffic survey data in order to develop the traffic models used to inform the TA (document Reference 7.2). Full details are included in the Traffic Data Collection Report (document reference 7.2A).

Assessment Methodology

17.4.14 As described above, the scope of the TA (document reference 7.2), which assesses the impact of the Scheme on the capacity of highway infrastructure, has been agreed with NCC.

17.4.15 As listed above, desk studies and site visits have been undertaken to identify key features of the existing road and pedestrian / cycle networks and to obtain data on existing collision rates and identify existing public transport services in the Study Area.

17.4.16 For the construction phase, the Contractor has provided indicative construction information as detailed in Chapter 2: Description of the Scheme. This information has been used to estimate the additional daily vehicle movements for the worst-case construction activity periods which relate to:

- Maximum daily staff/operative's movements; and
- Worst case deliveries.

17.4.17 A worst-case estimate of the number of additional trips to each construction compound and the Outer Harbour has been made using the following assumptions:

- All staff and operative trips are made by single occupancy car journeys;
- 50% of staff and operatives may choose to leave site during the evening peak hour 1700-1800 (even though normal working hours finish at 1900);
- HGV movements are in the 6-hour period between 0900 and 1500 (interpeak period).

17.4.18 In terms of trip distribution, 80% are from the A47 north and 20% from the A47 south, based on a high-level review of the road network and significant areas of population and commercial activity.

17.4.19 For the operational phase, a comprehensive traffic modelling exercise has been undertaken in order to provide a quantified assessment of the impacts of the Scheme. This has been developed on a two-tier approach, based on the work submitted with the Outline Business Case with additional refinements in response to feedback received from DfT and NCC.

17.4.20 The development of the two-tier modelling is fully documented in the TA and the following supplementary Technical Reports, which also include an updated appraisal of the Value for Money of the Scheme.

- Traffic Data Collection Report (Appendix A of the TA (document reference 7.2));

- Paramics Local Model Validation Report (Appendix B of the TA (document reference 7.2));
- Paramics Forecasting Report (Appendix C of the TA (document reference 7.2));
- Economic Appraisal Report (document reference 7.6);
- Wider Impacts in Transport Appraisal Technical Note (Appendix F of the Economic Appraisal Report (document reference 7.6));
- SATURN LMVR Addendum (Appendix A of the Economic Appraisal Report (document reference 7.6)); and
- SATURN Forecasting Report (Appendix B of the Economic Appraisal Report (document reference 7.6)).

17.4.21 The SATURN (Simulation and Assignment of Traffic to Urban Road Networks) model has been developed primarily to quantify the strategic impacts of the scheme and inform the economic appraisal.

17.4.22 Outputs from the SATURN model have been used in order to produce a quantified assessment of the impacts of:

- Air Quality (see Chapter 6);
- Noise (see Chapter 7); and
- Driver Stress (see Chapter 14: People and Communities).

17.4.23 Outputs from the SATURN model have also been used to input to the Cost and Benefit to Accidents – Light Touch (COBALT) assessment, which informs the assessment of the impacts on collision and safety as described in Section17.8 below.

17.4.24 The Paramics Discovery Microsimulation model has been developed in order to provide a detailed quantified assessment of the operational impacts of the Scheme. It is able to more accurately model on-street behaviour and network capacity issues such as lane usage and exit blocking compared to conventional model analysis such as LINSIG, JUNCTIONS 9 and SATURN.

17.4.25 Of particular relevance to the Scheme, it can accurately model the impacts of the anticipated bridge openings, including the build-up and dissipation of queues at each opening period.

17.4.26 The Paramics model has been used to inform the assessment of driver delay, as described in paragraphs 17.4.40 17.4.38and 17.4.42. It has also

been referenced in the assessment of impacts on public transport users (bus users) in paragraph 17.4.35 below.

17.4.27 LINSIG junction models have also been developed for key signalised junctions in the Study Area. LINSIG is used in parallel with Paramics in order to assist in the optimisation process.

17.4.28 The models have been developed in line with WebTAG Guidance, including the development of an updated uncertainty log which comprises a record of assumptions made which affect travel demand and supply, including land use and highway infrastructure developments. A copy of the uncertainty log can be found in the SATURN Forecasting Report (Appendix B of document reference 7.6) and the Paramics Forecasting Report (Appendix C of document reference 7.2).

17.4.29 Models have been developed for the following scenarios:

- 2018 Baseline Model;
- 2023 Do Minimum (Opening Year future baseline);
- 2023 Do Something (Opening Year with Scheme);
- 2038 Do Minimum; and
- 2038 Do Something.

17.4.30 Chapter 19: Cumulative Effects describes the approach to cumulative assessment and provides details of the cumulative developments which have been explicitly modelled for the purposes of this assessment. There are more developments in the cumulative assessment than have been explicitly modelled because there are a number of cumulative developments which would not have an impact on traffic flows within the Study Area.

Effects on Public Transport Users (Bus Users)

17.4.31 There are no formal or published guidelines for the assessment of impacts on the public transport network. Accordingly, professional judgement has been applied to determine the magnitude of impact on the public transport network, as described below.

17.4.32 Information on the timetables and routes has been obtained from the official websites of public transport operators. The location of bus stops was determined by visual inspection of Google street view and maps.

17.4.33 For the construction phase, the indicative construction phasing information has been considered in order to estimate the likely scale and duration of impact on bus users, for example:

- Any construction activities likely to result in full or partial closures to roads with existing bus routes, and where proposed, for which time periods and what duration;
- Any construction activities likely to require the temporary relocation of an existing bus stop and hinder access to this for passengers; and/or
- Any increases in flows due to construction traffic likely to cause additional delay to bus journeys.

17.4.34 After careful examination of the available information, bus services across the Study Area has been included in the Paramics model, along with their complete timetables and allowance for waiting times at all bus stops.

17.4.35 For the operation phase, reference has been made to forecast changes in bus transport journey times along key bus service routes within the Study Area from the Paramics Discovery model.

17.4.36 The forecast changes in bus journey times have been reviewed for the proposed opening year of the Scheme (2023) during the following time periods during a typical weekday:

- AM peak 0800 – 0900;
- Interpeak 1300 – 1400; and
- PM peak 1630 – 1730.

17.4.37 A qualitative assessment of the existing and proposed bus infrastructure within the Scheme design has also been undertaken, using professional judgement.

Driver Delay

17.4.38 For the construction phase, indicative construction information provided by the Contractor has been reviewed and an estimate made of the worst case increase in trips associated with staff, operatives and HGV movements on important links.

17.4.39 Any increase below 5% is considered to have a negligible impact on driver delay. Impacts on important links above 5% are considered in further detail.

17.4.40 For the operation phase, reference is made to forecast changes in driver journey times along key routes through the Study Area from the Paramics Discovery model. The identified routes are:

- A47 Acle New Road to Outer Harbour;

- A47 Acle New Road to A47 South;
- A47 South to Outer Harbour;
- A47 South to Pleasure Beach; and
- Gorleston Town Centre to Great Yarmouth Town Centre.

17.4.41 The forecast changes in journey times have been reviewed for the proposed opening year of the Scheme (2023) during the following time periods during a typical weekday:

- AM peak 0800 – 0900; and
- PM peak 1630 – 1730.

Pedestrian and Cyclist Journey Times and Delay

17.4.42 The IEMA Guidelines (Ref 17.1) recommend that rather than relying on thresholds for pedestrian and cycle delay the assessor should use judgement to determine whether there will be a significant impact.

17.4.43 For the construction phase, the indicative construction information provided by the Contractor has been reviewed in order to establish the construction activity most likely to impact on pedestrian and cycle journey times and delay, and an estimate has been made of the temporary change in journey times during construction.

17.4.44 For a new development, increases in traffic levels as a consequence of a development are likely to lead to increased delay to pedestrians and cyclists wishing to cross roads. The degree of pedestrian and cycle delay therefore corresponds to the level of severance. The Scheme is not a 'development' that would generate trips but would instead create a reassignment of trips throughout the Study Area.

17.4.45 Therefore, for the operational phase, the impact of those reassigned trips has been assessed in order to determine whether there is a beneficial or detrimental effect on pedestrian and cyclist journey times and delay.

17.4.46 The operational phase assessment has involved identification of the existing network of PRoW, other NMU routes and the road network likely to be affected by the Scheme. NMU routes which have been included in the assessment were identified from OS mapping.

17.4.47 The change in journey distance for pedestrians between residential areas and key destinations on the west and east sides of the River Yare have been assessed. Using guidance from DMRB, Volume 11, Section 3, Part 8, Pedestrians, Cyclists, Equestrians and Community Effects (Ref 17.5) and

professional judgement, the impacts of the following changes have been identified and a descriptive assessment on the impacts to all users provided:

- Journey routes;
- Journey lengths; and
- Journey times.

17.4.48 A qualitative assessment of the existing and proposed pedestrian and cyclists' infrastructure within the Scheme design has been undertaken, using professional judgement.

Collisions and Safety

17.4.49 The IEMA Guidelines (Ref 17.1) state that an assessment of road safety on the highway network should be undertaken based on recent collision records. Personal Injury Collision (PIC) data has been obtained for the Study Area from STATS19 Road Safety Data for a five-year period to the end of December 2017 and is summarised in Paragraph 17.5.33 in the baseline conditions section of this chapter.

17.4.50 For the construction phase, consideration has been given to the indicative construction information provided by the Contractor and how traffic management, diversion routes and estimated increase in traffic flows on important links may increase the frequency of accidents or change their type or location.

17.4.51 For the operational phase, professional judgement is used to determine the significance of the Scheme on collisions and safety following detailed analysis undertaken as part of the Economic Appraisal Report (document reference 7.6) using COBALT software (Cost Benefit of Accidents – Light Touch) which is a computer program developed by the DfT to undertake the analysis of the impact on accidents as part of economic appraisal for a road scheme.

Fear and Intimidation

17.4.52 In the absence of commonly agreed thresholds for judging the significance of likely fear and intimidation impacts, IEMA Guidelines (Ref 17.1) suggest the thresholds outlined in Table 17.5 below are used to assess the magnitude of impact on fear and intimidation.

Table 17.5: Example of Fear and Intimidation. Source: (Ref 17.1).

Degree of Hazard	Average Traffic Flow over 18 hr Day (veh/hr)	Total 18 hr HGV Vehicle Flow	Average Speed over 18hr hr Day (mph)
Extreme	1,800 +	3,000 +	20 +
Great	1,200 – 1,800	2,000 – 3,000	15 – 20
Moderate	600 – 1,200	1,000 – 2,000	10 - 15

17.4.53 For the construction phase, the realistic worst case increases in trips on important links have been derived from the indicative construction information provided by the Contractor for average 18-hour traffic flow and 18-hour HGV flow. These are compared with the forecast 2023 do minimum flows from the SATURN model to establish whether any of the links would experience an increase in degree of hazard as a result of construction activity. Average speeds have not been calculated for the construction phase, but it is anticipated that as there will be increases in traffic, there will not be increases in speed so the degree of hazard in relation to average speed will not change.

17.4.54 For the operational phase, the forecast 2023 do something flows from the SATURN model on important links are compared with the forecast do minimum flows and a review undertaken of any links which are expected to experience an increase in degree of hazard.

17.4.55 The assessment of fear and intimidation has considered the links that increase and reduce in degree of hazard as a result of the construction and operational phases and will apply professional judgement to determine the overall magnitude of change from baseline conditions across the links assessed.

17.4.56 Details of this assessment are included in Appendix 17B.

Significance Criteria

17.4.57 The assessment of potential effects as a result of the Scheme has taken into account both the construction and operational phases. The construction phase includes enabling works, demolition, earthworks and construction activities as set out in Chapter 2: Description of the Scheme. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Scheme and the sensitivity of the affected receptor, as well as a number of other factors that are outlined in more detail in Chapter 4: Approach to EIA. The sensitivity of the affected receptor is assessed on a scale of very high, high, medium, low and negligible, and the magnitude of change is assessed on a scale of major, moderate, minor, negligible and no change.

17.4.58 Professional judgement has been used to assess the sensitivity of the receptor and the magnitude of change from baseline conditions of each effect.

Effect Significance

17.4.59 The significance of each effect has been determined using the Significance Matrix presented in Chapter 4: Approach to EIA. Effects deemed to be of moderate, large or very large significance are considered significant effects.

17.5 Baseline Conditions

Baseline Traffic Conditions

17.5.1 A full description of the baseline conditions including data collated is included in Chapter 4 of the TA (document reference 7.2).

17.5.2 Figure 17.3 shows further detail of the existing river crossings and the roads in and around the town centre.

17.5.3 Great Yarmouth lies at the mouth of the River Yare, which separates the town from the other parts of the Borough. The River Yare is navigable to small coastal vessels between Norwich and the North Sea. The historic town centre and sea front lie on a narrow peninsula, sandwiched between the river and the sea. It is linked to Gorleston-on-Sea and other parts of the Borough by two bridges over the river:

- The A1243 Haven Bridge (two lanes in each direction, single carriageway); and
- The A47 Breydon Bridge (one lane in each direction, single carriageway).

17.5.4 Both are lifting bridges, to enable boats and ships to pass through. To the west of Breydon Bridge lies Breydon Water, a large, sheltered estuary which forms the gateway to the Norfolk Broads. The A1243 Haven Bridge is the key route into and out of the town centre and peninsula from the south, with an alternative route along Acle New Road for trips from the north and heavy loads.

17.5.5 The Breydon Bridge, constructed in 1985, enables A47 traffic to bypass the centre of the town. The Haven Bridge provides access into the northern part of the town centre. There are, however, no bridges further south than this. As a result, the southern part of Great Yarmouth, which is built on the peninsula, is effectively isolated from the rest of the Borough.

17.5.6 The existing river crossings do not provide adequate access to the port and employment areas in the southern part of the peninsula. The lack of a direct

bridge means that traffic is forced onto unsuitable routes within the town centre, including the historic South Quay. Congestion, especially on the Haven Bridge, causes delays and makes journey times unreliable. The mixture of port-related and local traffic makes it more difficult for people to access the town centre, seafront, and leisure facilities.

17.5.7 Breydon Bridge and Haven Bridge are subject to high traffic flows and become severely congested during peak hours. Great Yarmouth and Gorleston also experience a dramatic increase in traffic flows during the holiday season. This extra traffic conflicts with town centre, port and commercial traffic, creating congestion problems on the town centre road network, particularly on the A47, South Quay, North Quay, Fullers Hill and Lawn Avenue.

17.5.8 The lack of a direct river crossing into the peninsula makes Great Yarmouth seem remote and discourages inward investment. Bus users, cyclists and pedestrians have long, indirect journeys into the peninsula, which discourages commuting to work by more sustainable modes.

17.5.9 The scheme objectives, detailed in the Case for the Scheme (document reference 7.1) are as follows:

- To support Great Yarmouth as a centre for both offshore renewable energy and the offshore oil and gas industry, enabling the delivery of renewable energy NSIPs and enhancing the Port's role as an international gateway;
- To improve access and strategic connectivity between Great Yarmouth port and the national road network thereby supporting and promoting economic and employment growth (particularly in the Enterprise Zone);
- To support the regeneration of Great Yarmouth, including the town centre and seafront, helping the visitor and retail economy;
- To improve regional and local access by enhancing the resilience of the local road network, reducing congestion and improving journey time reliability;
- To improve safety and to reduce road casualties and accidents, in part by reducing heavy traffic from unsuitable routes within the town centre;
- To improve access to and from the Great Yarmouth peninsula for pedestrians, cyclists and buses, encouraging more sustainable modes of transport and also reducing community severance; and
- To protect and enhance the environment by reducing emissions of greenhouse gases and minimising the environmental impact of the Scheme.

17.5.10 Chapter 4 of the TA (document reference 7.2) provides details of survey data that was collected in 2018 to determine the baseline conditions in Great Yarmouth and develop the traffic models that have been used for the assessment of the impacts of the Scheme. Table 17.6 shows the observed flows on important links in the morning peak, inter-peak and evening peak periods.

Table 17.6: Traffic Flows on Links (derived from ATC surveys 2018)

ID	Link	A.M. peak flow 2-way (veh)	Inter-peak flow 2-way (veh)	P.M. peak flow 2-way (veh)
1	A47 - Breydon Bridge	2,468	2,040	2,645
2	Haven Bridge	1,807	1,654	1,968
3	Lawn Avenue	1,333	1,268	1,444
4	Northgate Street	753	538	640
5	North Denes Road	485	317	668
6	North Drive	625	435	575
7	Gapton Hall Rd	1,176	920	1,330
8	Burgh Rd	482	335	522
9	Beccles Rd	959	710	985
10	A47/Beccles Rd	2,979	2,292	3,015
11	S Denes Rd	288	318	330
12	S Beach Parade	112	120	162
13	A47 New Rd	1,438	1,212	1,620
14	Caister Rd	1,619	1,448	1,666
15	A149 Caister By-Pass	1,430	1,169	1,342
16	B1370 Middleton Rd	814	640	836
17	Southtown Rd	767	691	801
18	B1141 Priory Plain	792	812	721
19	Euston Rd	217	304	284
20	Acle New Rd	1,974	1,932	1,967

17.5.11 Congestion is a problem in peak periods throughout the year with large queues forming on important roads in the town. Table 17.7 below, taken from Chapter 4 of the TA (document reference 7.2), shows the maximum queue lengths that were observed during queue length surveys undertaken between 7 a.m. and 7 p.m. on Thursday 8th March 2018.

Table 17.7: Maximum Observed Queue Lengths (meters)

Location	Direction	Queue Length (m)
Pasteur Road/Southtown Road Junction	From Pasteur Road	>150
Pasteur Road/Southtown Road Junction	From Bridge Road	124
Pasteur Road/Southtown Road Junction	From Southtown Road	110
Bridge Road/ North Quay Junction	From North Quay	73
Bridge Road/ North Quay Junction	From South Quay	74
Bridge Road/ North Quay Junction	From Bridge Road	>150
South Quay/Yarmouth Way Junction	From the north	>150
South Quay/Yarmouth Way Junction	From the south	68
Fullers Hill Roundabout	From Acle New Road	88
Fullers Hill Roundabout	From North Quay (north)	>150
Fullers Hill Roundabout	From Fullers Hill	39
Fullers Hill Roundabout	From North Quay (south)	72

17.5.12 Congestion problems seen at peak times also occur during the summer when many tourists visit the town centre, pleasure beach and seafront attractions. On days with especially fine weather, increased numbers of day trippers add to traffic and congestion. The raising of the bridges to allow shipping to pass through creates further significant delays and long queues which can take a very long time to clear. The Scheme, whilst also a lifting bridge, would provide additional network capacity, reducing overall traffic on Haven Bridge and the build-up of queues – in effect increasing resilience.

17.5.13 Critically, congestion at the bridges makes it difficult to provide adequate access to the important employment areas in the South Denes Enterprise Zone, including the new deep water outer harbour.

17.5.14 Congestion affects bus users and cyclists, as well as car users. Pedestrians are also affected by the long traffic signal cycle times needed to handle demand at junctions.

17.5.15 Chapter 7 of the TA (document reference 7.2) assesses current and forecast future traffic conditions and the transport impacts of the Scheme. This chapter includes analysis of forecast journey times for key routes in Great Yarmouth. These results are presented for the do minimum scenario in Table 17.8. This table demonstrates that journey times are forecast to increase in 2023 and would continue to deteriorate without intervention as a result of increased congestion and delay.

Table 17.8: Forecast Journey Time Changes – 2018 and 2023, AM Peak and PM Peak

From	To	AM Base 2018 (minutes)	AM DM 2023 No Scheme (minutes)	PM Base 2018 (minutes)	PM DM 2023 No Scheme (minutes)
A47 Acle New Road	Outer Harbour	7.9	8.8	8.9	10.1
A47 Acle New Road	Pleasure Beach	6.6	7.4	7.6	8.6
A47 Acle New Road	A47 (south)	6.7	6.4	8.2	7.3
A47 (south)	Outer Harbour	8.6	9.8	9.5	10.8
A47 (south)	Pleasure Beach	7.9	8.6	9	9.7
Gorleston (Town Centre)	Gr. Yarmouth (Town Centre)	8.5	9	9.8	9.3

Public Transport Network

17.5.16 Bus services cover the main corridors through the town, with all routes from outlying areas serving the town centre and Market Gates bus station. The majority of bus services in Great Yarmouth are operated by First in Norfolk and Suffolk, with a small number operated by other local bus operators.

17.5.17 Most bus services run in a north - south direction connecting Great Yarmouth with the Caister-on-Sea to the north or Gorleston-on-Sea to the

south. Exceptions to this are bus service 2, a circular route serving the town centre and the peninsula only, and bus service 74 which runs between Great Yarmouth Town Centre and Little Plumstead to the west.

17.5.18 The bus services which operate in the vicinity of the Scheme are illustrated in Figure 17.4 and described below. Apart from service 2, all these services run along Southtown Road and Beccles Road.

17.5.19 It should be noted that this information was correct at the time of writing, but detailed timetables and services are often subject to change.

Pedestrian and Cycle Network

17.5.20 The River Yare divides the western side of Great Yarmouth from the town centre, sea front, harbour and other destinations on the South Denes peninsula. To access these facilities, all pedestrian and cycle journeys between east and west have to cross the existing bridges. For pedestrians this means using Haven Bridge, as the Breydon Bridge has no footways. As a result, for many trips the time and distance involved is significant when compared with the equivalent “crow fly” distance.

17.5.21 Table 17.9 demonstrates the journey times for pedestrians and cyclists between locations on either side of the river using the current facilities. The routes for these journey times are shown in Figure 17.7 and 17.8.

Table 17.9: Current Walking and Cycling Journey Times

From	To	Walking Journey Times	Cycling Journey Times
Peggotty Road Community Centre	Harfreys Industrial Estate	47 mins	12 mins
Peggotty Road Community Centre	Southtown Common	44 mins	12 mins

17.5.22 Using current facilities available for pedestrians and cyclists means that a trip from Peggotty Road, approximately half way down the peninsula, to Southtown Common on the western side of the river would involve travelling around 4km, which equates to around 44 minutes for a pedestrian and 12 minutes for a cyclist. This route is over 6 times the length of the “crow fly” distance between these two points which is just under 600m.

Pedestrian Network

17.5.23 The pedestrian network along the eastern bank of the River Yare is adequate, with footways generally provided on both sides of the A1243. Along South Quays Road the footways are generally between 1.5m and 2.0m in width, however as you travel further south these become very

narrow, with footways of between 1.0m and 1.5m in width on both sides of Southgates Road and South Denes Road. South of Hartman Road there are also large stretches of South Denes with no footway provision.

17.5.24 On the western side of the river, the pedestrian network is less comprehensive with no public realm space or footway directly alongside the river due to the existing industrial units that occupy this space.

17.5.25 On Southtown Road, which runs parallel to the River Yare, there are footways of between 1.2m to 1.5m on both sides the carriageway and at the signalised junction of William Adams Way / Beccles Road / Southtown Road there are pedestrian crossing facilities. To the south of Southtown Road there is limited footway provision along Malthouse Lane and Riverside Road.

17.5.26 Footways of about 2m in width are provided along the south side of William Adams Way, however at the A47 / William Adams Way roundabout, only informal pedestrian crossing facilities are provided. There is a ramped pedestrian and cycle bridge on William Adams Way which provides access to Suffolk Road and Queen Anne's Road.

17.5.27 Haven Bridge is the main crossing for pedestrians travelling between Gorleston and Great Yarmouth. Footways of approximately 2m in width are provided on Bridge Road on approach and across the River Yare on both sides of the carriageway. Breydon Bridge to the north has no footways and is not considered suitable for use by non-motorised users due to the 50mph speed limit.

Cycle Network

17.5.28 Great Yarmouth's cycle network, as shown in Figure 17.5, comprises of sections of National Cycle Network (Routes 30 and 517) and the Regional Cycle Network, as well as other signposted on-road cycle routes (referred to as pedalways), advisory cycling routes and some traffic free cycle routes.

17.5.29 Existing opportunities for cyclists to cross the River Yare are limited. The Breydon Bridge has designated cycle lanes on either side of the carriageway, however, these are unsegregated and pose a risk to cycle users due to the nature of the road (50mph speed limit). The Haven Bridge has a shared use path leading up to it on either side of the river as part of the National Cycle Network Route 517, however, there is no provision on the crossing itself and cycle users have to dismount along the east bank of the River Yare. There is a wide segregated footway/cycleway along the western side of A13243 South Quay between Haven Bridge and Nottingham Way. South of Nottingham Way and towards the location of the Scheme there is no designed cycle route or infrastructure along the A1243. Pedalway Route 1 runs parallel to the A1243 along Blackfriars Road, Camden Road and Admiralty Road and connects with Pedalway Route 2 which runs along the

beach front. This route is principally on-street along quieter residential roads with limited provision for cyclists.

17.5.30 Opposite the Haven Bridge, there is a dedicated cycle lane on Regent Street (Pedalway Route 7) which provides cycle access to the town centre. To the north of Haven Bridge, an on-road cycle route starts at Stonecutters Way and runs through to George Street, and The Conge, before linking in with National Cycle Route 30 at the North Quay junction.

17.5.31 On the western side of the River Yare, Southtown Road is designated as National Cycle Network Route 517. The route is non-segregated apart from a section close to the Pasteur Road junction. The route continues on to Malthouse Lane and Riverside Road before reaching Gorleston. Pedalway Routes 5 and 6 follow the same route before turning on to Ferry Hill at the Riverside Road junction towards Bradwell and Gorleston respectively. Pedalways Routes 3 and 4 follow Pasteur Road on an off-carriageway footway/cycleway from Haven Bridge before continuing on to Gapton Hall Road towards Burgh Castle and Belton.

Community Facilities

17.5.32 There are a number of community facilities in the vicinity of the Principal Application Site, with two allotment gardens and the MIND Centre and Grounds located within the Principal Application Site. Full details of the community facilities within 500m of the Principal Application Site are provided in the Baseline Conditions section of Chapter 14: People and Communities and community facilities within 2km of the Principal Application Site are listed in Appendix 14C. Table 17.10 summarises the community facilities within 500m of the Principal Application Site. Community facilities within the immediate vicinity of the Principal Application Site are shown in Figure 14.2.

Table 17.10: Community Facilities within the Study Area

Name	Type of Facility	Direction from the Principal Application Site	Distance from the Principal Application Site
Two allotment gardens (north-east of the Queen's Anne Road and Suffolk Road junction)	Allotment Garden	N/A	Within the Principal Application Site
MIND Centre and Grounds	Community Centre / Allotment Garden	N/A	Within the Principal Application Site
Southtown Common	Recreation Ground	S and E	0m

Name	Type of Facility	Direction from the Principal Application Site	Distance from the Principal Application Site
Recreation Ground (including children's play area and sports pitches)			
Harfrey's Industrial Estate	Shops	W	0m
East Coast Black Belt School	Sport centre	E	10m
Peggotty Community Centre	Community Centre	E	11m
Kingsgate Community Centre	Community Centre	N	15m
Allotment gardens (south-west of the recreation ground)	Allotment Garden	SE	35m
Sure Start Children's Centre	Childcare Centre	E	40m
Community Centre Harry Miller Court	Community Centre	E	77m
The Great Yarmouth Day Services	Community Centre	S	81m
The Redeemed Christian Church of God	Church	NE	105m
Claydon Pavilion Community Centre	Community Centre	SW	125m
Allotments on Common Road	Allotment Garden	S	159m
Nova Training Centre	Community Centre	S	160m
The Shine Centre	Community Centre	S	170m
St James Church	Church	NE	200m
St John Ambulance	Community Centre	N	230m

Name	Type of Facility	Direction from the Principal Application Site	Distance from the Principal Application Site
Great Yarmouth Primary Academy	Primary School	NE	243m
Trafalgar College	Secondary School	N	244m
East Coast College	Secondary School	N	253m
Manor Close Communal Rooms	Community Centre	SW	380m
Edward Worlledge Ormiston Academy	Primary School	N	384m
Lichfield Community Centre	Community Centre	NW	424m
King Street	High Street	N	500m
Seventh Day Adventist Church	Church	SE	500m

Personal Injury Collisions

17.5.33 Personal Injury Collisions (PIC) data for the Great Yarmouth area was obtained from STATS19 Road Safety Data from the five-year period between July 2013 and June 2018. In total, there were 637 recorded injury collisions in the study area. More detailed accident analysis can be found within Section 4 of the TA (document reference 7.2). The locations are shown in Figure 17.6 in Volume III.

Future Baseline

17.5.34 The traffic modelling has been developed to take into account committed changes to the highway network and known developments. Details are included in the uncertainty logs within the SATURN LMVR Addendum and Paramics LMVR.

17.6 Sensitive Receptors

17.6.1 The following are the sensitive receptors which have been assessed across the Study Area:

- Motorised Users;
- Bus Users;

- Pedestrians; and
- Cyclists.

17.7 Establishing the Scenario for Assessment

Construction Phase

17.7.1 The following effects are considered to be potentially significant during the construction phase and will therefore be considered further:

- Effects on Public Transport Users (bus users);
- Driver delay;
- Pedestrian and cyclist journey times and delay (pedestrian and cyclist amenity is covered in Chapter 14: People and Communities);
- Collisions and safety; and
- Fear and intimidation.

17.7.2 It is proposed that a Framework CTMP (Appendix A to document reference 6.16) and Framework CWTP (Appendix B to document reference 6.16) are produced as part of the mitigation for the construction phase, as requested in the Scoping Opinion from PINS (outlined in Table 17.2). These documents will be developed by the Contractor and agreed with the local highway authority before construction commences, as required by the Outline CoCP (document reference 6.16).

17.7.3 The Framework CTMP sets out high level principles of the management and control strategy related to NMUs and vehicular movements during construction and the Framework Workforce Travel Plan will include measures to minimise the number of single occupancy car trips by promotion of other sustainable modes, and control of car parking.

17.7.4 Frameworks of both of these documents are appended to the Outline CoCP (document reference 6.16).

Operational Phase

17.7.5 The following effects are considered to be potentially significant during the operational phase and will therefore be considered further:

- Effects on Public Transport Users (bus users);
- Driver delay;

- Pedestrian and cyclist journey times and delay (pedestrian and cyclist amenity is covered in Chapter 14: People and Communities);
- Collisions and safety; and
- Fear and intimidation.

17.7.6 As described in Chapter 3: Alternatives, the Scheme has been designed with a number of embedded mitigation measures to accommodate the forecast traffic flows and enable the safe and convenient movement of all users during the operational phase. The Scheme includes new junctions on each side of the river which has been designed to tie into the surrounding road network according to relevant design standards.

17.7.7 The new junctions include controlled crossing facilities for pedestrians and cyclists and static signage will direct motorised and non-motorised users to the most appropriate route depending on their destination.

17.7.8 The Scheme also includes new Variable Message Signs (VMS) at six key locations which would be activated when required to display information including:

- Forthcoming closures of the new bridge and other matters relating to the operation of the new bridge;
- Routes which highway users are required or recommended to use, or not to use;
- Other matters of relevance to the operation of the local highway network; and
- Any other matter likely to be of assistance or interest to highway users.

17.7.9 The implementation of VMS signs will provide drivers with an alternative route and this minimise the risk of long delays and queueing as a result of the bridge openings.

17.8 Assessment of Effects, Mitigation and Residual Effects

17.8.1 This section of the chapter assesses whether the effects identified in section 17.7 will be significant during the construction and operational phases of the Scheme. For each of the topic areas that have been carried forward for further assessment, the effects of the Scheme with embedded mitigation are assessed. Embedded mitigation includes the measures that have been identified and adopted that are inherent to the design of the Scheme, and those that can realistically be expected to be applied as part of standard

construction environmental practice, or as a result of policy or legislative requirements.

17.8.2 As no gaps in embedded mitigation have been identified, or the assessment has otherwise identified that the Scheme would have a beneficial effect, no additional mitigation measures have been proposed. The residual effects of the Scheme during the construction and operational phases are therefore as reported below.

17.8.3 As the Scheme progresses to full approval, the Full Business Case will set out the Applicant's plans for monitoring and evaluation. This will include monitoring changes in traffic patterns, accidents and performance of key junctions across the network. This will enable the Applicant to make adjustments where necessary, for example to traffic signal timings.

Construction Phase

Public Transport Users (Bus Users)

17.8.4 Figure 17.4 details the existing bus routes which serve the town and surrounding areas. There are two main routes on each side of the river. On the west the routes follow Southtown Road onto Beccles Road (through the Principal Application Site). On the east, the routes follow Admiralty Road.

17.8.5 As described in the Framework CTMP (appended to the Outline CoCP (document reference 6.16)), the proposed construction traffic methodology will be developed in order to minimise the impact upon the general public, all road users and construction staff during the construction phase.

17.8.6 The Contractor has developed a preliminary construction programme as described in Chapter 2: Description of the Scheme. It is envisaged that the works to form the western approach structures and the Southtown Bridge would require temporary contraflow arrangements on Southtown Road for several weeks and a small number of full overnight closures.

17.8.7 This would result in additional temporary delays to bus journeys using this route during these construction activities. It is not anticipated that it would be necessary to relocate the existing bus stops.

17.8.8 The temporary minor adverse impacts on driver delay, described in the section below, are also applicable to buses.

17.8.9 In accordance with standard working methods detailed in the Framework CTMP (Appendix A to document reference 6.16), the contractor will:

- Seek to minimise delays and control queues by providing manual control of the contraflow signals during the busier morning and evening peak periods;

- Provide advance notification of the works would be provided, in order to allow bus operators to make any necessary adjustments to timetabling and to ensure users are aware and can plan their journeys in advance to allow additional time.

17.8.10 The sensitivity of public transport (bus) users is considered to be medium, and the magnitude of change is considered to be minor adverse. Therefore, there would be likely to be a short-term **slight adverse (not significant)** effect on public transport (bus).

Driver Delay

17.8.11 During the construction period, there would be likely to be some temporary increases in driver delay for some users, due to:

- Traffic management to enable construction activities to be undertaken on carriageway, for example reduced road capacity or temporary traffic lights;
- Diversions relating to full closures; and
- Increased traffic flow due to construction related traffic (staff/operatives and transfer of materials and plant).

17.8.12 As described in the Framework CTMP (appended to the Outline CoCP (document reference 6.16), the proposed construction methodology and phasing will be developed in order to minimise the impact upon the general public, all road users and construction staff during the construction phase.

17.8.13 The proposed general site working hours, as detailed in Chapter 2: Description of the Scheme, have been set to ensure the vast majority of staff trips would be made outside of the weekday network peak hours.

17.8.14 These details would be developed and agreed in liaison with the highway authority, however the indicative information demonstrates that the construction work can be effectively phased in order to meet the anticipated programme whilst minimising disruption to other road users and the general public, for example it is envisaged that:

- Southtown Road would remain open to traffic in both directions other than for a small number of overnight closures whilst the deck beams are being laid;
- The works to change the direction of Sutton Road and Swanstons Road would be undertaken at different times to ensure a convenient alternative route is available; and

- The construction of the proposed roundabout on William Adams Way would be phased to ensure that there would be two-way traffic flow maintained at all times other than during a small number of night time closures.

17.8.15 Additional daily vehicle movements have been estimated based on the information in the indicative construction information provided by the Contractor, as discussed in the assessment methodology. This has been compared with forecast 2023 do minimum link flows in Table 17.11.

Table 17.11: Worst Case Estimated Additional Trips from Construction Activity

	2023 interpeak			2023 PM peak		
Link	**Link Flows**	**Additional Trips**	**% increase**	**Link Flows**	**Additional Trips**	**% increase**
Breydon Bridge	2,491	40	2%	2,963	17	1%
Haven Bridge	2,174	4	0%	2,300	15	1%
North Quay	1,157	16	1%	1,133	58	5%
South Quay	2,240	18	1%	2,426	73	3%
Southgates Road	778	18	2%	851	73	**9%**
South Denes Road	322	18	**6%**	378	73	**19%**
Marine Parade	444	0	0%	548	-	0%
South Beach Parade	350	0	0%	405	-	0%
Admiralty Road	145	0	0%	187	-	0%
Sutton Road	59	0	0%	50	-	0%
Swanston's Road	50	0	0%	55	-	0%
Main Cross Road	132	0	0%	168	-	0%
Salmon Road	102	0	0%	110	-	0%
William Adams Way	665	48	**7%**	760	21	3%

	2023 interpeak			2023 PM peak		
Link	**Link Flows**	**Additional Trips**	**% increase**	**Link Flows**	**Additional Trips**	**% increase**
Beccles Road	1,211	0	0%	1,350	-	0%
Southtown Road	578	0	0%	828	-	0%
A47 north of Harfrey's Roundabout	3,214	42	1%	3,059	32	1%
A47 south of Harfrey's Roundabout	3,037	14	0%	3,291	19	1%
Fullers Hill	887	-	0%	958	-	0%
Yarmouth Way	686	-	0%	721	-	0%
Suffolk Road	191	-	0%	318	-	0%
Pasteur Road	1,580	4	<1%	1,324	15	1%
Lawn Avenue	1,717	-	0%	1593	-	0%

17.8.16 It can be seen that, even with worst case assumptions, the impact on the majority of important links is nil or negligible (less than 5% increase). The exceptions are:

- William Adams Way may experience an increase in vehicles during the interpeak period of up to 7%; and
- South Denes Road/Southgates Road may experience an increase in traffic of up to 6% during the interpeak and 19% during the PM peak.

17.8.17 In accordance with standard working methods detailed in the Framework CTMP (Appendix A to document reference 6.16), the contractor will seek to:

- Avoid deliveries during peak periods where reasonably practicable; and
- Reduce single occupancy vehicle trips during peak periods.

17.8.18 The sensitivity of drivers to delay is considered to be medium, and the magnitude of change considered to be minor adverse.

17.8.19 Therefore, there would be likely to be a short-term **slight adverse (not significant)** effect on driver delay.

Pedestrian and Cyclist Journey Times and Delay

17.8.20 As described in Section 17.5 and shown on Figure 17.5, there is an established network of National, Regional and local cycle routes within Great Yarmouth. This includes National Cycle Route 517 on Southtown Road which passes through the Principal Application Site.

17.8.21 Facilities for pedestrians in the areas in and around the Principal Application Site are also generally adequate, comprising footways of reasonable width and controlled crossing facilities in some locations.

17.8.22 As described in the Framework CTMP (Appendix A of the Outline CoCP (document reference 6.16), the proposed construction methodology would be developed in order to minimise the impact upon the general public, all road users and construction staff during the construction phase, including pedestrians and cyclists.

17.8.23 This would include ensuring works are phased, designed and managed to minimise the impact on pedestrian and cycle journey times and delays. For example:

- Post demolition and prior to the completion of the proposed roundabout and associated crossings, pedestrians and cyclist would be directed to use the nearby controlled crossings at the junction with Southtown Road; and

- An example of a journey that would be affected by this measure is from Drifter's Way to Southtown Common. The current route taken by cyclists and pedestrians using the footbridge and the proposed diversion using the junction with Southtown Road to make this journey are shown in Figure 17.9. The increase in distance from this diversion on the trip from Drifters Way to Southtown Common is approximately 300m. This equates to around an additional 4 minutes of walking time, from 6½ minutes to 10½ minutes, and approximately 1 minute of additional cycling time, from 1½ minutes to 2½ minutes. This analysis is based on an average walking speed of 5km/h and an average cycling speed of 20km/h.

17.8.24 In accordance with standard working methods detailed in the Framework CTMP (Appendix A to document reference 6.16), the contractor will seek to:

- Minimise disruption by maintaining pedestrian access to existing businesses wherever practicable during the works on Sutton Road and Swanstons Road; and

- Retain pedestrian and cycle access along the southern boundary of William Adams Way to minimise disruption to access of Southtown Common during the demolition of the footbridge on William Adams Way.

17.8.25 The sensitivity of pedestrians and cyclists to journey times delay is considered to be medium, and the magnitude of change is considered to be minor adverse. Therefore, there would be likely to be a short-term **slight adverse (not significant)** effect on pedestrian and cyclist journey times and delay.

Collisions and Safety

17.8.26 The construction of the Scheme would require temporary changes to the road network in order to undertake specific activities such as the Western Approach highway works, the Southtown Road bridge constriction and the construction of the proposed signal junction on South Denes Road and associated change of direction on Sutton Road and Swanstons Road.

17.8.27 There would also be a minor increase in traffic flows, including HGVs and construction plant on some of the important links as shown in Table 17.11 above. Both of these factors may affect safety and could contribute to a change in the location, type and rate of collisions.

17.8.28 In accordance with standard working methods detailed in the Outline COCP (document reference 6.16), the Framework CTMP and the Framework CWTP (both appendices to document reference 6.16), the Contractor will seek to:

- Implement all reasonably practicable measures to avoid/limit and mitigate the deposition of mud and other debris on the highway, which could obscure road markings and lead to an increase in skidding or present a hazard to pedestrians and cyclists crossing the carriageway;
- Be tidy and safe with a clutter-free site so it is safe for pedestrians, cyclists and other road users;
- Have clear and consistent signage to explain what is happening;
- Take up as little road/pavement space as possible with a compact working area and eliminating the unnecessary use of cones, safety barriers and storage of materials; and
- Give particular consideration to the needs of pedestrians and cyclists to ensure that safe (and where necessary signed) routes remain available where possible and commensurate with demand. This would include HGV safety standards to ensure cyclist and pedestrian safety such as the use of a banksman.

17.8.29 The sensitivity of road users to collisions and safety is considered to be high, and the magnitude of change is considered to be minor adverse. Therefore, there would be likely to be a short-term **slight adverse (not significant)** effect on collisions and safety.

Fear and Intimidation

17.8.30 Increases in traffic may increase fear and intimidation for non-motorised users (pedestrians and cyclists). This impact is dependent on the volume of traffic, its HGV composition, proximity to non-motorised users and other factors such as pavement widths and protection.

17.8.31 Additional daily vehicle movements have been estimated based on the information in the indicative construction information provided by the Contractor, as discussed in the assessment methodology. This has been compared with forecast 2023 do minimum link flows for 22 links that were identified as important links in the TA (document reference 7.2).

17.8.32 Based on indicative construction phasing information it is expected that changes in traffic flows will be nil or negligible for the majority of links in the Study Area, even when applying worst case assumptions. The exceptions are William Adams Way and South Denes Road/Southgates Road.

17.8.33 Appendix 17B provides details of the estimated increases in average 18-hour traffic (veh/hr) and total HGVs over 18 hours for important links in the network for the do minimum and construction scenarios. Average speeds have not been calculated for the construction phase but it is anticipated that, as there will be increases in traffic, there will not be increases in speed so the degree of hazard in relation to average speed will not change.

17.8.34 To assess how these changes in traffic might affect fear and intimidation of non-motorised users, a degree of hazard has been attributed to each of the important links in both the before and during construction scenarios, using the traffic and HGV flow thresholds from Table 17.5. This analysis is presented in Appendix 17B.

17.8.35 This assessment found that none of the forecast changes in average traffic flows or HGV flows due to construction cause a change in the degree of hazard for any links that were assessed.

17.8.36 In accordance with standard working methods detailed in the Framework CTMP (Appendix A to document reference 6.16) and Framework CWTP (Appendix B to document reference 6.16), the contractor will seek to:

- Minimise the number of single occupancy car trips;

- Manage and schedule deliveries involving HGVs to ensure that these vehicles operate during the agreed hours and only use the specified routes to and from the strategic road network; and

- Plan and manage works in order to maintain safe, protected routes for pedestrians and cyclists with minimal diversions.

17.8.37 The sensitivity of non-motorised users to fear and intimidation is considered to be high, and the magnitude of change prior to mitigation, is considered to be minor adverse. Therefore, there is likely to be a short-term **slight adverse (not significant)** effect on fear and intimidation for non-motorised users.

Operational Phase

Public Transport Users (Bus Users)

17.8.38 The effect on journey times for public transport (bus) users has been assessed with reference to the Paramics Discovery Model, as described in Section 7.10 of the TA. Tables 7.50 and 7.51 of the TA (document reference 7.2) demonstrate that the overall impact of the Scheme is to reduce bus journey time by an average of 12 seconds during the morning peak period and 40 seconds during the evening peak period.

17.8.39 The Scheme also incorporates improvements to the urban realm which will benefit local residents and visitors, non-motorised users and bus users. This includes the relocation and upgrade of the existing southbound bus stop on Southtown Road. The current facility is sub-standard and requires passengers to negotiate several steps in order to board or alight the bus.

17.8.40 The existing southbound bus stop on Southtown Road will be relocated south of the new Southtown Bridge in order to enable step free access and to better tie in with the proposed pedestrian and cycle routes. It will incorporate space for up to two buses to wait, plus a shelter with seating and lighting.

17.8.41 Initial consultation has been undertaken with representatives from First Bus. Norfolk County Council will continue to liaise with the main operators in order to obtain a formal response and to investigate opportunities to improve the existing bus network by the creation of new or extended services such as circular routes using the Third River Crossing.

17.8.42 The sensitivity of public transport (bus) users is considered to be medium, and the magnitude of change prior to mitigation, is considered to be moderately beneficial. Therefore, there would be likely to be a long-term **moderate beneficial (significant)** effect on public transport (bus) users.

Driver Delay

17.8.43 The effect on journey times for drivers has been assessed with reference to the Paramics Discovery Model, as described in detail in Chapter 7 of the TA (document reference 7.2).

17.8.44 The TA (document reference 7.2) demonstrates that the overall impact of the Scheme is to reduce average journey times on all routes considered within the Study Area, with the greatest saving forecast for trips between locations on the peninsula such as the Outer Harbour and Pleasure Beach, where savings of up to 6 minutes are forecast. Table 17.12 to Table 17.14 below, taken from Section 7 of the TA, show the forecast journey time savings for the AM and PM time periods.

Table 17.12: Forecast Journey Time Savings 2023 AM Peak

From	To	Without Scheme	With Scheme	Time Saving (Minutes)
A47 Acle New Road	Outer Harbour	8.8	8.1	0.7
A47 Acle New Road	Pleasure Beach	7.4	6.9	0.5
A47 Acle New Road	A47 (south)	6.4	6.3	0.1
A47 (south)	Outer Harbour	9.8	5.1	4.7
A47 (south)	Pleasure Beach	8.6	6.4	2.2
Gorleston (Town Centre)	Great Yarmouth (Town Centre)	9.0	7.9	1.1

Table 17.13: Forecast Journey Time Savings 2023 Inter Peak

From	To	Without Scheme	With Scheme	Time Saving (Minutes)
A47 Acle New Road	Outer Harbour	8.2	7.2	1.0
A47 Acle New Road	Pleasure Beach	7.1	6.7	0.4
A47 Acle New Road	A47 (south)	5.6	5.6	0.0
A47 (south)	Outer Harbour	9.0	4.6	4.4
A47 (south)	Pleasure Beach	7.7	5.9	1.8

From	To	Without Scheme	With Scheme	Time Saving (Minutes)
Gorleston (Town Centre)	Great Yarmouth (Town Centre)	8.3	7.5	0.8

Table 17.14: Forecast Journey Time Savings 2023 PM Peak

From	To	Without Scheme	With Scheme	Time Saving (Minutes)
A47 Acle New Road	Outer Harbour	10.1	8.8	1.3
A47 Acle New Road	Pleasure Beach	8.6	7.1	1.5
A47 Acle New Road	A47 (south)	7.3	6.3	1.0
A47 (south)	Outer Harbour	10.8	4.8	6.1
A47 (south)	Pleasure Beach	9.7	5.7	4.0
Gorleston (Town Centre)	Great Yarmouth (Town Centre)	9.3	7.8	1.5

17.8.45 Table 7.12 of the TA (document reference 7.2) summarises the network average journey time savings – which are 30 seconds and 66 seconds per vehicle for the AM and PM time periods respectively.

17.8.46 The sensitivity of drivers is considered to be medium, and the magnitude of change prior to mitigation, is considered to be moderately beneficial. Therefore, there would belikely to be a long-term **moderate beneficial (significant)** effect on driver delay.

Pedestrian and Cyclist Journey Times and Delay

17.8.47 The Scheme would provide a link between the peninsula and areas west of the river and has been designed to incorporate formal pedestrian and cycle routes and controlled crossings.

17.8.48 Figures 17.7 and 17.8 illustrate example walking and cycling routes and journey times between destinations on either side of the river. Journey times are calculated using an average walking speed of 5kph and cycling speed of 20kph, as recommended in DMRB Volume 11 (Ref 17.5). This analysis, summarised in Table 17.15 and Table 17.16 shows that substantial time savings are forecast as a result of the Scheme.

Table 17.15: Walking Journey Time Savings

From	To	Without Scheme	With Scheme	Time Saving (Minutes)
Peggotty Road Community Centre	Harfreys Industrial Estate	47 mins	18 mins	29 mins
Peggotty Road Community Centre	Southtown Common	44 mins	9 mins	35 mins

Table 17.16: Cycling Journey Time Savings

From	To	Without Scheme	With Scheme	Time Saving (Minutes)
Peggotty Road Community Centre	Harfreys Industrial Estate	12 mins	4½ mins	7½ mins
Peggotty Road Community Centre	Southtown Common	12 mins	2 mins	10 mins

17.8.49 The sensitivity of pedestrians and cyclists is considered to be medium, and the magnitude of change prior to mitigation, is considered to be major beneficial. Therefore, there would belikely to be a long-term **large beneficial (significant)** effect on pedestrian and cyclist journey times and delay.

Collisions and Safety

17.8.50 The Scheme is forecast to result in a considerable redistribution of traffic thus impacting flows on a number of links and junctions in the Study Area. As part of the Economic Appraisal of the Scheme, the DfT software Cost and Benefits to Accidents - Light Touch (COBA-LT) has been used to assess how these changes in flow may impact on the number of accidents that occur. The COBA-LT assessment is explained in detail in Section 7.12 of the TA (document reference 7.2).

17.8.51 The COBA-LT assessment forecast that the Scheme will save 20 accidents in the 60-year appraisal period, reducing the total accidents from 5,174 to 5,154. The Scheme is forecast to prevent 53 slight casualties and 1 serious casualty, bringing the total casualties to 30 fatal, 436 serious and 6,717

slight. These results demonstrate that the Scheme provides a limited improvement to the overall safety of links and junctions in the Study Area.

17.8.52 The sensitivity of road users to collisions and safety is considered to be high, and the magnitude of change prior to mitigation, is considered to be minor beneficial. Therefore, there would belikely to be a long-term **slight beneficial (not significant)** effect on collisions and safety.

Fear and Intimidation

17.8.53 Increases in traffic may increase fear and intimidation for non-motorised users (pedestrians and cyclists). This impact is dependent on the volume of traffic, its HGV composition, proximity to non-motorised users and other factors such as pavement widths and protection.

17.8.54 In the absence of commonly agreed thresholds for judging the significance of likely fear and intimidation impacts, IEMA Guidelines (Ref 17.2) suggest the thresholds outlined in Table 17.17 are used as an option to assess the magnitude of impact on fear and intimidation.

Table 17.17: Example of Fear and Intimidation. Source: (Ref 17.1)

Degree of Hazard	Average Traffic Flow over 18 hr Day (veh/hr)	Total 18 hr HGV Vehicle Flow	Average Speed over 18hr hr Day (mph)
Extreme	1,800 +	3,000 +	20 +
Great	1,200 – 1,800	2,000 – 3,000	15 – 20
Moderate	600 – 1,200	1,000 – 2,000	10 - 15

17.8.55 Reference has been made to forecast flows and speeds from the SATURN and Paramics models for 22 links that were identified as important links in the TA (document reference 7.2).

17.8.56 Table 17.18 and Table 17.19 below provide details of the links assessed that experience a change in degree of hazard as a result of the Scheme. The complete assessment, including the locations that did not change in degree of hazard, is provided in Appendix 17B.

Table 17.18: 2023 Forecast Changes to Degree of Hazards as a result of the Scheme

Location	Without Scheme Degree	With Scheme Degree	Change
Average Traffic over 18hr (veh/hr)			
A47 - Breydon Bridge	Extreme	Great	Reduction
A1243 - Haven Bridge	Great	Moderate	Reduction

A1243 - South Quay	Moderate	Below Moderate	Reduction
Southgates Rd	Below Moderate	Moderate	Increase
William Adams Way	Below Moderate	Moderate	Increase
Beccles Road	Below Moderate	Moderate	Increase
A47 - South of Gapton Hall Roundabout	Extreme	Great	Reduction
Pasteur Road	Moderate	Below Moderate	Reduction
HGV 18hr Flow			
A1243 - Haven Bridge	Moderate	Below Moderate	Reduction
18hr Average Speed			
Sutton Road	Moderate	Great	Increase

Table 17.19: 2038 Forecast Changes to Degree of Hazards as a result of the Scheme

Location	Without Scheme Degree	With Scheme Degree	Change
Average Traffic over 18hr (veh/hr)			
A1243 - Haven Bridge	Great	Moderate	Reduction
Southgates Rd	Below Moderate	Moderate	Increase
William Adams Way	Below Moderate	Moderate	Increase
Southtown Rd	Moderate	Below Moderate	Reduction
Fullers Hill	Moderate	Below Moderate	Reduction
HGV 18hr Flow			
A1243 - Haven Bridge	Moderate	Below Moderate	Reduction
A47 - South of Gapton Hall Roundabout	Moderate	Below Moderate	Reduction
18hr Average Speed			
Sutton Road	Moderate	Great	Increase
Southtown Rd	Great	Extreme	Increase

17.8.57 The above tables show that, of the 22 locations assessed, Southgates Road, William Adams Way and Beccles Road are forecast to experience an increase in degree of hazard for average traffic flow, no locations experience an increase in degree of hazard for HGV flow and only two locations, Sutton Road and Southtown Road, experience an increase in degree of hazard for average speed.

17.8.58 The tables demonstrate that the Scheme is forecast to reduce the degree of hazard based on average traffic flow at seven locations and reduce the degree of hazard based on HGV flow at two locations. There are no reductions to degree of hazard based on average speed as a result of the Scheme at the locations assessed.

17.8.59 The proposed removal of the William Adams Way footbridge would mean that non-motorised users travelling from the north to south of William Adams Way would have to use at-grade crossings rather than a segregated footbridge. The use of at grade crossings could increase the impact of the Scheme on fear and intimidation to non-motorised users but the inclusion of suitable crossing points, wide paths and guard rails should prevent significant adverse impacts.

17.8.60 As there are more links from the assessment that see a reduction in degree of hazard as a result of the Scheme, and as many of the areas that see increases in degree of hazard have safety measures such as guard rails, wide paths and crossings in place, the overall impact of the Scheme on fear and intimidation is forecast to be beneficial to non-motorised users.

17.8.61 The sensitivity of non-motorised users is considered to be medium, and the magnitude of change prior to mitigation, is considered to be moderately beneficial. Therefore, there would be likely to be a long-term **moderate beneficial (significant)** effect on non-motorised users.

Monitoring

17.8.62 No monitoring is considered to be required over and above that which would normally be carried out. As part of any internal environmental audits undertaken by the Contractor and / or included in the Outline CoCP (document reference 6.16) and its subsequent development the full CoCP.

17.9 Limitations and Assumptions

17.9.1 The significance of effect for public transport (bus) users has been based on currently published information on bus services, frequencies, routes and timetables. It is anticipated that bus operators may choose to amend their services following the opening of the Scheme. For example operators could create circular services linking the town centre with destinations on both sides of the river which could create further beneficial effects on public transport associated with the Scheme that have not been considered in this assessment.

17.9.2 It has not been possible to assess the potential effect at this time, but it can be reasonably anticipated that the opening of the Scheme would allow greater flexibility for operators in terms of bus routing and therefore improve public transport accessibility, particularly for trips between the peninsula and areas to the west and south of the River.

17.10 Summary

17.10.1 An assessment has been undertaken to establish the effect of the Scheme on sensitive receptors. The significance of each effect has been determined following IEMA guidelines (Ref 17.1) and by applying professional judgement when required.

17.10.2 At present, Great Yarmouth has two road bridges to provide crossing points across the River Yare, both bridges experience high traffic volumes and experience severe congestion during peak periods. Congestion problems also occur in the town during the summer when greater numbers of tourists visit Great Yarmouth.

17.10.3 The assessment of the impacts of the Scheme during construction has demonstrated that the Scheme would belikely to have a temporary, slight adverse impact on all traffic and transport effects assessed.

17.10.4 During the operational phase, the assessment has shown that the Scheme would have a large beneficial (significant) effect on pedestrian and cyclist journey times and delay, a moderate beneficial (significant) effect for public transport users, driver delay and fear and intimidation of non-motorised users and a slight beneficial effect on collisions and safety.

17.10.5 Table 17.20 below presents a summary of the significant effects that have been assessed in this chapter.

Table 17.20: Summary of Effects Table for Traffic and Transport

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Construction Phase				
Public Transport (Bus Users)	Bus Users	Slight - / T / D / ST	n/a	Slight - / T / D / ST
Journey Times and Delay	All Motorised Users	Slight - / T / D / ST	n/a	Slight - / T / D / ST
	Non-Motorised Users	Slight - / T / D / ST	n/a	Slight - / T / D / ST
Collisions and Safety	All Motorised and Non-Motorised Users	Slight - / T / D / ST	n/a	Slight - / T / D / ST
Fear and Intimidation	Pedestrians and Cyclists	Slight - / T / D / ST	n/a	Slight - / T / D / ST
Operational Phase				
Public Transport (Bus Users)	Bus Users	Moderate + / P / D / LT	n/a	Moderate + / P / D / LT

Description of Effects	Receptor	Significance and Nature of Effects Prior to Additional Mitigation / Enhancement	Summary of Additional Mitigation / Enhancement	Significance and Nature of Effects Following Additional Mitigation / Enhancement (Residual)
Journey Times and Delay	All Motorised Users	Moderate + / P / D / LT	n/a	Moderate + / P / D / LT
	Pedestrians and Cyclists	Large + / P / D / LT	n/a	Large + / P / D / LT
Collisions and Safety	All Motorised and Non-Motorised Users	Slight + / P / D / LT	n/a	Slight + / P / D / LT
Fear and Intimidation	Pedestrians and Cyclists	Moderate + / P / D / LT	n/a	Moderate + / P / D / LT

Key to table:

+ / - = Positive or Negative P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short-Term, Medium-Term or Long-Term N/A = Not Applicable

References

Ref 17.1: The Institute of Environmental Management and Assessment, (1993), Guidelines for the Environmental Assessment of Road Traffic.

Ref 17.2: Ministry of Housing, Communities and Local Government (2019). National Planning Policy Framework.

Ref 17.3: Department of Transport (2014). National Policy Statement for National Networks.

Ref 17.4: Department of Transport (2012). National Policy Statement for Ports.

Ref 17.5: The Highways Agency et al, (1993), Design Manual for Roads and Bridges, Volume 11, Section 3, Part 8 - Pedestrians, Cyclists Equestrians and Community Effects.

18 Major Accidents and Disasters

18.1 Introduction

18.1.1 This chapter reports the outcome of the assessment of likely significant effects arising from the vulnerability of the Scheme to major accidents and/or disasters (MA&D). Notably the chapter considers:

- The vulnerability of the Scheme to MA&D; and/or
- The Scheme's potential to cause a MA&D.

18.1.2 The chapter describes the assessment methodology, the baseline conditions at the Study Area, any embedded and additional mitigation adopted for the purposes of the assessment, a summary of the likely significant effects taking into account national legislation, the further mitigation measures required to avoid, prevent, reduce or offset any significant negative effects, and the likely residual effects after these measures have been employed.

18.1.3 To date, there is no specific guidance on how to consider MA&D within the context of EIA. However, this assessment considers emerging EIA good practice, which refers to other relevant documentation, including the Cabinet Office's National Risk Register (NRR) of Civil Emergencies (Ref 18.1).

18.1.4 The assessment of MA&D identifies whether an appropriate risk management structure is in place, for both health and safety, and environmental risks. It also reports on whether the potential for MA&D events to impact on human health and/or the environment has been identified and that it will be managed to be as low as reasonably practicable by the Applicant. This has been achieved through a review of available documentation and regulatory requirements. The purpose of the assessment is to identify risks which require additional precautionary mitigation actions beyond those already embedded into the design, construction and operation of the Scheme.

18.1.5 The structure of this chapter does not conform to the typical chapter structure used elsewhere in this ES as it is recognised that existing legislation, for example, health and safety requirements, already identify risks and help to protect human and environmental receptors. Additionally, sensitive receptors are not assessed using the same methodology as other specialist assessments. A different methodology for assessment is used which is outlined in Section 18.6. In order to remain proportionate, this chapter identifies and assesses risks that are relevant to the Scheme. As per the EIA Regulations, *the Environmental Statement must be prepared, taking into account the results of any relevant UK environmental assessment, which is reasonably available to the applicant with a view of avoiding*

duplication. This chapter signposts other regulatory frameworks and documentation where these risks have been or will be addressed. To the extent that any risks have not been adequately addressed, this chapter identifies these risks and considers whether additional mitigation measures may be necessary.

18.1.6 This chapter is intended to be read as part of the wider ES, with particular reference to all environmental topic chapters (Chapter 6 to Chapter 17). Additionally, references to other DCO documents are made throughout the assessment.

18.1.7 The terminology for elements of MA&D are presented in Table 18.1. This terminology is based on that defined in EU Directive 2012/18/EU (Ref 18.2).

Table 18.1: MA&D Terminology

Term	Definition
Risk	The likelihood of an impact occurring combined with the effect or consequences of the impact on a receptor if it does occur.
Major Accident	An event that threatens immediate or delayed serious damage to human health, welfare and/or the environment. Serious damage includes the loss of life or permanent injury and/or permanent long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts. The significance of this effect will take into account the extent, severity and duration of harm and the sensitivity of any receptors.
Disaster	A naturally occurring phenomenon such as an extreme weather event or ground-related hazard event with the potential to cause an event or situation that meets the definition of a major accident as defined above.

18.2 Competent Expert

18.2.1 The MA&D lead, Jerome Kreule, holds a MEnvSci degree in Environmental Sciences (Sustainable Environmental Management) from the University of Southampton (2017). The MA&D lead has multi-disciplinary experience in the preparation of Environmental Statements.

18.3 Legislation, Policy and Guidance Summary

Legislative Framework

18.3.1 Table 18.2 provides a summary of the key legislation, policy and guidance for this assessment.

18.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 18A (document reference 6.2).

Table 18.2: Summary of Key Legislation, Policy and Guidance

Legislation / Policy / Guidance	Summary	Chapter Reference
Directive 2014/52/EU (Ref 18.3)	Recital 15 of the Directive states: "*In order to ensure a high level of protection of the environment, precautionary actions need to be taken for certain projects which, because of their vulnerability to major accidents, and/or natural disasters (such as flooding, sea level rise, or earthquakes) are likely to have significant adverse effects on the environment. For such projects, it is important to consider their vulnerability (exposure and resilience) to major accidents and/or disasters, the risk of those accidents and/or disasters occurring and the implications for the likelihood of significant adverse effects on the environment*".	This is addressed through the production of this chapter and assessment, with particular relevance is the Significance Record (see Section 18.7).
EIA Regulations (Ref 18.4)	Schedule 4 Paragraph 8 of the EIA Regulations state: "*A description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned. Relevant information available and obtained through risk assessments pursuant to EU legislation such as Directive 2012/18/EU of the European Parliament and of the Council or Council Directive 2009/71/Euratom or UK environmental assessments may be used for this purpose provided that the*	This is addressed through the reference to embedded mitigation measures in relation to the Scheme and the full assessment contained within the Significance Record (see Section 18.7) and consultation of the Cabinet Office

Legislation / Policy / Guidance	Summary	Chapter Reference
	requirements of this Directive are met. Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies".	National Risk Register.
The Cabinet Office National Risk Register (NRR) of Civil Emergencies (2017 Edition) Ref (18.1)	The Government produced this document to provide information on events that would *"… cause widespread damage and would require some form of government response*" and provide guidance on how to prepare for such events. The document is divided into four sections; identifying risks included, describing consequences, details risks and management strategies and outlines a methodology for identifying, assessing and prioritising risks. The NRR is based on information from the National Risk Assessment, a classified assessment of risks to the UK over a five-year period.	Used as the basis of potential MA&D events to be scoped into the assessment (see Section 18.6) and assessed (see Section 18.7).

18.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

18.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6), Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

18.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

18.4.3 Table 18.3 and 18.4 provide a summary of the scoping opinions and Section 42 responses received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter.

Table 18.3: Summary of Scoping Options Received

Scoping Opinion Item	Consultee	Response
"The ES should include a description and assessment (where relevant) of the likely significant effects resulting from accidents and disasters applicable to the Proposed Development. The Applicant's attention is drawn to the comments of the HSE in Appendix 2 to the Opinion with regards to two major accident hazard installations in the vicinity of the Proposed Development. The Applicant should make use of appropriate guidance (e.g. that referenced in the Health and Safety Executives (HSE) Annex to Advice Note 11 (Ref 18.5)) to better understand the likelihood of an occurrence and the Proposed Development's susceptibility to potential major accidents and hazards. The description and assessment should consider the vulnerability of the Proposed Development to a potential accident or disaster and also the Proposed Development's potential to cause an accident or disaster. The assessment should specifically assess significant effects resulting from the risks to human health, cultural heritage or the environment. Any measures that will be employed to prevent and control significant effects should be presented in the ES."	PINS	This is addressed through the preparation of this chapter, forming part of the ES. The chapter considers the two installations identified by consultation with HSE (Transco Great Yarmouth Gas Holders and ASCO Fuels and Lubricants) (see Section 18.7).
"Relevant information	PINS	This is considered further

Scoping Opinion Item	Consultee	Response
available and obtained through risk assessments pursuant to European Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council or Council Directive 2009/71/Euratom or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met. Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies."		as part of the Significance Record (see Section 18.7). Additionally, Directive 2012/18/EU has been used to define terms (see Section 18.1).

Table 18.4: Summary of Section 42 Responses Received

Section 42 Item	Consultee	Response
Comment identifying Transco Great Yarmouth Gas Holder as a hazardous installation.	HSE	The Chapter has acknowledged the presence of these two sites, Control of Major Accident Hazards (COMAH) installations, raised by HSE and outlined them as key features to consider in the assessment process. Particular consideration was given to the MA&D risk to and as a result of these sites during the assessment and appropriate additional mitigation measures are outlined in section 18.7.
Comment identifying ASCO Fuels and Lubricants as a hazardous installation.		

Section 42 Item	Consultee	Response
Comments that the final ES should confirm that impacts associated with electromagnetic fields have been evaluated and will not be significant.	Public Health England	The potential for impacts associated with electromagnetic fields was deemed not applicable to any element of the Scheme and subsequently not included in the full scoping processes or the MA&D assessment.

Excluded Effects

18.4.4 Non-MA&D health and safety risks, such as accidents associated with construction plant/equipment, are scoped out of this assessment as managing the risks to employees is already covered by detailed H&S legislation (with more detail outlined in Appendix 18A (document reference 6.2)):

- The Health and Safety at Work Act (HSWA) 1974 (Ref 18.6);
- The Management of Health and Safety at Work Regulations 1999 (Ref 18.7);
- The Occupier's Liability Act 1984 (Ref 18:8);
- The Supply of Machinery (Safety) Regulations 2008 (Ref 18:9); and
- The Construction (Design and Management) (CDM) Regulations 2015 (Ref 18.10).

Extent of the Study Area

18.4.5 Table 18.5 outlines the elements of the Scheme considered in this assessment.

Table 18.5: Application Site Considerations

Site	Consideration
Principal Application Site	The main elements of the Scheme; the bridge and associated works, are the focus of the MA&D assessment.
Satellite Application Sites	Not considered in this assessment.
Application Site	n/a

18.4.6 The extent of the Study Area for the assessment is the Principal Application Site and a 1km buffer around the Principal Application Site (see Figure 1.1).

Sites of interest within this Study Area include two COMAH sites (see Table 18.6).

18.4.7 The Satellite Application Sites were excluded from the assessment due to the nature of these elements of the Scheme not having the potential to result in or increase the potential for a MA&D event in comparison to baseline conditions.

18.4.8 Assessments within the ES such as the resilience of the Scheme to climate change and Flood Risk Assessment (FRA) are within the scope of this chapter. Further information on receptors, baselines and assessment details can be found in these chapters and where relevant, reference to these chapters has been provided. This chapter assesses the potential hazards identified in these chapters and the subsequent potential for risk events.

Method of Baseline Data Collation

Desk Study

18.4.9 The assessment has collected baseline information from other chapters of the ES to identify the sensitive receptors and the Scheme's risk to MA&D. In particular the baseline information contained with Chapter 13: Climate Change, Chapter 12: Flood Risk, Chapter 14: People and Communities, Chapter 17: Traffic and Transport and Chapter 11: Road Drainage and the Water Environment is pertinent to this assessment.

18.4.10 In accordance with Schedule 4 Paragraph 8 of the EIA Regulations (Ref 18.4), available safety assessments were used to inform the identification and assessment of likely significant environmental effects. For the purposes of the Scheme this includes the consultation of resources such as CDM risk registers and the NRR (Ref 18.1).

18.4.11 Additional baseline information has been gathered on features external to the Scheme which could contribute a potential source of hazard to the Scheme. This information has been sourced via a desk-based study. Such features may include, but are not limited to:

- COMAH sites;
- Historical records of MA&D;
- Proximity to other major infrastructure;
- Proximity to operational industrial facilities; and
- Proximity to surface water bodies.

18.4.12 Future baseline data, where practicable and appropriate to assess, has been considered in ES chapter assessments. The relevant environmental chapter should be consulted for this information.

Site Visit

18.4.13 For the purpose of this assessment, no site visit was required.

Assessment Methodology

18.4.14 The potential for identified MA&D to result in a significant environmental effect has been evaluated using a risk-based approach. The approach considers the environmental consequences of a risk scenario, the likelihood of these consequences occurring, taking into account planned design and embedded mitigation, and the acceptability of the subsequent risk to the environment. The process followed includes:

- Identifying and classifying risks;
- Scoping these risks;
- Defining the impact;
- Assessing the risk; and
- Outlining risk management (mitigation) options.

18.4.15 The following sub-headings explain each of the aforementioned points in detail.

Identifying and Classifying Risks

18.4.16 Serious damage is defined as the loss of life or permanent injury/and or permanent or long-lasting damage to an environmental receptor which cannot be restored through minor clean-up and restoration efforts.

18.4.17 Risk is defined as the likelihood of an impact occurring, combined with effect or consequences of the impact on a receptor if it does occur (see Plate 18.1).

18.4.18 Risk identification has used existing sources of information wherever possible, such as risk assessments undertaken for the Scheme as part of other processes or risk events identified within the UK's current NRR (Ref 18.1). The risk identification activity focused on collating and reviewing these existing sources.

18.4.19 In order to identify whether a risk event has the potential to result in a MA&D, which also has the potential to have a significant adverse effect on an environmental receptor, three components need to be present: a source, a pathway (between source and receptor) and a receptor. As such, and as recommended by Defra (Ref 18.11), the assessment uses the following conceptual model:

- The **source** is the original cause of the hazard, which has the potential to cause harm;
- The **pathway** is the route by which the source can reach the receptor; and
- The **receptor**, which is the specific component of the environment that could be adversely affected, if the source reaches it.

18.4.20 High likelihood / high consequence events are not included in this assessment. The nature of these events, having the potential to occur at a relatively high frequency with serious consequences, is assumed to be at an unacceptable level of risk for the Scheme to have receive approval for construction. Because of this it has been assumed that the design of the Scheme and regulatory risk assessment processes will have identified, avoided and/or managed out any such risks (see Plate 18.1) and as such no further assessment is required.

18.4.21 Low likelihood / High consequence events are the focus of this assessment. The assessment identifies relevant events and determines whether a significant environmental effect is possible. Mitigation and response strategies required to demonstrate proper management of these risks are subsequently identified (see Plate 18.1).

- An event of Low likelihood is defined for the purposes of this assessment as an event which may occur during the lifetime of the Scheme (construction and operation) but is unlikely to occur more frequently than within a five-year period. Mitigation measures will reflect what is reasonable for such rare events, considering their potential consequence.
- An event of High consequence is considered to lead to a significant adverse effect, serious damage, which typically align with definitions given for each environmental topic.

18.4.22 All low consequence events, whatever their likelihood, do not meet the definition of MA&D (defined above) and as such are not relevant to this assessment. Such minor events would be dealt with under mitigation measures outlined in other assessments within this ES.

18.4.23 Plate 18.1 summarises the scope of the MA&D assessment on the basis of likelihood and consequence of events.

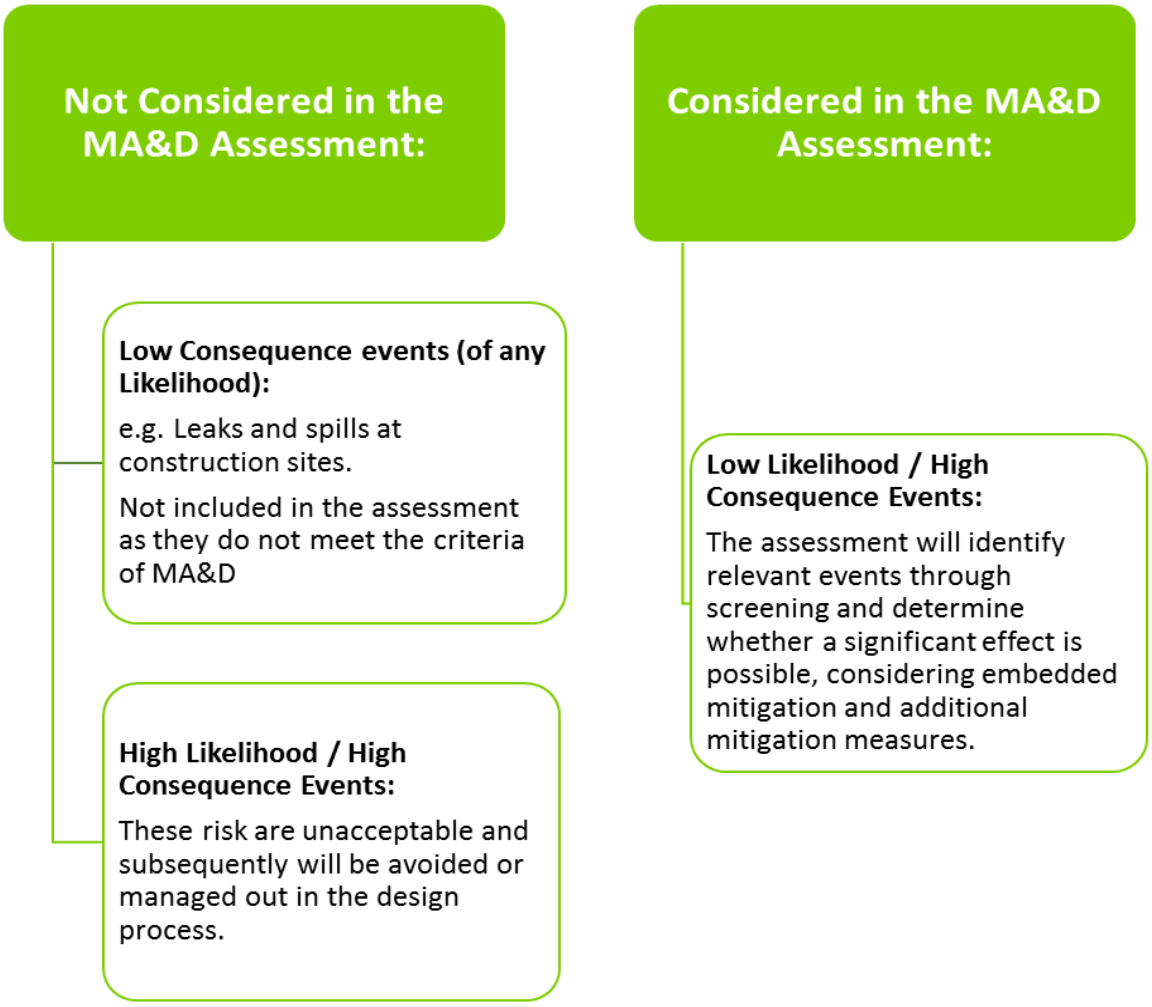


Plate 18.1: Summary of Risk Event Considered in the Scope of Assessment for MA&D

Scoping Risks

18.4.24 The following scoping process has been used to identify those risk events which may require further consideration within the assessment:

1. Identifying Risk - Review of existing risk assessment/registers to identify potential risks (as described above);
2. Location Risks - Is there a potential source, and/or pathway and/or receptor? If not, no further assessment is required;

3. Scheme Risks - What is the nature of the potential impact? Is there the potential for significant adverse effects on or as a result of the Scheme?
4. Scoping Decision – Scope in or out of assessment based on steps 2 and 3.

18.4.25 For the potential MA&D's not scoped out during this process, a full assessment has been undertaken. This assessment forms the basis for recommending additional mitigation measures, if and where appropriate.

Defining the Impact

18.4.26 A reasonable worst-case impact has been assumed for each MA&D risk assessed. This identification has been based on the NRR (Ref 18.1) and, where necessary, by consultation with environmental specialists for each relevant environmental topic within the ES.

Assessment of Risk

18.4.27 The risk and resulting significance of effects associated with MA&D has been assessed using the following criteria, as appropriate to the effect concerned:

- The presence and nature of embedded/additional mitigation measures;
- The nature of the realistic worst-case impact;
- The sensitivity of receiving environment and receptors;
- The reversibility and duration of effects; and
- Consultation with specialists and their assessment for MA&D events related to their assessments.

18.4.28 Where required, the assessment of risk and the determination of the significance of effects has relied on the professional judgement of the competent expert and environmental specialists that were consulted.

18.4.29 A significant adverse effect is considered to mean risk of an event resulting in the loss of life or permanent injury, and/or permanent or long-lasting damage to an environmental receptor. For the purposes of the assessment the risk of a MA&D event is considered to be either significant or not significant.

18.4.30 A significance rating has been provided for the following stages, taking into account:

- The embedded mitigation associated with the Scheme; and
- Any additional mitigation measures proposed as a result of this assessment.

Risk Management (Mitigation) Options

18.4.31 The assessment has considered, in consultation with relevant environmental specialists, whether the identified risk is managed through existing mitigation measures. If any identified risk is identified but there is no demonstrable risk management, additional measures may be required and have been proposed.

18.4.32 Risk management options fall into one of the following categories consistent with the mitigation hierarchy used for the EIA. Full details of risk management can be found in the signposted documents:

- Eliminate (avoid) the risk, by adopting alternative processes in order to eliminate the source of the hazard, or remove the receptor;
- Reduce the risk by adapting the Scheme such that either the likelihood or the impact of the MA&D event can be reduced;
- Isolate the risk, by using physical measures to ensure that should the risk event occur, it can be effectively isolated such that there is no pathway;
- Control the risk, by ensuring that appropriate control measures are in place so that should a risk event occur, it can be appropriately managed and controlled; and
- Exploit the risk, if it presents potential benefits or new opportunities.

18.4.33 Risk management options can be implemented both before and after the MA&D occurs, such as through intervention and barriers (pre-event measures) or mitigation and controls (post-event measures).

18.4.34 Risk management options, for the purpose of this assessment, fall into two classes:

- Embedded Mitigation: Existing mitigation measures included within the Scheme design, as a result of other assessments or legislation/policy with relevance to the Scheme; and
- Additional Mitigation: Measures proposed as a result of the assessment, where gaps in embedded mitigation have been identified.

18.5 Baseline Conditions

18.5.1 The baseline relevant to this topic comprises:

- Existing MA&D event risks without the presence of the Scheme;
- Features external to the Scheme that contribute a potential source of hazard to the Scheme; and
- Future baseline details.

18.5.2 Future baseline data, where practicable to assess, has been considered in ES chapter assessments. The relevant environmental topic chapter should be consulted for this information.

Baseline Accident and Disaster Risks

18.5.3 MA&D event risks relevant to the baseline in the absence of the Scheme include extreme weather events, flood risk, road traffic collisions industrial accidents and urban hazards such as fires.

18.5.4 The MA&D events considered in the baseline assessment only include those that were scoped in to the assessment (see Section 18.6 and Table 18.7). Those events scoped out have not been assessed. Additionally, a summary of the baseline conditions of the water environment have been provided, due to their relevance to multiple MA&D events.

18.5.5 Full baseline conditions in relation to these hazards can be found in the following chapters and DCO documents:

- Chapter 6 – Air Quality;
- Chapter 11 – Road Drainage and the Water Environment;
- Chapter 12 – Flood Risk;
- FRA (document reference 6.2);
- Chapter 13 – Climate Change;
- Chapter 14 – People and Communities;
- Chapter 17 – Traffic and Transport; and
- Transport Assessment (TA) (document reference 7.2).

Poor Air Quality

18.5.6 Air quality monitoring data demonstrates that there have been no exceedances of air quality objectives in the years of monitoring (2012-2016).

Water Environment

18.5.7 The main surface water feature within the Study Area is the River Yare which flows north to south through the Principal Application Site. The river is around 100m wide, with banks consisting of engineered quay walls. The river is subject to continuous dredging activity.

18.5.8 The River Yare forms part of the Norfolk East Transition/Coastal Operational Catchment. This waterbody is linked with several protected areas but is also heavily modified, containing engineered flood protections, bridges and navigational infrastructure. This waterbody extends south and into the North Sea, which is similarly heavily modified.

Flooding

18.5.9 The Scheme lies predominantly within floodplain cited as Flood Zone 3 (land having a 1% or greater annual probability of river flooding or a 0.5% or greater annual probability of sea flooding), the highest risk zone defined by the EA. Additional areas of land classified as being within Flood Zone 2 (1%-0.1% annual probability of river flooding or a 0.5%-0.1% annual probability of sea flooding) are present within the Study Area.

18.5.10 The River Yare is a tidal river. Two tidal gauges are located within 3km of the Scheme (2.7km south and 1.5km north). The highest tide ever recorded is 3.32m (on 1st January 1970). A recent tidal flooding event in December 2013 saw tidal defences being overtopped, causing flooding throughout Great Yarmouth.

18.5.11 A number of EA flood defence assets are located throughout Great Yarmouth with much of the town dependent on these assets as protection from tidal flooding.

18.5.12 Groundwater flooding is prominent in Great Yarmouth. The NCC Preliminary Flood Risk Assessment Report (Ref 18.12) identified that approximately 1,000 to 10,000 properties in Great Yarmouth are susceptible to flooding, including within the Study Area.

Severe Weather – Storms and gales. Typhoons, hurricanes and cyclones

18.5.13 Recent flooding events that occurred in 2014, 2013, 2007 and 2006, which caused extensive property damage and overwhelmed some flood defences, were all the results of storms events (Ref 18.13).

18.5.14 Other historic flood events have occurred with some regularity throughout the 20th century, with notable events in 1953, 1978 and 1983.

18.5.15 Hurricanes/cyclones/typhoons cannot form in or around the UK as sea temperatures are not warm enough to sustain a wind speed of at least

120hm/h, a measurement used to classify hurricanes. However, storm events that were former hurricanes are experienced throughout the UK.

Severe Weather – Wave Surges

18.5.16 Great Yarmouth's vulnerability to storm surge events is high. Tidal surges in the North Sea have historically lead to flood warnings and evacuations across the east coast of England, including Great Yarmouth.

Severe Weather – Extreme temperatures (low and high), heavy snow, droughts

18.5.17 The Study Area vulnerability to extreme temperature events is rated from high to medium (Ref 18.14).

18.5.18 The Norfolk Community Risk Register (Ref 18.14) rates the area risk of extreme temperature events (both low extremes with associated snowfall and heatwaves) at a medium risk, with low temperature events at a medium likelihood and heatwave events at a medium-high likelihood. Peak temperatures within Great Yarmouth reach approximately 30^{o}C.

18.5.19 Droughts are a result of insufficient rainfall. Previous major UK droughts, the 2010-2012 event, impacted Great Yarmouth. 2010 rainfall was not significantly reduced however, 2011 saw rainfall reduced to 65-75% of 1981-2010 average levels (Ref 18.15).

Severe Weather – Coastal Fog

18.5.20 Coastal fog is a regular occurrence along the eastern coast of the UK and is most common during Spring and Summer. The most common occurrences in the UK are as a result of warm air cooling over the North Sea coast, of which the Study Area is in.

Urban Fires

18.5.21 No urban fires have been recorded within the Study Area.

Human Diseases

18.5.22 The World Health Organisation (WHO) records no outbreaks of diseases in the Study Area between 2012 and 2019 (Ref 18.6)

Power and Systems Failure

18.5.23 Large scale power cuts in Great Yarmouth, including the Study Area, occurred as recently as 2017, with thousands of homes and businesses losing power for less than 24 hours.

Industrial and Urban Accidents

18.5.24 Two industrial sites of interest are within the Study Area, with no recorded accidents occurring.

Pollution Accidents

18.5.25 No pollution events are recorded in the Study Area.

Public Disorder

18.5.26 No events of public disorder have recorded in the Study Area (Ref 18.17 and Ref 18.18) in the period of 2016-2018.

Malicious Attacks/Terrorism

18.5.27 No acts of terrorism have occurred in the Study Area.

Unexploded Ordnance

18.5.28 As detailed in Chapter 16: Geology and Soils, Great Yarmouth is a high-risk area according to Zetica UXO risk maps. Previous UXO finds have occurred within the Study Area.

Major Traffic Accidents

18.5.29 Between 2013 and 2016 eight slight and one serious traffic accident has occurred within the vicinity of the Scheme along the A47, Williams Adam Way Roundabout, Suffolk Road, Queen Anne's Road and William Adams Way.

Major Naval Accidents

18.5.30 The River Yare is a navigational waterway and the port has operational quays in multiple locations within Great Yarmouth. The port handles a wide variety of cargos as well as servicing offshore windfarms. 1.28 million tonnes of cargo passed through the port in 2016.

18.5.31 No recent naval accidents have been recorded.

Baseline Features that Contribute a Potential Source of Hazard

18.5.32 As far as is reasonably practicable, the route of the Scheme has been designed to avoid existing features that have the potential to present a hazard to the construction/demolition and operation of the Scheme. There are two sites within 1km where hazardous materials and/or substances are stored, used or made in quantities to trigger registration under the COMAH Regulations.

18.5.33 Features external to the Scheme that lie within adjacent to the land required for construction and which present a potential source of hazard, either during construction or operation include, but are not limited to the following:

- The River Yare and connected water bodies;
- The North Sea;
- Adjacent roads;
- Transco Great Yarmouth Gas Holders;
- ASCO Fuels and Lubricants; and
- Potential presence of UXO.

Future Baseline

18.5.34 Future baseline data, where appropriate to assess it, has already been considered in other ES chapter assessments. The relevant environmental chapter should be consulted for this information.

18.5.35 Topics that are covered by future baseline assessments in other Chapters and documents are listed below:

- Flooding - Chapter 12: Flood Risk and the FRA (document reference 6.2);
- Severe Weather (Storms and gales, typhoons, hurricanes and cyclones) – Chapter 12: Flood Risk and the FRA (document reference 6.2);
- Severe Weather (Wave surges) - Chapter 12: Flood Risk and the FRA (document reference 6.2);
- Severe Weather (Extreme temperatures (low and high), heavy snow, droughts) - Chapter 12: Flood Risk and the FRA (document reference 6.2);
- Severe Weather (Coastal fog) - Chapter 12: Flood Risk and the FRA (document reference 6.2);
- Major Traffic Accidents – Chapter 17: Traffic and Transport and The TA (document reference 7.2); and
- Major Naval Accidents - Preliminary Navigational Risk Assessment (pNRA) (document reference 6.14).

18.5.36 Topics where it is not possible to forecast the future baseline conditions for the event, or where future baseline information is not available, are set out below:

- Urban Fires;
- Human Diseases;
- Power and Systems failure;
- Industrial and Urban accidents;
- Pollution accidents;
- Public Disorder;
- Malicious Attacks/Terrorism; and
- UXO.

18.6 Establishing the Scenario for Assessment

18.6.1 The assessment of MA&D was not included in the scoping report. Therefore, a scoping summary is outlined below.

18.6.2 Risks have been considered both inside and outside of the Principal Application Site, along with potential external influencing factors (see Table 18.6) within 1km of the Principal Application Site.

18.6.3 Legislative compliance obligations relating to the Scheme activities have been considered in the assessment scenario.

18.6.4 While the assessment of significance does not deal with specific receptors, broader identification of sensitive receptors is provided to place the assessment in context has. The sensitive receptors are listed below:

- Members of the public and local communities;
- COMAH sites (see Table 18.6);
- The natural environment, including ecosystems, land and soil quality, air quality, surface and groundwater resources and landscape; and
- The interaction between the above factors.

Table 18.6: External Influencing Factors

External Influencing Factor	Summary
COMAH Sites	Transco Great Yarmouth Gas Holders ASCO Fuels and Lubricants
Significant Surface Watercourses	The River Yare flows under the main feature of the Scheme, the bridge.
Flood Zones	Most of the Scheme lies in flood zone 3 (high probability) with some additional areas in flood zone 2 (medium probability) areas.
Urban Environments	The Scheme is entirely within the urban centre of Great Yarmouth. Apart from the River Yare, the surroundings are entirely urban.
Agricultural Activities	Surrounds the urban area of Great Yarmouth to the west, south and north-west of the Scheme. The nearest being approximately 600m from the Principal Application Site.

Scoping - Initial Risk List

18.6.5 The initial risk list forms the main component of the scoping process by ruling out any potential accidents and/or disasters that are considered highly unlikely to occur. This scoping process illustrates that due account has been taken of the full range of potential accidents and disasters and that the assessment process is fully transparent.

18.6.6 Table 18.7 provides an initial scoping list of MA&D for consideration. This list has been based on the NRR (Ref 18.1) identified in Section 18.2, the nature and scale of the Scheme (bridge and associated infrastructure) and the location of the Scheme (central urban environment crossing water sources). The potential for a location risk and a risk to the Scheme is recorded in a yes/no format, with additional information included. Those MA&Ds that have been scoped out have justification provided. Those that cannot be scoped out have been carried forward for assessment.

18.6.7 The scoping exercise is based on a source-pathway-receptor model and considers the following:

- Source – Likely MA&D events and/or the Scheme;
- Pathway – Aspects of the Proposed Development which may interact with or give rise to natural and man-made hazards; and
- Receptor – Identified environmental topics, the Scheme or receptors for MA&D events.

Table 18.7: Initial Risk List

Accident/Disaster Group and Type	Location Risk	Potential Risk to Phase and/or Aspect of Scheme	Scoping for Further Consideration
Flooding – Coastal, Rivers and Streams, Surface Water and Groundwater, Avalanches	Yes The Principal Application Site in particular the road access to the bridge.	Yes (construction and operation) work in and adjacent to the River Yare.	Scope In
Severe Weather – Storms and gales, typhoons, hurricanes and cyclones	Yes The Principal Application Site has a pathway to the North Sea.	Yes (construction and operation) work in and adjacent to the River Yare.	Scope In
Severe Weather – Wave Surges	Yes The Principal Application Site has a pathway to the North Sea.	Yes (construction and operation) work in and adjacent to the River Yare.	Scope In
Severe Weather – Extreme temperatures (low and high), heavy snow, Droughts	Yes In line with UK climate change projections.	Yes (construction and operation)	Scope In
Severe Weather – Coastal Fog	Yes The Principal Application Site has a pathway to the North Sea.	Yes (construction and operation), given the Principal Application Site's proximity to the North Sea.	Scope In

Accident/Disaster Group and Type	Location Risk	Potential Risk to Phase and/or Aspect of Scheme	Scoping for Further Consideration
Space weather – Solar Flares, Solar Energetic Particles, Coronal Mass Ejections	Yes	No (construction and operation)	Scope Out
Geophysical – Earthquakes, Volcanic Activity, Landslides and Tsunamis	No Geophysical events such as those listed either occur outside the UK (volcanic activity) or of an insufficient magnitude to lead to major damages (earthquakes).	No (construction and operation)	Scope Out
Poor Air Quality	Yes Urban environment in proximity to road network.	Yes (construction and operation) due to the nature of activities in both phases	Scope In
Wildfires	No The Application Site is not located in areas of habitat at risk of wildfires.	No (construction and operation)	Scope Out
Urban Fires	Yes The Application Site is located near fuel storage areas.	Yes (construction and operation)	Scope In

Accident/Disaster Group and Type	Location Risk	Potential Risk to Phase and/or Aspect of Scheme	Scoping for Further Consideration
Human Diseases	Yes The Application Site is within a densely populated urban environment.	Yes (construction only). Construction activities generate human interaction. The operational phase is scoped out due to the Scheme not increasing human interaction compared to baseline conditions.	Scope In (construction only)
Animal Diseases – Disease that can spread from animals to humans and those that cannot	No The Application Site is within an urban environment, which separates it from the nearest agricultural land.	No (construction and operation). The Scheme does not generate interaction with animals.	Scope Out
Power Failure	Yes	Yes (operation only). Disruption to road network and bridge operation. The construction phase is scoped out as this aspect of the Scheme is not present until the Scheme is	Scope In (operation only)

Accident/Disaster Group and Type	Location Risk	Potential Risk to Phase and/or Aspect of Scheme	Scoping for Further Consideration
		operational.	
System Failure (e.g. hydraulic or mechanical failure)	Yes	Yes (operation only) Disruption to road network and bridge operation. Construction phase is scoped out of construction phase as the aspect of the Scheme is not present until operation.	Scope In (operation only)
Major Traffic Accidents	Yes The Scheme is a road bridge development.	Yes (construction and operation). The nature of the Scheme as a road infrastructure project results in risk.	Scope In
Major Naval Accidents – Collision with the bridge element of the Scheme	Yes The Scheme is in a navigation channel with the risk of a naval collision.	Yes (construction and operation). The nature of the Scheme restricts navigation routes.	Scope In
Industrial and Urban Accidents	Yes The nature of surrounding	Yes (construction and	Scope In

Accident/Disaster Group and Type	Location Risk	Potential Risk to Phase and/or Aspect of Scheme	Scoping for Further Consideration
	land-use means potential accidents could result in a major hazard.	operation). The nature of the Scheme as a road infrastructure and proximity to storage areas results in risk.	
Pollution Accidents	Yes The nature of surrounding land-use means potential accidents could result in a major pollution incident with pathways to the water environment.	Yes (construction and operation). Proximity to storage areas and watercourses results in risk.	Scope In
Industrial Action	No No recent local record of industrial action.	No (construction and operation).	Scope Out
Public Disorder – Rioting, looting, vandalism, violence and arson by multiple individuals	Yes The Scheme is located within a densely populated area. Serious disorder could consequently result in damage to infrastructure.	Yes (construction and operation). Potential for disruption in all phases if a public disorder event occurs.	Scope In

Accident/Disaster Group and Type	Location Risk	Potential Risk to Phase and/or Aspect of Scheme	Scoping for Further Consideration
Malicious Attacks/Terrorism – Crowded places, Transport systems, Infrastructure, Cyber-attacks and Chemical/Biological/Radiological/Nuclear	Yes The Scheme is located within a densely populated area and would be a significant location within the local road network.	Yes (construction and operational). A potential major infrastructure target.	Scope In
Unexploded Ordnance	Yes According to Zetica UXO, the Application Site is located in a high bomb risk area, adjacent to some sites of interest (though not UXO find sites).	Yes (construction phase). The operational phase is scoped out as the Scheme does not facilitate exposure to potential UXO since, once constructed, it does not disturb ground conditions.	Scope In (construction phase only)

18.7 Assessment of Mitigation, Risk and Significance

Embedded Mitigation

18.7.1 Several mechanisms are in place that reduce the vulnerability of the Scheme to MA&D events, or mitigate significant effects on the environment should they occur. These are outlined in other assessments/documentation relating to the DCO, or are otherwise requirements pursuant other statutory regimes. These measures are treated as 'embedded mitigation' for the purpose of this assessment. Embedded mitigation encompasses measures included in the design phase, existing legislation and policy, and measures recommended as a result of other assessments that form part of the DCO.

18.7.2 The Scheme will reduce to as low as reasonably practicable the risk of MA&D events occurring and mitigating any such events.

18.7.3 Embedded mitigation comprises two categories, outlined below. These are those arising as a result of the Scheme design or outcomes from other assessments, and those already existing from other sources that relate to the Scheme.

<u>The Scheme</u>

18.7.4 Embedded mitigation measures are set out where relevant in the MA&D Significance Record. Further information on these mitigation measures can be found in the following documents:

- The Outline CoCP (document reference 6.16);
- Environmental Statement Chapters 2, 6, 11, 12, 13 and 14;
- Drainage Strategy (document reference 6.2);
- FRA (document reference 6.2);
- pNRA (document reference 6.14);
- TA (document reference 7.2);
- Framework Construction Traffic Management Plan (document reference 6.2);
- Design Report (document reference 7.4);
- Design Report Appendix A: Approach to Detailed Design (document reference 7.4a); and
- Design Report Appendix D: Lighting Report (document reference 7.4d).

Other Sources

18.7.5 Other embedded mitigation measures detailed in the MA&D Significance Record rely on legislation and/or strategies of external jurisdiction to the DCO application:

- Employers have the obligation to protect construction and maintenance workers through compliance with existing H&S legislation (detailed in Appendix 18A (document reference 6.2));
- Safety Policy obligations are required by Peel Ports Great Yarmouth (detailed in Appendix 18A (document reference 6.2)); and
- Design Codes that the Scheme has been designed to (Design Manual for Roads and Bridges (DMRB) and Eurocode – Basis of Structural Design), detailed in the Chapter 2: Description of the Scheme.

Additional Mitigation Requirements

18.7.6 Gaps in mitigation (MA&D event risk not mitigated for by embedded mitigation measures) are outlined in the MA&D Significance Record as 'Additional Mitigation' and are proposed to fill gaps highlighted in the assessment.

18.7.7 The applicant is currently undergoing consultation with the operators of two COMAH sites (Transco and ASCO) regarding potential impacts and interactions between the Scheme and the two sites. The following mitigation measure is proposed:

- The construction methodology to detail measures to mitigate risks associated with COMAH sites (in the Outline CoCP (document reference 6.16)).

Residual Significance

18.7.8 The residual risk significance of potential MA&D events after mitigation is recorded in the MA&D Significance Record for the construction and operation phases outlined below in Table 18.8.

Table 18.8: MA&D Significance Record (overleaf)

ID	Risk Event	Hazard Description	Hazard Source and/or Pathway	Reasonable Worst Consequence	Embedded Mitigation	Risk Significance	Additional Mitigation	Risk Residual Significance
Construction								
1	Flooding – Coastal/Tidal	Flooding of elements of the Principal Application Site resulting in damage and/or disruption to construction activities and/or injury/death to construction workers.	The North Sea and the River Yare	Could cause loss of life or permanent injury; local area evacuation; significant damage to equipment.	• Emergency procedures and processes (Outline CoCP (document reference 6.16)) • Emergency Flood Plan Measures (FRA (document reference 6.2) and Chapter 12: Flood Risk) • Mitigation Measures (Outline CoCP (document reference 6.16)) • Measures outlined in the Drainage Strategy (document reference 6.2). • Mitigation Measures (FRA (document reference 6.2)) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2)) • A response to a significant flood event is coordinated by the Norfolk Resilience Forum (all category 1 responders together with Peel Ports Great Yarmouth). The response is based on the	Significant	Given the baseline level of flood risk within Great Yarmouth, it is not possible to completely remove the risk of flooding to the access roads during a tidal flood event.	Significant

					predicted severity of the flood event (using information from the EA) but will include closure of river crossings as appropriate to protect life.			
2	Flooding – Rivers and streams	Flooding of elements of the Principal Application Site resulting in damage and/or disruption to construction activities and/or injury/death to construction workers.	The River Yare	Could cause loss of life or permanent injury; local area evacuation; significant damage to equipment.	• Emergency procedures and processes (Outline CoCP (document reference 6.16)) • Mitigation Measures (Outline CoCP (document reference 6.16)) • Measures outlined in the Drainage Strategy (document reference 6.2). • Mitigation Measures (FRA (document reference 6.2)) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2)) • A response to a significant flood event is coordinated by the Norfolk Resilience Forum (all category 1 responders together with Peel Ports Great Yarmouth). The response is based on the predicted severity of the flood event	Not Significant	None required	Not Significant

					(using information from the EA) but will include closure of river crossings as appropriate to protect life.			
3	Flooding – Surface and groundwater	Flooding of elements of the Principal Application Site resulting in damage and/or disruption to construction activities and/or injury/death to construction workers.	Precipitation and the River Yare	Could cause loss of life or permanent injury; local area evacuation; significant damage to equipment.	• Emergency procedures and processes (Outline CoCP (document reference 6.16)) • Mitigation Measures (Outline CoCP (document reference 6.16)) • Ground conditions mitigation (Outline CoCP (document reference 6.16)). • Measures outlined in the Drainage Strategy (document reference 6.2). • Mitigation Measures (FRA document reference 6.2) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2)) • A response to a significant flood event is coordinated by the Norfolk Resilience Forum (all category 1 responders together with Peel Ports Great Yarmouth). The response is based on the	Not Significant	None required	Not Significant

					predicted severity of the flood event (using information from the EA) but will include closure of river crossings as appropriate to protect life.			
4	Severe Weather – Storms and gales	Damage, disruption and/or injury/death to construction activities and construction workers as a result of violent weather in and around the water.	The North Sea	Could cause loss of life or permanent injury; local area evacuation; significant damage to equipment.	• Mitigation Measures (Outline CoCP (document reference 6.16)) • Measures outlined in the Drainage Strategy (document reference 6.2) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Significant	• Additional emergency procedures and processes (Outline CoCP (document reference 6.16))	Not Significant
5	Severe Weather – Wave surges	Damage, disruption and/or injury/death to construction activities and construction workers as a result of violent weather in and around the water.	The North Sea	Could cause loss of life or permanent injury; local area evacuation; significant damage to equipment.	• Mitigation Measures (Outline CoCP (document reference 6.16)) • Measures outlined in the Drainage Strategy (document reference 6.2) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Significant	• Additional emergency procedures and processes (Outline CoCP (document reference 6.16))	Not Significant
6	Severe Weather – Extreme high temperatures	Disruption, delay and injury to construction activities and construction workers due to temperatures and associated weather effects.	UK climate	Could result in disruption to construction activities.	• Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Not Significant	• Additional emergency Procedures to address risk (Outline CoCP (document	Not Significant

							reference 6.16))	
7	Severe Weather – Extreme low temperatures	Disruption, delay and injury to construction activities and construction workers due to temperatures and associated weather effects.	UK climate	Could result in disruption to construction activities.	• Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Not Significant	• Additional emergency Procedures to address risk (Outline CoCP (document reference 6.16))	Not Significant
8	Severe Weather - Coastal Fog	A reduction in visibility increasing the likelihood of collisions and other risks during construction activities.	The North Sea	Could result in disruption to construction activities and damage/injury to equipment and workers if activities continue.	• Existing H&S legislation (see Section 18.7.4 and Appendix 18.A) • Procedure outlined in Peel Ports Marine Safety Management Systems (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Not Significant	• Additional emergency Procedures to address risk (Outline CoCP (document reference 6.16)) • Navigation and other lighting measures for use during construction activities (Outline CoCP (document reference 6.16))	Not Significant
9	Poor Air Quality	Health impacts to construction workers as a result of exposure to concentrated areas of poor air quality during construction activities.	Construction equipment and vehicles	Death as a result of pre-existing health conditions; pressure on local healthcare facilities.	• Mitigation Measures (Outline CoCP (document reference 6.16)) • Mitigation Measures (Chapter 6: Air Quality) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Not Significant	None Required	Not Significant
10	Urban Fires	Disruption, damage and	Ignition sources	Could cause loss of life or	• Emergency	Not Significant	None Required	Not Significant

		injury/death to construction activities and workers resulting from a fire during construction.	and combustible materials.	permanent injury; significant damage to equipment; damage to surrounding property and infrastructure; disruption to essential services.	procedures and processes (Outline CoCP (document reference 6.16)) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))			
11	Human Diseases	Contraction of a disease (most likely pandemic flu) by construction workers during construction.	Respiratory, vector-borne, blood-borne and food-borne transmission, Construction workers.	Could result in health impact and/or death to human receptors; and facilitate the spread of a pandemic flu strain.	• Hygiene and contaminant measures (Outline CoCP (document reference 6.16)) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Not Significant	None Required	Not Significant
12	Major Traffic Accidents	Collisions of vehicles resulting in injury/death to human receptors and/or damage to construction equipment and delays to activities.	Construction vehicles and vehicles using adjacent road network.	Could cause loss of life or permanent injury; significant damage to equipment; damage to surrounding property and infrastructure; disruption to essential services.	• Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2) • Framework Construction Traffic Management Plan (document reference 6.2) • Public information measures (Chapter 14: People & Communities) • Mitigation and Best Practice Measures (TA (document reference 7.2) and Chapter 17: Traffic and Transport)	Not Significant	None Required	Not Significant

13	Major Naval Accidents	Collisions of vehicles resulting in injury/death to human receptors and/or damage to construction equipment and/or damage to the Scheme.	Construction workers and equipment operating within or directly adjacent to the River Yare.	Could cause loss of life or permanent injury; significant damage to equipment; permanent damage to the Scheme; damage to surrounding property and infrastructure; disruption to essential services.	• Naval channel access obligations (Outline CoCP (document reference 6.16)) • Construction mitigation measures (pNRA) (document reference 6.14) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2)) • Procedure outlined in Peel Ports Marine Safety Management Systems (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Not Significant	None Required	Not Significant
14	Industrial and Urban Accidents	Accidents resulting in fires and/or explosions (with the associated risks of injury and/or death and damage to surrounding construction activities) and the release of contaminants to the environment.	Construction workers, workers at industrial facilities, industrial facilities (ASCO and Transco sites), construction equipment, construction activities and the River Yare.	Could cause loss of life or permanent injury; significant damage to equipment; permanent damage to the Scheme; evacuation of staff; damage to surrounding property and infrastructure; environmental contamination; disruption to essential services.	• Explosion control mitigation measures (Outline CoCP (document reference 6.16)) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Significant	• Construction methodology to detail measures to add to the Outline CoCP (document reference 6.16) to mitigate risks associated with COMAH sites (the ASCO and Transco Sites). • Additional emergency Procedures to address risk (Outline CoCP (document reference 6.16)) • See section	Significant

							18.7.7 for details on outstanding consultation requirements.	
15	Pollution Accidents	The release of contaminants to the environment.	Construction Plant, Contact with industrial facilities, storage of pollutants, and The River Yare.	Environmental contamination.	• Emergency procedures and processes (Outline CoCP (document reference 6.16)) • Implementation of standard good practice pollution control measures (Outline CoCP (document reference 6.16)) • Pollution prevention guidance and best practice (Outline CoCP (document reference 6.16)) • Watching brief during works (Outline CoCP (document reference 6.16)) • Water environment protection measures (Outline CoCP (document reference 6.16)) • Dewatering and groundwater controls measures (Chapter 11: Road Drainage and the Water Environment) • Existing H&S legislation (see Section 18.7.4 and Appendix 18.A	Not Significant	None Required	Not Significant

					(document reference 6.2))			
16	Public Disorder	Violence associated with public disorder resulting in damage to construction activities and/or attacks and injuries to construction workers.	People	Could cause physical/psychological injury; disruption and/or damage to construction activities and/or equipment; evacuation of staff.	• Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Not Significant	• Additional emergency Procedures to address risk (Outline CoCP (document reference 6.16))	Not Significant
17	Unexploded Ordnance	Explosions as a result of disturbance of ordnance during construction activities, resulting in injury/death of construction workers and other human receptors.	Contact with Construction workers and/or construction activities.	Could cause loss of life or permanent injury; significant damage to equipment; permanent damage to the Scheme; evacuation of staff; damage to surrounding property and infrastructure; disruption to essential services.	• Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2))	Significant	• Additional emergency Procedures to address risk (Outline CoCP (document reference 6.16))	Not Significant
18	Malicious Attacks/Terrorism	Targeted violence resulting in potential significant damage to the Scheme itself or users of the Scheme.	People	Could cause loss of life or permanent injury; significant damage to equipment; permanent damage to the Scheme; evacuation of staff; damage to surrounding property and infrastructure; disruption to essential services.	• Existing H&S legislation (see Section 18.7.4 and Appendix 18.A (document reference 6.2)) • Restriction of access to construction site (Outline CoCP (document reference 6.16))	Not Significant	• Additional emergency Procedures to address risk (Terrorism) (Outline CoCP (document reference 6.16)) • Security Provisions (communication and agreement with the police etc.) (Outline CoCP (document reference 6.16))	Not Significant
Operation								
19	Flooding - Coastal/Tidal	Flooding of elements of the Scheme resulting in damage and/or disruption	The North Sea and the River Yare	Could cause loss of life or permanent injury; local area evacuation;	• See level rise adaptation measures (see	Significant	Given the baseline level of flood risk within Great	Significant

		to surrounding property/infrastructure and/or potential injury and/or death to users.		significant damage to the Scheme and/or surrounding property/infrastructure.	Chapter 13: Climate Change) • Measures outlined in the Drainage Strategy (document reference 6.2) • Emergency Flood Plan Measures (FRA (document reference 6.2) and Chapter 12: Flood Risk) • Sustainable Drainage Systems (SuDS) implementation (Chapter 12: Flood Risk) • Adaptation measures (Chapter 13: Climate Change) • Variable Message Sign (VMS) (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme) • A response to a significant flood event is coordinated by the Norfolk Resilience Forum (all category 1 responders together with Peel Ports Great Yarmouth). The response is based on the		Yarmouth, it is not possible to completely remove the risk of flooding to the access roads during a tidal flood event.	

					predicted severity of the flood event (using information from the EA) but will include closure of river crossings as appropriate to protect life.			
20	Flooding – Rivers and streams	Flooding of elements of the Scheme resulting in damage and/or disruption to surrounding property/infrastructure and/or potential injury and/or death to users.	The River Yare	Could cause loss of life or permanent injury; local area evacuation; significant damage to the Scheme and/or surrounding property/infrastructure.	• Measures outlined in the Drainage Strategy (document reference 6.2) • Emergency Flood Plan Measures (FRA (document reference 6.2)) • SuDS implementation (Chapter 12: Flood Risk) • Adaptation measures (Chapter 13: Climate Change) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme) • A response to a significant flood event is coordinated by the Norfolk Resilience Forum (all category 1 responders together with Peel Ports Great Yarmouth). The response is	Not Significant	None Required	Not Significant

					based on the predicted severity of the flood event (using information from the EA) but will include closure of river crossings as appropriate to protect life.			
21	Flooding – Surface and groundwater	Flooding of elements of the Scheme resulting in damage and/or disruption to surrounding property/infrastructure and/or potential injury and/or death to users.	Precipitation and the River Yare	Could cause loss of life or permanent injury; local area evacuation; significant damage to the Scheme and/or surrounding property/infrastructure.	• Measures outlined in the Drainage Strategy (document reference 6.2) • SuDS measures (FRA (document reference 6.2)) • SuDS implementation (Chapter 12: Flood Risk) • Adaptation measures (Chapter 13: Climate Change) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme) • A response to a significant flood event is coordinated by the Norfolk Resilience Forum (all category 1 responders together with Peel Ports Great Yarmouth). The response is	Not Significant	None Required	Not Significant

					based on the predicted severity of the flood event (using information from the EA) but will include closure of river crossings as appropriate to protect life.			
22	Severe Weather – Storms and gales	Damage and/or disruption to surrounding property/infrastructure and/or potential injury and/or death to users as a result of violent weather in and around the water.	The North Sea	Could cause loss of life or permanent injury; local area evacuation; significant damage to the Scheme and/or surrounding property/infrastructure.	• Measures outlined in the Drainage Strategy (document reference 6.2) • Adaptation measures (Chapter 13: Climate Change) • Emergency Flood Plan Measures (FRA (document reference 6.2)) • Flood event measures (Chapter 12: Flood Risk) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
23	Severe Weather – Wave surges	Damage and/or disruption to surrounding property/infrastructure and/or potential injury and/or death to users as a result of violent weather in and around the water.	The North Sea	Could cause loss of life or permanent injury; local area evacuation; significant damage to the Scheme and/or surrounding property/infrastructure.	• See level rise adaptation measures (see Chapter 13: Climate Change) • Measures outlined in the Drainage Strategy (document	Not Significant	None Required	Not Significant

					reference 6.2) • Adaptation measures (Chapter 13: Climate Change) • Emergency Flood Plan Measures (FRA (document reference 6.2)) • Flood event measures (Chapter 12: Flood Risk) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)			
24	Severe Weather – Extreme high temperatures	Disruption, delay and injury to infrastructure and users of the Scheme due to temperatures and associated weather effects.	UK climate	Could result in disruption to the Scheme and injury to users.	• Adaptation measures (Chapter 13: Climate Change) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
25	Severe Weather – Extreme low temperatures	Disruption, delay and injury to infrastructure and users of the Scheme due to temperatures and associated weather effects.	UK climate	Could result in disruption to the Scheme and injury to users.	• Adaptation measures (Chapter 13: Climate Change) • VMS (TA document reference 7.2) and Design Report	Not Significant	None Required	Not Significant

					(document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)			
26	Severe Weather - Coastal Fog	A reduction in visibility increasing the likelihood of collisions and other risks.	The North Sea	Could result in disruption to navigation due to reduced visibility or damage to the Scheme/people if navigation of channel continues during the weather event.	• Navigational Lighting (Design Report Appendix A (document reference 7.4a) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Procedure outlined in Peel Ports Marine Safety Management Systems (see Section 18.7.4 and Appendix 18.A (document reference 6.2)) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
27	Poor Air Quality	Health impacts to users of the Scheme as a result of exposure to concentrated areas of poor air quality.	Marine and Road vehicles	Death as a result of pre-existing health conditions; pressure on local healthcare facilities.	• Mitigation Measures (Chapter 6: Air Quality) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
28	Urban Fires	Disruption, damage and	Ignition sources	Could cause loss of life or	• Procedure outlined	Not Significant	• Emergency	Not Significant

		injury/death to the Scheme, surrounding properties/infrastructure and users resulting from fires.	and combustible materials.	permanent injury; significant damage to the Scheme; damage to surrounding property and infrastructure; disruption to essential services.	in Peel Ports Marine Safety Management Systems (see Section 18.7.4 and Appendix 18.A (document reference 6.2)) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Maintenance obligations (Chapter 2: Description of the Scheme) • Design Codes (Chapter 2: Description of the Scheme)		Preparedness & Response Plan (bridge closure, evacuation etc.)	
29	Power Failure	Disruption to operation of the Scheme and risk of injury and/or death.	Human error, severe weather, electricity overload.	Injury and/or death of users; disruption of essential service and the Scheme; Disruption to local road network.	• Adaptation measures (Chapter 13: Climate Change) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Maintenance Obligations (Chapter 2: Description of the Scheme) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
30	Systems Failure	Disruption to operation of the Scheme and risk of injury and/or death.	Human error, utilities failure, electricity failure.	Injury and/or death of users; disruption of essential service and the Scheme; Disruption to	• Adaptation measures (Chapter 13: Climate	Not Significant	None Required	Not Significant

				local road network.	Change) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Maintenance obligations (Chapter 2: Description of the Scheme) • Design Codes (Chapter 2: Description of the Scheme)			
31	Major Traffic Accidents	Collisions of vehicles resulting in injury/death to human receptors and/or damage to construction equipment and delays to activities.	Vehicles using the Scheme.	Could cause loss of life or permanent injury; significant damage to the Scheme; damage to surrounding property and infrastructure; disruption to essential services.	• VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Static Destination Signage Strategy (TA (document reference 7.2)) • Improvements to resilience of road network as a result of the Scheme (TA (document reference 7.2)) • Vehicle and access safety measures (Design Report (document reference 7.4)) • Highways Lighting (Design Report Appendix D (document reference 7.4d)) • Mitigation Measures (Chapter 17: Traffic	Not Significant	None Required	Not Significant

					and Transport) • Design Codes (Chapter 2: Description of the Scheme)			
32	Major Naval Accidents	Collisions of vehicles resulting in injury/death to human receptors and/or damage to construction equipment and/or damage to the Scheme.	Naval vessels navigating the channel	Could cause loss of life or permanent injury; significant; permanent damage to the Scheme; damage to surrounding property and infrastructure; disruption to essential services.	• Operation mitigation measures (pNRA) (document reference 6.14) • Control tower and safety measures (Design Report (document reference 7.4)) • Navigational Lighting (Design Report Appendix A (document reference 7.4a)) • Procedure outlined in Peel Ports Marine Safety Management Systems (see Section 18.7.4 and Appendix 18.A (documents reference 6.2)) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
33	Industrial and Urban Accidents	Accidents resulting in fires and/or explosions (with the associated risks of injury and/or death and damage to the Scheme and users of the Scheme, as well as the	Workers at industrial facilities, industrial facilities (ASCO and Transco	Could cause loss of life or permanent injury; significant damage to equipment; permanent damage to the Scheme; evacuation of staff;	• Maintenance Obligations (Chapter 2: Description of the Scheme)	Significant	Discussion is currently undergoing with operators of COMAH sites. See section 18.7.7 for	Significant

		release of contaminants to the environment.	sites), and the River Yare.	damage to surrounding property and infrastructure; environmental contamination; disruption to essential services.	• Design Codes (Chapter 2: Description of the Scheme)		details on outstanding consultation requirements.	
34	Pollution Accidents	The release of contaminants to the environment.	Contact with industrial facilities, storage of pollutants, vehicles using the Scheme and The River Yare.	Environmental Contamination.	• Pollution treatment/mitigation measures (Drainage Strategy (document reference 6.2)) • Surface Water Pollution mitigation and drainage design measures (Chapter 11: Road Drainage and the Water Environment) • VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
35	Public Disorder	Violence associated with public disorder resulting in damage and disruption to the Scheme.	People	Could cause physical/psychological injury; disruption and/or damage to construction activities and/or equipment; evacuation of staff.	• VMS (TA document reference 7.2) and Design Report (document reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)	Not Significant	None Required	Not Significant
36	Malicious Attacks/Terrorism	Targeted violence resulting in potential significant damage to the Scheme itself or users of the Scheme.	People	Could cause loss of life or permanent injury; permanent damage to the Scheme; evacuation of staff; damage to	• VMS (TA document reference 7.2) and Design Report (document	Not Significant	• Emergency Preparedness & Response Plan (Terrorism).	Not Significant

				surrounding property and infrastructure; disruption to essential services.	reference 7.4) • Design Codes (Chapter 2: Description of the Scheme)		• Security Provisions (communication and agreement with the police etc.) These provisions and agreements are to be prepared, and the consultation with the police completed, prior to the Scheme becoming operational.	

18.8 Limitations and Assumptions

18.8.1 It has been assumed that all risks assessed have the potential to result in a MA&D event, taking a worst-case approach to assessment.

18.8.2 The Scheme is being designed and its implementation guided by other industry standards and codes, which include both mandatory and non-mandatory requirements. These standards include the requirements to eliminate, or reduce as far as reasonably practicable, the risk to people and the environment through design.

18.8.3 Environmental effects associated with events that do not meet the definition of a MA&D event (such as minor spills of contaminates that can be contained within the construction site) are not considered in this chapter, instead being addressed in the relevant topical chapter.

18.8.4 A presumption of standard good practice and regulatory compliance has been assumed for all construction, maintenance and management activities associated with the Scheme.

18.8.5 No site visits were conducted for the purpose of this assessment, a desk-based assessment was conducted with support from other environmental specialists.

18.8.6 No new modelling or risk assessments were completed to inform this assessment. The assessment instead sign-posts to previously completed model outputs, risk assessments and any gaps identified in these.

18.8.7 Where information has not been available, professional judgement has been used to reach conclusions.

18.9 Summary

18.9.1 Given the processes that are in place it is considered that the risks of any MA&D event occurring will be managed to be as low as reasonably practicable. As a result, the significant environmental effects arising from the vulnerability of the Scheme to MA&D events are as a result of coastal/tidal flooding risk (during construction and operation) and industrial and urban accidents (during construction and operation).

18.9.2 The key baseline conditions in relation to MA&D are the existing residual flood risk associated with the Scheme location. The key external influencing factors are the existence of the two COMAH sites.

18.9.3 The key embedded mitigation measures for the construction phase are those detailed in the Outline CoCP (document reference 6.16) and existing H&S legislation (see Appendix 18A) (document reference 6.2).

18.9.4 The key embedded mitigation measures for the operation phase are those outlined in Peel Ports and other maritime bodies safety/navigation strategies (see Appendix 18A) (document reference 6.2), the TA (document reference 7.2) and Chapter 13: Climate Change.

18.9.5 Of the additional mitigation measures required, of most importance are additional measures needed to address industrial risks associated with the Transco and ASCO facilities (COMAH sites) within 1km of the Scheme. These measures are required for both the construction and operation stage and are included in the Outline CoCP (document reference 6.16) and are to be prepared in a management plan. Details on the currently undergoing consultation process between the Applicant and the COMAH site operators are outlined in section 18.7.7.

18.9.6 Table 18.9 presents a summary of significant effects.

Table 18.9. Summary of Significant Effects

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation / Enhancement	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
Construction Phase				
Flooding (Coastal/Tidal): Flooding of elements of the Scheme resulting in damage and/or disruption to surrounding property/infrastructure and/or potential injury and/or death to users.	The Scheme and receptors identified in Section 18.6	Significant	• Extensive embedded mitigation measures (see Section 18.7) • Given the baseline level of flood risk within Great Yarmouth, it is not possible to completely remove the risk of flooding to the access roads during a tidal flood event.	Significant
Industrial and Urban Accidents: Accidents resulting in fires and/or explosions (with the associated	The Scheme and receptors identified in	Significant	• Additional emergency Procedures to address risk	Significant

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation / Enhancement	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
risks of injury and/or death and damage to surrounding construction activities) and the release of contaminants to the environment.	Section 18.6		(Outline CoCP (document reference 6.16)) • See section 18.7.7 for details on outstanding consultation requirements.	
Operational Phase				
Flooding (Coastal/Tidal): Flooding of elements of the Scheme resulting in damage and/or disruption to surrounding property/infrastructure and/or potential injury and/or death to users.	The Scheme and receptors identified in Section 18.6	Significant	• Extensive embedded mitigation measures (see Section 18.7) • Given the baseline level of flood risk within Great Yarmouth, it is not possible to completely remove the risk of flooding	Significant

Description of Effects	Receptor	Significance and Nature of Effects Prior to Mitigation / Enhancement	Summary of Mitigation / Enhancement	Significance and Nature of Effects Following Mitigation / Enhancement (Residual)
			to the access roads during a tidal flood event.	
Industrial and Urban Accidents: Accidents resulting in fires and/or explosions (with the associated risks of injury and/or death and damage to the Scheme and users of the Scheme, as well as the release of contaminants to the environment.	The Scheme and receptors identified in Section 18.6	Significant	• See section 18.7.7 for details on outstanding consultation requirements.	Significant

References

Ref 18.1: Cabinet Office (2017). National Risk Register of Civil Emergencies – 2017 Edition.

Ref 18.2: The European Union (2012). Directive 2012/18/EU: On the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC

Ref 18.3: The European Parliament and the Council of the European Union (2014). Directive 2014/52/EU, amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.

Ref 18.4: The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. The Stationary Office (2017) http://www.legislation.gov.uk/uksi/2017/572/pdfs/uksi_20170572_en.pdf.

Ref 18.5: The Planning Inspectorate (2017). Advice Note 11: Working with public bodies in the infrastructure planning process: Annex G – The Health and Safety Executive.

Ref 18.6: The Health and Safety at Work Act (HSWA) 1974; Harold Glover, Controller of her Majesty's Stationary Office and Queens Printer of Acts of Parliament. https://www.legislation.gov.uk/ukpga/1974/37/pdfs/ukpga_19740037_en.pdf

Ref 18.7: The Management of Health and Safety at Work Regulations 1999; The Stationary Office. http://www.legislation.gov.uk/uksi/1999/3242/pdfs/uksi_19993242_en.pdf

Ref 18.8: The Occupier's Liability Act 1984; W.J Sharp, Controller of her Majesty's Stationary Office and Queens Printer of Acts of Parliament. https://www.legislation.gov.uk/ukpga/1984/3/contents

Ref 18.9: The Supply of Machinery (Safety) Regulations 2008. The Stationary Office. http://www.legislation.gov.uk/uksi/2008/1597/contents/made

Ref 18.10: The Construction (Design and Management) (CDM) Regulations 2015. The Stationary Office. http://www.legislation.gov.uk/uksi/2015/51/contents/made

Ref 18.11: Defra (2011). Guidelines for Environmental Risk Assessment and Management: Green Leaves III, Cranfield University and Department for Environment, Food and Rural Affairs.

Ref 18.12: Norfolk County Council (2011). Preliminary Flood Risk Assessment: Norfolk County Council.

Ref 18.13: Norfolk County Council (2015). Investigation Report into flooding across Great Yarmouth Borough during the summer of 2014.

Ref 18.14: Norfolk Resilience Forum (2014). Community Risk Register Matrix.

Ref 18.15: Met Office (2013). England and Wales drought 2010 to 2012.

Ref 18.16: World Health Organisation (2019). Emergencies preparedness, response – United Kingdom of Great Britain and Northern Ireland: Country Information.

Ref 18.17: Norfolk Constabulary (2016-2018). North Yarmouth Crime Map.

Ref 18.18: Norfolk Constabulary (2016-2018). South Yarmouth Crime Map.

19 Cumulative Effects

19.1 Introduction

19.1.1 This chapter presents the findings of the Cumulative Effects Assessment (CEA) of the Scheme on the receiving environment during both the construction and operational phases. It is supported by Figures 19.1 and 19.2.

19.1.2 The focus of this CEA is to assess how the effects of the Scheme interact with the effects of other developments, and to assess the effects that occur between the different environmental topics. The in-combination (see paragraph 19.1.6) portion of the assessment has been based upon Cumulative Effects Assessment Advice Note 17 (Version 1, December 2015) (Ref 19.1) (herein referred to as 'Advice Note 17').

19.1.3 The term cumulative is not defined in either the EIA Directive (Ref 19.2) or the EIA Regulations (Ref 19.3). Therefore, for the purpose of this assessment, the definition from Volume 11, Section 2, Part 5 of the DMRB (Ref 19.4) has been used. This definition identifies two types of cumulative impact:

- "Cumulative impacts from a single project; and
- Cumulative impacts from different projects (in combination with the project being assessed)."

19.1.4 In the first type (cumulative impacts from a single project), the impact arises from the combined action of a number or different environmental topic-specific impacts upon a single receptor/resource.

19.1.5 In the second type (cumulative impacts from different projects, in combination with the project being assessed), the impact may arise from the combined action of a number of different projects, in combination with the project being assessed, on a single receptor/resource. This can include multiple impacts of the same or similar type from a number of projects upon the same receptor/resource.

19.1.6 As described in Chapter 4: Approach to the EIA, this CEA assesses both types of cumulative impacts. Those from a single project (herein referred to as 'effect interactions') that occur where a resource or receptor is affected by different aspects of the Scheme, and cumulative impacts from different projects (herein referred to as 'in-combination effects'), that occur because of

the likely impacts on a shared resource or receptor of the Scheme interacting with the impacts of 'other developments' in the vicinity.

19.1.7 The assessment is primarily based on the results of technical chapters 6-18 and corresponding appendices (document reference 6.2). Additional non-ES documents that have been used to inform the assessment are:

- Transport Assessment (TA) (document reference 7.2); and
- Habitat Regulations Assessment (HRA) (Document reference 6.11).

Study Area

19.1.8 The study area for the assessment has been determined following consideration of the likely significant effects that could reasonably arise from the projects that have been considered alongside the Scheme. The Zone of Influence (ZOI) for each environmental topic is defined by relevant guidelines discussed in each respective chapter and is shown in Figure 19.1 and detailed in Table 19.13. Other developments that fall within these ZOI have been considered on a case by case basis. A list of all other developments considered in the ZOI is contained in Table 19.15. The location of the other developments that were assessed (the short list) is shown in Figure 19.2 and detailed in Table 19.16.

Future Baseline

19.1.9 A future baseline assessment has not been carried out for the purpose of this assessment. The in-combination assessment presents future baseline conditions as part of the assessment process.

19.2 Competent Expert

19.2.1 Jerome Kreule, holds a MEnvSci degree in Environmental Sciences (Sustainable Environmental Management) from the University of Southampton (2017). Jerome has multi-disciplinary experience in the preparation of Environmental Statements, including CEA assessments.

19.2.2 Anna Hagan hold a MSc degree in Sustainability, Planning and Environmental Policy from Cardiff University (2018). Anna has experience assisting in the preparation of Environmental Statements, including CEA assessments.

19.3 Legislation, Policy and Guidance Summary

19.3.1 Table 19.1 provides a summary of the key legislation, policy and guidance for this assessment.

19.3.2 A summary of all applicable legislation, policy and guidance of relevance to this assessment is provided in Appendix 19A (document reference 6.2).

Table 19.1: Summary of Key Legislation, Policy and Guidance

Legislation	Summary	Chapter Reference
The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref 19.3)	These regulations cover the process of EIA in the context of town and country planning in England. They apply the amended EU Directive 2014/52/EU. Paragraph 5, Schedule 4 of the EIA Regulations 2017 state that an ES should include: "*A description of the likely significant effects of the development on the environment resulting from, inter alia:* *(e) the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources."* The description of the likely significant effects on the factors: "*[…] should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the development*."	This chapter complies with the regulations describing the likely significant cumulative effects with other projects as a result of the construction and operation of the Scheme. The assessment methodology is detailed in Section 19.4 and the full assessment is located in Section: 19.6.
The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (Ref 19.5)	These regulations provide specific thresholds of scale to determine if a development requires an EIA. Advice Note 17 specifies that statutory definitions of EIA screening thresholds can be of assistance when considering whether the scale and nature of the developments identified in the ZOI are likely to interact with the proposed	This chapter uses the thresholds taken from the regulations as part of stage 1 and stage 2 of the in-combination assessment.

Legislation	Summary	Chapter Reference
	project and to result in a cumulative effect.	
The National Planning Policy Framework (NPPF) 2019 (Ref 19.6)	Paragraph 180 states: *"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development."* Paragraph 181 states: *"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications.*"	The chapter has considered these principles throughout both the in-combination and effect interaction assessment.
The National Policy Statement for National Networks (NN NPS) (Ref 19.12)	This policy statement outlines the main objectives on Government Policy for National Networks. The NN NPS states that the SoS should take into account *"potential adverse impacts, including any longer term and cumulative adverse impacts, as well as any measures to avoid, reduce of compensate for any adverse impacts*". The Examining Authority	The chapter fulfils the policy considering the interrelationship between effects rather than only in isolation. This assessment was conducted in the form of in-

Legislation	Summary	Chapter Reference
	should consider how significant cumulative effects and the interrelationships between effects might as a whole affect the environment, even though they may be considered on an individual basis with mitigation measures in place.	combination and effect interaction assessments, found in Sections 19.5 and 19.6.
The National Policy Statement for Ports (NPS for Ports) (Ref 19.7)	The NPS for Ports provides a framework for the decisions on proposals for new port development. It applies, wherever relevant, to associated development, such as road and rail links, for which consent is sought alongside that for the principal development. The NPS for Ports specifically identifies adverse cumulative impacts upon health as a topic for consideration within an ES, as well as the cumulative effects from flooding and the potential shortage of construction workers.	The chapter fulfils the policy by considering potentially adverse cumulative effects on human receptors, in the context of human health impacts.
Planning Inspectorate Advice Note 17: Cumulative Effects Assessment (Ref 19.1)	This advice note identifies the nature of projects (referred to as 'other developments' in the Advice Note) that should be considered in a CEA. It advises that a pragmatic approach should be undertaken in respect of what is feasible and reasonable, where there is a lack of information to fully assess impacts.	This guidance methodology has been used to complete the in-combination CEA (see section 19.4 and 19.6)
	Paragraph 3.4.5 states: *"In preparing the assessment, it should not be forgotten that a key purpose of EIA is to inform the examination and decision-making process (its findings must be 'taken into consideration'). Whilst applicants should make a genuine* *attempt to assess the effects arising from multiple, individually non-*	This guidance has been considered throughout the assessment contained in this chapter.

Legislation	Summary	Chapter Reference
	significant effects, the CEA should be proportionate and not be any longer than is necessary to identify and assess any likely significant cumulative effects that are material to the decision-making process, rather than cataloguing every conceivable effect that might occur."	
Planning Inspectorate Advice Note 9: Rochdale Envelope (Ref 19.8)	This advice note reaffirms the established principle that: *"The ES should not be a series of separate unrelated topic reports. The inter-relationship between aspects of the proposed development should be assessed and careful consideration should be given by the developer to explain how inter-relationships have been assessed in order to address the environmental impacts of the proposal as a whole. It need not necessarily follow that the maximum adverse impact in terms of any one topic impact would automatically result in the maximum potential impact when a number of topic impacts are considered collectively. In addition, individual impacts may not be significant but could become significant when their interrelationship is assessed. It will be for the developer to demonstrate that the likely significant impacts of the project have been properly assessed."*	The assessment of effect interactions ensures that the ES is not a series of separate assessments collated into one document, but rather a comprehensive assessment drawing together the environmental effects (see section 19.5).

19.4 Scope, Methodology and Significance Criteria

Scope of the Assessment

19.4.1 This section sets out the scope of the assessment and evidence base which has developed following further iterative assessment since the scoping report (document reference 6.6) add Scoping Opinion and PIER (appended to Consultation Report (document 5.2)).

Consultation

19.4.2 An overview of consultation undertaken on the Scheme is provided in Chapter 5: Consultation.

19.4.3 Table 19.2 provide a summary of the scoping opinions received, and the associated replies response from the Applicant which have informed the scope, methodology and assessments in this chapter. No specific section 42 responses were made in relation to this chapter.

Table 19.2: Summary of Scoping Opinions Received and Responses within this Chapter

Section of Scoping Opinion	SoS Comments	Response
3.3.1	The Inspectorate recommends that in order to assist the decision-making process, the Applicant uses tables: • To demonstrate how the assessment has taken account of this Opinion; • To identify and collate the residual effects after mitigation for each of the aspect chapters, including the relevant interrelationships and cumulative effects; and • To set out the proposed mitigation and/or monitoring measures including cross-reference to the means of securing such measures (e.g. a DCO requirement).	• Table 19.2 demonstrates how the assessment has taken account of this Scoping Opinion; and • Table 19.11, Table 19.12 and Table 19.17 set out the proposed mitigation, residual effects and/or monitoring measures, including cross-reference to the means of securing such measures (e.g. a DCO requirement).
3.3.6	The Scoping Report makes reference to 'new developments', projects and committed developments, particularly at Section 6.13 Traffic and Transport and	Table 19.15 and Appendix 19B (document reference 6.2) include the status of other developments at the time of writing, including the anticipated construction programme

Section of Scoping Opinion	SoS Comments	Response
	Section 6.14 Cumulative Effects. The Scoping Report does not indicate the stage of development these developments are likely to be at the point of the DCO application. The Applicant should clearly state in the ES which developments will be assumed to be under construction or operational as part of the future baseline.	and operational opening dates where known.
4.13 (ID 1)	Flood Risk and Great Yarmouth Tidal Barrier: The Scoping Report states that the Flood Risk Assessment will adopt a worst-case approach by excluding the Great Yarmouth Tidal Barrier from the assessment model. The Inspectorate is content that this would result in a worst-case scenario in terms of flood risk; however, the same cannot be said of other aspects chapters which should rightly include an assessment of the Great Yarmouth Tidal Barrier in the cumulative assessment. The ES should clearly explain any assumptions made in the Cumulative Effects Assessment (CEA) assessment matrix (where produced).	It is understood that this project is at the early concept stage and the funding has not yet been applied for. It was therefore excluded from the CEA as part of Stage 2 of the in-combination assessment. Justification of exclusion is shown in section 19.6.
4.13 (ID 2)	Traffic: The Scoping Report states that operational phase effects for air quality and noise, and some aspects of the road drainage will include cumulative effects	This information has been provided in section 19.6.

Section of Scoping Opinion	SoS Comments	Response
	in so far that the traffic data on which they are based includes both future development and natural traffic growth. The cumulative effects assessment should clearly state the other developments that have been included within the traffic data, and provide appropriate cross-reference to other aspect chapters, as applicable.	
4.13 (ID 3)	Consultation: The Applicant should also consult with GYBC regarding the projects to be included within the cumulative effects assessment.	The GYBC scoping response provided additional advice on other schemes for inclusion within the CEA. These include: South Denes Enterprise Zone; Beacon Park Enterprise Zone; Epoch 2 of the Great Yarmouth Flood Defence Improvements; A47 Junction improvements (Gapton Hall, Harfreys and Vauxhall); consent for 1,000 residential dwellings at Beacon Park; North Lowestoft Garden Village; and the proposed leisure developments south of Pleasure Beach. These schemes have been included in the long list of other developments in the CEA, and are listed within Table 19.15.
4.13 (ID 4)	Stage 1 – Zone of Influence: The Scoping Report identifies a total of eight other developments for consideration within the CEA. However, no evidence has been provided for the selection of these projects, such as ZOI analysis or a desk study. In addition, the level of certainty and tier of the projects, as detailed in Table 3 of the Planning Inspectorate's Advice	At the scoping stage the ZOI was still being established. The confirmed ZOIs for individual topics can be seen in Table 19.13, and justification/evidence provided in the technical chapters. The Scoping Report did not provide the level of certainty and tier of projects set out in Table 3 of Advice Note 17, as the CEA was still at Stage 1. The level of certainty and tier of projects can be seen in Table 19.15 and Appendix 19B (document

Section of Scoping Opinion	SoS Comments	Response
	Note 17 has not been provided. Further information regarding the CEA, including the desk study process and ZOI, must be provided in the ES to justify the projects that have been identified for inclusion in and exclusion from the CEA. The Applicant may wish to include a figure(s) in the ES or associated appendices identifying the location of the projects/plans considered in the CEA to aid understanding.	reference 6.2) within the long list of 'other developments'. Sections 19.4 and 19.6 contain further information on the desk study process through Stages 1-4, and provide justification for the inclusion and exclusion of projects.
4.13 (ID 5)	Stage 1 – Projects: The Inspectorate notes the identification of the "East Anglia Array Windfarm" in the list of projects. There are several East Anglia windfarms NSIPs proposed or consented. The ES should make clear to which NSIP(s) this relates.	The East Anglia Array is a wind farm development that consists of four phases, although it is noteworthy that two of these phases are proposed to be combined into a single DCO submission. These will be clearly distinguished as separate NSIPs that form part of a larger project. East Anglia ONE received development consent in August 2014. It is understood that construction of the onshore elements commenced in May 2017; the offshore works were due to commence in August 2018; first power is to be achieved in 2019; and full operation during 2020. The construction phase of this development is unlikely to significantly overlap with that of the Scheme. East Anglia THREE received development consent in August 2017. The Environmental Statement (Ref 19.9) submitted with the application states that *"Construction of the proposed East Anglia THREE project…would commence between 2020 and 2025"*. This will overlap with

Section of Scoping Opinion	SoS Comments	Response
		the construction phase of the Scheme. A scoping opinion for East Anglia TWO (Ref 19.10) and East Anglia ONE NORTH (Ref 19.11) was issued by the SoS in December 2017. The scoping opinion for both projects notes that *"Onshore construction works are anticipated to take approximately 18 to 24 months"*. However, the developer's website states that the construction of East Anglia TWO will commence in 2025 and construction of East Anglia ONE North will commence in 2026. The construction of these developments is unlikely to significantly overlap with that of the Scheme. On this basis East Anglia ONE, East Anglia ONE NORTH, and East Anglia TWO are excluded from the assessment, whilst East Anglia THREE is included. This was determined as part of Stage 2 of the in-combination assessment, as shown in Table 19.15 and Table 19.16.

Assessment Methodology

Effect Interactions

19.4.4 Some environmental topics interact, for example, changes in air quality, road traffic noise, and visual impact. Therefore, several effects on a receptor or resource shared by these environmental topics hypothetically could interact to produce a combined effect of overall greater significance than each individual effect on its own.

19.4.5 There is no established EIA methodology for assessing and quantifying the effects of multiple individual impacts on the same receptor or resource. However, as discussed in Chapter 4, this ES reports on effects resulting from the construction (including demolition), and operation of the Scheme.

This approach has been used in the assessments of each technical chapter of this ES to report the effects on receptors and resources, and therefore continues throughout this chapter.

19.4.6 The significance of effect interactions has been determined by considering the following factors:

- Which receptors or resources are affected by more than one environmental topic; and
- How the Scheme affects the condition of the receptor or resource, using information contained within each technical chapter.

19.4.7 The reported residual effects on receptors and resources within each of the technical chapters, Chapters 6-18, have been carried through to this effect interaction assessment. The assessment considers effect interactions at the construction phase and operational phase of the Scheme. Where more than one residual effect on a receptor or resource has been identified the effect interaction assessment has considered the potential for cumulative effects of greater significance than each individual effect considered separately. Where cumulative effects of greater significance have been identified consideration has been given to the need for additional mitigation measures.

19.4.8 This assessment considers any residual effects that are reported as very large, large, moderate or slight within separate technical chapters. Slight effects, while not significant, are considered in the assessment on the basis that multiple minor effects may interact to result in a significant effect. Neutral residual effects, those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error, reported in separate technical chapters are considered unlikely to accumulate to the extent that a significant cumulative effect would occur.

19.4.9 The assessment of effect interactions has been undertaken in three steps. These steps have been taken for assessment of both the construction and operation phase:

- Step A: Identification of receptors or resources considered in more than one technical chapter, and therefore having the potential to be affected by more than one environmental topic. It is during this step that exclusions have been identified to avoid overlap with information reported in technical chapters, as discussed in Section 19.4;
- Step B: For receptors or resources identified in step A, the significance of the residual effect from each relevant technical chapter have been identified; and

- Step C: For receptors or resources identified in step B, consideration has been given to whether there would be a cumulative effect and if so whether that effect would be of the same or greater significance than the component effects.

19.4.10 The significance of effect interactions cumulative effects has been determined using the significance criteria outlined in Chapter 4: Approach to EIA. Full details of the significance process can be found there. The significance criteria classifications have been reproduced in Table 19.3 below.

Table 19.3: Descriptors of the Significance of Effect Interactions

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

In-combination Effects

19.4.11 Advice Note 17 (Ref 19.1) has been adopted for the Scheme for the assessment of in-combination cumulative effects. The approach within Advice Note 17 identifies a four-stage process to the CEA process, summarised below in Table 19.4.

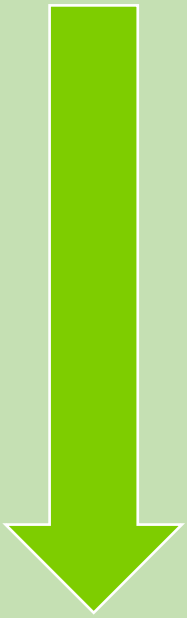
Table 19.4: In-combination Assessment: Main Stages and Activities

CEA Stage	Main Activities
Stage 1 **Establishing a Zone of Influence (ZOI) for the Scheme and identifying a long list of 'other developments'**	A desk study was undertaken to establish the ZOI for each environmental topic scoped within the Scheme. The ZOI analysis is documented in Table 19.13 and supported by Figure 19.1 which shows the ZOI boundary. A desk study was conducted of planning documents, development plan documents, and relevant development frameworks within the ZOI (applying professional judgement on a case by case basis), identifying a long list

CEA Stage	Main Activities
	of 'other developments' that are proposed within this area. These developments progressed to Stage 2. The long-list was sent to both NCC and GYBC for consultation (for details see Table 19.14).
Stage 2 **Identify a shortlist of 'other developments' for CEA**	The potential for significant cumulative effects of the developments in the long-list was assessed, applying exclusion/inclusion criteria. A shortlist of 'other developments' was identified to take forward for full CEA. A GIS map was produced (Figure 19.2) to show the location of the short list developments in relation to the Scheme. Information identifying the key issues to be taken forward to Stage 3 and Stage 4 is documented within the assessment, with further information in Appendix 19C (document reference 6.2). The shortlist was sent to both NCC and GYBC for consultation (for details see Table 19.14).
Stage 3 **Information gathering**	Information regarding the shortlisted 'other developments' was gathered to inform the full CEA, as documented in Appendix 19B and Appendix 19C (document reference 6.2).
Stage 4 **Assessment**	A review of each of the 'other developments' in turn has been undertaken to assess whether cumulative effects may arise. Mitigation measures have been identified in relation to any adverse cumulative effects. To identify suitable mitigation measures the apportionment of effect between the Scheme and the 'other developments' was considered, and professional judgement used. Where required, monitoring measures have been identified to confirm that mitigation measures are working as intended, or to confirm effects where there was uncertainty.

19.4.12 'Other Developments' are categorised into tiers by the certainty associated with the development (such as if the development is already under construction or is in a pre-application stage). This approach is published within Advice Note 17 and reproduced in Table 19.5 below.

Table 19.5: "Other Development" types for Inclusion in CEA

Tier 1	Under construction.	Decreasing level of detail likely to be available. 
	Consented application(s), whether under the Town and Country Planning Act, the Planning Act 2008 or other regimes, but not yet implemented.	
	Submitted application(s) whether under the Planning Act 2008 or other regimes but not yet determined.	
Tier 2	Projects on the Planning Inspectorate's Programme of Projects, NCC's planning register and GYBC's planning register, where a scoping report has been submitted.	
Tier 3	Projects on the Planning Inspectorate's Programme of Projects, the NCC's planning register and GYBC's planning register, where a scoping report has not been submitted.	
	Projects identified in the Great Yarmouth Local Plan (and emerging Local Plan), Great Yarmouth Development Plan and the Waveney Local Plan (with appropriate weight being given based on currency of adopted plan and progress toward adoption of emerging plans) recognising that information on any relevant proposals will be limited.	
	Projects identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward.	

19.4.13 Any projects identified as under construction that are expected to be completed before construction of the Scheme have been excluded from the assessment at Stage 2, as shown in Table 19.16.

19.4.14 Refused planning applications that are not subject to appeal have not been considered as their implementation is not considered to be reasonably foreseeable.

19.4.15 The assessment considers the capacity of environmental resources and receptors to accommodate changes that are likely to occur. This includes the duration, extent, type (additive or synergistic), frequency, value and resilience of the receptor, and likely mitigation.

19.4.16 It is important to note that the stages of the assessment have been conducted in parallel with one another rather than following a linear process suggested by the four stages in Advice Note 17. For example, the

information gathered at Stage 3 has informed Stage 2. Further information about the four stages of the CEA, and how they have been followed for the Scheme, are provided in the following sections.

In-combination Effects - Stage 1 and Stage 2

19.4.17 Stage 1 of the approach outlined in Advice Note 17 requires the identification of a 'long list' of other developments and high-level information, such as the development location or the boundary of the application. The long list of other developments initially presented in the EIA Scoping Report (document reference 6.6) has been under review during the preparation of this ES and updated as required.

19.4.18 Advice Note 17 states that the "…scale and nature of NSIPs will typically dictate a broad and temporal zone of influence (ZOI) for an NSIP". For individual environmental topics (see Table 19.13), the ZOI is defined by the relevant institutional guidelines which are discussed within each respective technical chapter (Chapters 6-18). However, in determining a ZOI for 'other developments' that could give rise to cumulative effects when interacting with the Scheme it is necessary to consider each development on a case by case basis. The consideration of other developments at this stage relies on professional judgement. Developments within the ZOI vary in distance from the Scheme, nature and scale and those determined as not having the potential for any cumulative effects from the Scheme are not listed.

19.4.19 The developments on the long list were evaluated to determine if they should be taken forward to the short list of 'other developments' for each individual environmental topic. Considerations included the temporal scope (construction and operation programmes of other developments), as well as whether there are any shared receptors or pathways for cumulative effects, to establish whether there is overlap and any potential for interaction.

19.4.20 Applications were assessed for inclusion within the long and short lists on a case by case basis and professional judgement was used. When considering urban development planning applications within the ZOI, EIA screening thresholds were applied to determine if the scale and nature of the development was likely to interact with the Scheme. The Infrastructure Planning EIA Regulations 2017 (Ref 19.3) does not set out thresholds, and therefore the EIA screening thresholds, set out in Schedule 2, category 10(b) 'Urban Development' projects, of the Town and Country Planning EIA Regulations 2017 (Ref 19.5), were used to set the threshold for the scale of developments to take forward to the short list. The thresholds are as follows:

- The development includes more than one hectare of urban development which is not dwelling house development; or

- the development includes more than 150 dwellings; or
- the overall area of the development exceeds five hectares.

19.4.21 The traffic model results informed the assessment of vehicle emissions within the air quality assessment (see chapter 6) and road traffic noise within the noise and vibration assessment (see chapter 7). The traffic modelling incorporated other developments into its future baseline information. As a result of this, operational impacts for these environmental topics have been excluded from this assessment (see paragraphs 19.6.7 and 19.6.13 for further information).

19.4.22 A desk study was completed to examine and record committed developments which, as a result of scope and nature or temporal scope, could have an in-combination cumulative effect with the Scheme. Developments suggested within the GYBC Scoping response (document reference 6.7) were also considered, and GYBC and NCC were consulted on the resulting list as shown in Table 19.14. Where neutral residual effects have been concluded on a receptor or environmental topic for either the Scheme or the 'other development' being considered, this has been used to screen out the receptor or environmental topic in Stage 2.

19.4.23 Where it is considered that interactions between other developments and the Scheme could potentially result in an in-combination cumulative effect, further assessment of the scale and nature of developments has been undertaken in Stage 3 and Stage 4.

In-combination Effects - Stage 3 and Stage 4

19.4.24 Information on 'other developments' included within the short list has been gathered from available third-party information sources in the public domain. This information has included, where available, reported environmental effects, design, location, construction programme (including demolition), and operational activities. Descriptions of the other developments which remain on the short list is included in Appendix 19B and 19C (document reference 6.2).

19.4.25 The in-combination CEA undertaken is reported in Section 19.6 and is based on the template within Appendix 1 of Advice Note 17. The table includes the assessment of the in-combination effects of the Scheme with the short listed 'other developments', along with any proposed additional mitigation.

19.4.26 For each shortlisted development, the residual effects (as stated in each technical chapter (Chapters 6-18)) of the Scheme alone on identified shared receptors or resources are detailed in the CEA table. The in-combination CEA table also presents the effects on the shared receptors or resources

from each shortlisted development, obtained from third-party information where available. Where information on effects from shortlisted developments has not been available, professional judgement has been used to identify the potential for significant cumulative effects.

19.4.27 The in-combination CEA considers the potential for significant residual cumulative effects with any required mitigation in place, see Table 19.6. The significance of the effect is formulated as a function of a receptor's or a resource's environmental value/sensitivity and the magnitude of the project impact. Advice Note 17 (Ref 19.1) states:

"The significance criteria used to assess likely cumulative effects should consider the capacity of environmental resources and receptors to accommodate changes that are likely to occur. The terminology used to determine significance should be explicit and ensure a clear understanding of the outcome of the CEA".

19.4.28 The significance of in-combination effects will be determined using the significance criteria for cumulative effects, published within Volume 11, Section 2, Part 5 of the DMRB (HA 205/08) (Ref 19.4). This has been reproduced in Table 19.6 below.

Table 19.6: Determining Significance of In-combination Effects

Significance	Definition of Effect
Severe	The receptor/resource is irretrievably compromised (adverse only)
Major	Effects that are considered to be very important considerations and are more likely to be material in the decision-making process.
Moderate	Effects that are unlikely to become issues on whether the project design should be selected, but where future work may be needed to improve on current performance.
Minor	Effects that are locally significant.
Not Significant	Effects that are beyond the current forecasting ability or are within the ability of the resource to absorb such change.

19.4.29 Advice Note 17 (Ref 19.1) provides guidance on considerations for determining the significance of cumulative effects. These are as follows:

- The duration of effect;
- The extent of the effect;
- The type of effect;
- The frequency of effect;
- The 'value' and resilience of the receptor affected; and

- The likely success of mitigation measures.

19.4.30 As the listed Advice Note 17 significance criteria (Ref 19.1) is just advisory and does not list specific criteria, Table 19.6 has been used (in line with DMRB (Ref 19.4) guidance) alongside the Advice Note 17 (Ref 19.1) guidance to assign significance criteria.

19.4.31 For the purpose of this assessment, those affects classified with moderate significance or above (major and severe) are defined as being Significant effects. Those effects of minor or below (not significant) are defined as being Not Significant.

19.5 Effect Interactions

Step A and Step B

19.5.1 The Step A assessment identified receptors and resources which could be affected by more than one environmental topic, and therefore potentially more than one type of residual effect. These receptors are referred to as 'common receptors'.

19.5.2 There are a number of interactions between topics that are taken into account in each of the technical chapters; related chapters are set out in the introduction to each chapter. Where multiple types of effect are already considered within one technical assessment, the reported findings are not repeated in this assessment. These include:

- With the exception of amenity which considers the Arboriculture Report (Appendix 8H, document reference 6.2), all of the effect interactions with ecological receptors are assessed within Chapter 8: Nature Conservation;
- Designated sites were considered in both Chapter 8 and the HRA (document reference 6.11) many of these were scoped out in the HRA assessment (and were subsequently not assessed in the ES) or were scoped out due to a lack of an established pathway for effect;
- Landscape designations are dealt with in Chapter 10: Townscape and Visual;
- With the exception of amenity, all potential effect interactions with heritage assets are dealt with in Chapter 9: Cultural Heritage
- All of the potential effect interactions with climate change are dealt with in Chapter 13: Climate Change.

19.5.3 The exclusions listed above apply to both the construction and operation effect interactions assessment.

Step A Assessment

19.5.4 The study area used for this assessment corresponds to the study areas outlined in the individual technical chapters (6-18).

19.5.5 The Step A assessment is presented in Table 19.7 and Table 19.8 below.

Table 19.7: Summary of Step A Assessment of Construction Phase Effect Interactions

Receptor	Air Quality	Noise and Vibration	Nature Conservation	Cultural Heritage	Townscape and Visual	Water Environment	Flood Risk	Climate Change	People and Communities	Materials	Geology	Traffic and Transport	Major Accidents and Disasters
Amenity	Yes	Yes	Yes	Yes	Yes	No	No	n/a	No	No	No	No	No
Human Health	Yes	Yes	No	n/a	No	Yes	Yes	n/a	Yes	No	Yes	Yes	Yes
Residents	Yes	Yes	n/a	n/a	Yes	No	Yes	n/a	Yes	No	No	No	Yes
Recreational Facilities and users	Yes	Yes	n/a	n/a	Yes	No	No	n/a	Yes	No	No	No	Yes
Roads, earthworks and other infrastructure	No	No	n/a	n/a	No	No	No	n/a	No	No	Yes	No	Yes
Motorised Vehicle Users	No	No	n/a	n/a	No	No	No	n/a	Yes	No	No	Yes	Yes
Non-motorised Users	No	No	n/a	n/a	Yes	No	No	n/a	Yes	No	No	Yes	Yes
Surface and Ground Water	No	No	n/a	n/a	No	Yes	No	n/a	No	No	Yes	No	Yes
Community facilities and users	Yes	Yes	n/a	n/a	Yes	No	Yes	n/a	Yes	No	No	No	Yes
Construction and Maintenance Workers	No	No	n/a	n/a	No	No	No	n/a	No	No	Yes	No	Yes

Table 19.8: Summary of Step A Assessment of Operation Phase Effect Interactions

Receptor	Air Quality	Noise and Vibration	Nature Conservation	Cultural Heritage	Townscape and Visual	Water Environment	Flood Risk	Climate Change	People and Communities	Materials	Geology	Traffic and Transport	Major Accidents and Disasters
Amenity	Yes	Yes	Yes	Yes	Yes	No	No	n/a	No	No	No	No	No
Health	Yes	Yes	No	n/a	No	Yes	Yes	n/a	Yes	No	Yes	Yes	Yes
Residents	Yes	Yes	n/a	n/a	Yes	No	Yes	n/a	No	No	No	No	Yes
Recreational facilities and users	Yes	Yes	n/a	n/a	Yes	No	No	n/a	Yes	No	No	No	Yes
Roads, earthworks and other infrastructure	No	No	n/a	n/a	No	No	No	n/a	No	No	No	No	Yes
Motorised Vehicle Users	No	No	n/a	n/a	No	No	No	n/a	Yes	No	No	Yes	Yes
Non-motorised Users	No	No	n/a	n/a	Yes	No	No	n/a	Yes	No	No	Yes	Yes
Surface and Ground Water	No	No	n/a	n/a	No	Yes	No	n/a	No	No	Yes	No	Yes
Community facilities and users	Yes	Yes	n/a	n/a	Yes	Yes	Yes	n/a	Yes	No	No	No	Yes
Construction and Maintenance Workers	No	No	n/a	n/a	No	No	No	n/a	No	No	No	No	Yes

Step B Assessment

19.5.6 Where Step A identifies that either there is only one type of effect for a particular receptor or resource, or only one technical chapter has identified effects on that receptor, it is assessed that there is no potential for an effect interaction to occur, and the receptor has not been taken through to Step B.

19.5.7 The assessment of effect interactions at Step A identified the following receptors as having potential for an effect interaction and therefore were to taken through to Step B:

- Amenity;
- Human Health;
- Residents;
- Recreational facilities and users, including terrestrial and marine activities;
- Motorised vehicle users;
- Non-motorised vehicle users (NMUs) including pedestrian and cyclist users of the local PRoW and non-designated public routes;
- Surface and groundwater; and
- Community facilities and users, including Kingsgate Community Church and MIND allotments.

19.5.8 Within these broad groups, individual receptors or groups of receptors that are adversely affected by the Scheme have been considered in Step A. The Step B assessment identifies the residual effects for each receptor which has progressed from Step A, and concludes whether there is a potential for the Scheme to result in a significant effect interaction.

19.5.9 Receptors that are adversely affected by two or more residual effects, of slight or greater significance, have been identified and the range of effects on specific groups of receptors is demonstrated in Table 19.9 and Table 19.10.

19.5.10 As mentioned in Chapter 4: Approach to EIA and Chapter 14: People and Communities, the in-combination effects of the Scheme on human health and amenity are addressed in this chapter. Due to the various effects and considerations of health and amenity presented in the ES it is impractical to present the effect interaction in the same way as other environmental effects on common receptors. Instead the effects interaction assessment for human health and amenity is presented separately within Step C to provide a clear and detailed assessment.

Table 19.9: Step B Assessment of Construction Phase Effect Interactions

Receptor	Air Quality	Noise and Vibration	Townscape and Visual	Water Environment	Flood Risk	People and Communities	Geology	Traffic and Transport	Major Accidents and Disasters	Progress to stage C?
Residents	Negligible to slight adverse (downwind and within 50m)	Neutral to very large adverse (depending on location)	Neutral to moderate adverse depending on viewpoint	n/a	Slight adverse to slight beneficial (depending on location)	Moderate adverse to slight adverse to properties	n/a	n/a	Significant risk from flooding and industrial and urban accidents	Yes
Recreational facilities and users	Negligible	Neutral to very large adverse (depending on location)	Slight adverse	n/a	n/a	slight adverse to moderate adverse from community severance. Slight adverse to moderate adverse to recreational activities	n/a	n/a	Significant risk from flooding and industrial and urban accidents	Yes
Roads, earthworks and other infrastructure	n/a	n/a	n/a	n/a	n/a	n/a	Neutral	n/a	Significant risk from flooding and industrial and urban accidents	No
Motorised vehicle users	n/a	n/a	Neutral to moderate adverse depending on viewpoint	n/a	n/a	Slight adverse	n/a	Slight adverse	Significant risk from industrial and urban accidents	Yes
Non-motorised users	n/a	n/a	Neutral to moderate adverse depending on viewpoint	n/a	n/a	Slight adverse	n/a	Slight adverse	Significant risk from industrial and urban accidents	Yes
Surface and ground water	n/a	n/a	n/a	Neutral to slight adverse on ground water (depending on groundwater receptor),	n/a	n/a	Neutral	n/a	Significant risk from industrial and urban accidents	Yes

				neutral to slight adverse on surface water (depending on watercourse)						
Community facilities and users	Negligible	Neutral to very large adverse (depending on location)	Moderate adverse	n/a	Slight adverse to moderate beneficial (depending on location)	Slight adverse to moderate adverse from community severance. Neutral to moderate adverse to community assets	n/a	n/a	Significant risk from flooding and industrial and urban accidents	Yes
Construction and maintenance workers	n/a	n/a	n/a	n/a	n/a	n/a	Neutral	n/a	Significant risk from flooding and industrial and urban accidents	No

19.5.11 Those receptors that are affected by a residual effect of greater than neutral from more than one technical chapter were taken forward to Step C, these include:

- Residents;
- Recreational facilities and users;
- Motorised vehicle users;
- Non-motorised vehicle users;
- Surface and ground water; and
- Community facilities and users.

Table 19.10: Step B Assessment of Operation Phase Effect Interactions

Receptor	Air Quality	Noise and Vibration	Townscape and Visual	Water Environment	Flood Risk	People and Communities	Geology	Traffic and Transport	Major Accidents and Disasters	Progress to stage C?
Residents	Negligible	Neutral to very large adverse (depending on location)	Neutral to moderate adverse year 1 (depending on viewpoint).	n/a	Slight adverse to slight beneficial (depending on location)	n/a	n/a	n/a	Significant risk from flooding and industrial and urban accidents	Yes

			Slight adverse to moderate beneficial year 15 (depending on viewpoint)							
Recreational facilities and users	Negligible	Neutral to very large adverse (depending on location)	Neutral	n/a	n/a	Moderate beneficial to terrestrial activities, slight adverse to marine activities	n/a	n/a	Significant risk from flooding and industrial and urban accidents	Yes
Roads, earthworks and other infrastructure	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Significant risk from flooding and industrial and urban accidents	No
Motorised vehicle users	n/a	n/a	Neutral to moderate adverse year 1 (depending on viewpoint). Slight adverse to moderate beneficial year 15 (depending on viewpoint)	n/a	n/a	Moderate beneficial	n/a	Slight to moderate beneficial	Significant risk from industrial and urban accidents	Yes
Non-motorised Users	n/a	n/a	Neutral to moderate adverse year 1 (depending on viewpoint). Slight adverse to moderate beneficial year 15 (depending on viewpoint)	n/a	n/a	Slight adverse to moderate beneficial (both removal and addition of facilities)	n/a	Slight to large beneficial	Significant risk from industrial and urban accidents	Yes
Surface and ground water	n/a	n/a	n/a	Neutral to ground water, neutral to large adverse to	n/a	n/a	Neutral	n/a	Significant risk from industrial	Yes

				surface water (depending on watercourse)					and urban accidents	
Community facilities and users	Negligible	neutral to very large adverse (depending on location)	Moderate adverse year 1. No assessment year 15.	Neutral	Slight adverse to moderate beneficial (depending on location)	Moderate beneficial	n/a	n/a	Significant risk from flooding and industrial and urban accidents	Yes
Construction and maintenance workers	Negligible	n/a	n/a	n/a	n/a	n/a	Neutral	n/a	Significant risk from flooding and industrial and urban accidents	No

19.5.12 Those receptors that are affected by a residual effect of greater than neutral from more than one technical chapter were taken forward to Step C, these include:

- Residents;
- Recreational facilities and users;
- Motorised vehicle users;
- Non-motorised vehicle users;
- Surface and ground water; and
- Community facilities and users.

Step C

19.5.13 Using professional judgement, receptors which have proceeded to Step C have been assessed to determine whether a cumulative effect would occur, and if that effect would be of greater significance than its individual effects. The results are shown in Table 19.11 and Table 19.12 below.

Table 19.11: Step C Assessment of Construction Phase Effect Interactions

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
Residents	Air Quality – Negligible to slight adverse to properties downwind and within 50m	Adverse effects are anticipated to residents from different topics. The identified adverse effects from the different topics will be temporary, and effects from noise and vibration will potentially be intermittent. Additionally, where adverse effects to residents have been identified, the nature of the effect varies depending on location, and resident type. Therefore, there are anticipated to be **slight adverse** (not significant) effect interactions.	No mitigation required
	Noise and Vibration – neutral to very large depending on location		
	Townscape and Visual – neutral to moderate adverse depending on viewpoint		
	Flood Risk – slight adverse to slight beneficial depending on location		
	People and Communities – slight adverse to moderate adverse		
	Major Accidents and Disasters – significant risk from flooding an industrial and urban accidents		
Recreational facilities and users	Air Quality – negligible	Adverse effects are anticipated to recreational facilities and users from different topics. The identified adverse effects from the different topics will be temporary, and effects from noise and vibration will potentially	No mitigation required
	Noise and Vibration – neutral to very large depending on location		
	Townscape and Visual – slight adverse		
	People and Communities – slight adverse to moderate adverse from community severance; slight adverse to		

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
	moderate adverse to recreational activities	be intermittent. Additionally, where adverse effects to recreational facilities and users have been identified within the topics the nature of the effect varies on location, and type of recreational activity (terrestrial or marine). Therefore, there are anticipated to be **slight adverse** (not significant) effect interactions.	
	Major Accidents and Disasters – significant risk from flooding an industrial and urban accidents		
Motorised vehicle users	Townscape and Visual – neutral to moderate adverse depending on viewpoint	Adverse effects to motorised vehicle users have been identified from different topics. The identified adverse effects from the different topics will be temporary, and where adverse effects to motorised vehicle users have been identified within topics the nature of the effect varies on location. Therefore, there are anticipated to be **slight adverse** (not significant) effect interactions.	No mitigation required
	People and Communities – slight adverse		
	Traffic and Transport – slight adverse		
	Major Accidents and Disasters – significant risk from industrial and urban accidents		
Non-motorised users	Townscape and Visual – neutral to moderate adverse depending on location	Adverse effects to NMUs have been identified from different topics. The identified adverse effects from the different topics will be temporary, and where significant	No mitigation required
	People and Communities – slight adverse		
	Traffic and Transport – slight adverse		

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
	Major Accidents and Disasters – significant risk from industrial and urban accidents	adverse effect to NMUs have been identified within topics, the nature of the effect varies on location. Therefore, there are anticipated to be **slight adverse** (not significant) effect interactions.	
Surface and ground water	Water Environment – neutral to slight adverse depending on surface/ground water receptors	Adverse effects to surface and groundwater have been identified from two topics. Some adverse effect are identified from water environment but none of these are significant (the highest being slight adverse). Additionally, where a significant risk has been identified from major accidents and disasters, the nature of the effect varies on location. Therefore, there are anticipated **slight adverse** (not significant) effect interactions.	No mitigation required
	Major Accidents and Disasters – significant risk from industrial and urban accidents		
Community facilities and users	Noise and Vibration – negligible to very large depending on location	Adverse effects are anticipated to community facilities and users in different topics. The identified adverse effects from the different topics will be temporary, and effects from noise and vibration will potentially be intermittent.	No mitigation required
	Townscape and Visual – moderate adverse		
	Flood Risk – slight adverse to moderate beneficial		
	People and Communities – slight adverse to moderate adverse from community		

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
	severance; neutral to moderate adverse to community assets	Additionally, where adverse effects to community facilities and users have been identified within the topics the nature of the effect varies on location. Therefore, there are anticipated to be **slight adverse** (not significant) effect interactions.	
	Major Accidents and Disasters – significant risk from flooding an industrial and urban accidents.		

Table 19.12: Step C Assessment of Operation Phase Effect Interactions

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
Residents	Air quality - negligible	Both adverse and beneficial effects are anticipated to residents. The nature of effect for different topics varies on location. Additionally, townscape and visual adverse effects are considered temporary with the effects becoming significantly beneficial over time. Therefore, there are anticipated to be **neutral** (not significant) effect interactions.	No mitigation required
	Noise and Vibration – negligible to very large depending on location		
	Townscape and Visual – neutral to moderate adverse year 1 (depending on viewpoint); slight adverse to moderate beneficial year 15 (depending on viewpoint)		
	Flood Risk – slight adverse to slight beneficial depending on location		
	Major Accidents and Disasters – significant risk from flooding an industrial and urban accidents		
Recreational facilities and users	Air quality - negligible	Both adverse and beneficial effects to recreational facilities and users are anticipated. The nature of the effect from noise and	No mitigation required
	Noise and Vibration – negligible to very large depending on location		

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
	People and Communities – moderate beneficial to terrestrial activities; slight adverse to marine activities	vibration and major accidents and disasters vary on location. Additionally, the nature of effect from different topics varies on location, and type of recreational activity (terrestrial or marine). Therefore, there are anticipated to be **neutral** (not significant) effect interactions.	
	Major Accidents and Disasters – significant risk from flooding an industrial and urban accidents		
Motorised vehicle users	Townscape and Visual – neutral to moderate adverse in year 1 depending on viewpoint; slight adverse to moderate beneficial year 15 (depending on viewpoint)	For all the topics which identify effects to motorised vehicle users, except major accidents and disasters and some visual (viewpoints), effects are anticipated to be beneficial. Additionally, the nature of effect from different topics varies on location. Therefore, there are anticipated to be **slight beneficial** (not significant) effect interactions.	No mitigation required
	People and Communities – moderate beneficial		
	Traffic and Transport – slight to moderate beneficial		
	Major Accidents and Disasters – significant risk from industrial and urban accidents		
Non-motorised users	Townscape and Visual – neutral to moderate adverse in year 1 depending on viewpoint; slight adverse to moderate beneficial year 15 (depending on viewpoint)	Anticipated effects to NMUs are both adverse and beneficial. Adverse effects from townscape and visual are considered temporary with the effects becoming significantly beneficial overtime. Additionally, the nature of effect from different topics varies on location. Furthermore, adverse effects from people and	No mitigation required
	People and Communities – slight adverse to moderate beneficial (both removal and addition of facilities)		
	Major Accidents and Disasters – significant risk		

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
	from industrial and urban accidents	communities are not considered significant, however there will be beneficial significant effects to NMUs from the new facilities provided. Therefore, there are anticipated to be **slight beneficial** (not significant) effect interactions.	
Surface and ground water	Water Environment – neutral to large adverse depending on the surface/ground water receptor Major Accidents and Disasters – significant risk from industrial and urban accidents	Adverse effects to surface and groundwater have been identified from two topics. Significant adverse effects are identified from water environment for two surface water receptors (moderate adverse, the River Yare and large adverse, surface water ponds). Additionally, where a significant risk has been identified from major accidents and disasters, the nature of the effect varies on location. Due to the proximity of the significant effects (the River Yare), there are anticipated to be **slight adverse** (not significant) effect interactions.	No mitigation required
Community facilities and users	Noise and Vibration – negligible to very large depending on location Townscape and Visual – moderate adverse to some	Anticipated effects to community facilities are both adverse and beneficial. Additionally, the nature of the effect	No mitigation required

Receptor/ Resource	Residual significance of effect	Effect Interaction assessment	Mitigation
	viewpoints in year 1 (no assessment for year 15)	from some topics varies on location. Therefore, there are anticipated to be **neutral** (not significant) effect interactions.	
	Flood Risk – slight adverse to moderate beneficial		
	People and Communities – moderate beneficial		
	Major Accidents and Disasters – significant risk from flooding an industrial and urban accidents		

Human Health

19.5.14 This section identifies potential effect interactions the Scheme could have to human health.

19.5.15 Some chapters have directly assessed effect on human health receptors, these are as follows:

- Driver stress is assessed in Chapter 14;
- The effect to human health from contaminated soils, exposure to gas, risk of ground collapse, and build-up of gases is assessed in Chapter 16;
- Fear and intimidation from road traffic is assessed in Chapter 17; and
- Effects to human health from major accidents and disasters is assessed in Chapter 18.

19.5.16 Other effects which have the potential to cause impacts to human health from the construction phase have been identified, they are as follows:

- Construction dust emissions in Chapter 6;
- Construction noise and vibration in Chapter 7;
- Contamination of water, and poor water quality in Chapter 11 and Chapter 16;
- Flood risk in Chapter 12; and
- Community severance in Chapter 14.

19.5.17 Other effects to human health from the operation phase have been identified, they are as follows:

- Vehicle emissions in Chapter 6;
- Road traffic noise in Chapter 7;
- Contamination of water, and poor water quality in Chapter 11 and Chapter 16;
- Flood risk in Chapter 12; and
- Community severance in Chapter 14.

19.5.18 These assessments relate to health due to potential for the environmental effect to subsequently lead to a detrimental impact on human health, such as contaminated water coming into contact with human receptors, or that the assessment of these effects is linked to health, such as air quality standards which are set for the protection of human health.

19.5.19 The assessment of effects on human health during the construction phase is informed by the following assessments of effects taken from the signposted chapters:

- The assessment in Chapter 6 concludes that there will be a **negligible** to **slight adverse** effect to air quality from construction dust emissions;
- The assessment in Chapter 7 concludes that there will be a **neutral** to **large adverse** effect on noise and vibration depending on location and proximity to the Scheme;
- The assessment in Chapter 11 concludes that there will be **neutral** to **slight adverse** effects on surface and groundwater;
- The assessment in Chapter 12 concludes that there will be a **slight adverse** to **moderate beneficial** effect on flood risk, depending on receptor location;
- The assessment in Chapter 14 concludes that there will be a **slight adverse** effect to community severance for the majority of community and recreational facilities assessed, a **moderate adverse** effect to community severance for Kingsgate Community Centre and two allotments gardens to the north-east of Suffolk Road and Queen Anne's Road junction, and a **slight adverse** effect to driver stress;
- The assessment in Chapter 16 concludes that there will be **neutral** effects to controlled waters, the River Yare, the Principal aquifer, and the Secondary A aquifer. The assessment also concludes that there will be a **neutral** effect to human health from contaminated soils, exposure to gas, and ground collapse;

- The assessment in Chapter 17 concludes that there will be a **slight adverse** effect to fear and intimidation; and
- The assessment in Chapter 18 concludes that there is a significant risk from flood risk and industrial and urban accidents during the construction phase.

19.5.20 Adverse effects are anticipated to human health in different topics. The identified adverse effects from the different topics will be temporary, and effects from noise and vibration will potentially be intermittent. Additionally, where adverse effects to residents have been identified within the topics the nature of the effect varies depending on location. Therefore, the anticipated effect interaction on human health during the construction phase is anticipated to be **slight adverse** (not significant).

19.5.21 No mitigation is proposed. Therefore, the residual effect interaction remains as **slight adverse** (not significant).

19.5.22 The assessment of effect on human health during the operation phase is informed by the following assessments of effects taken from the signposted chapters:

- The assessment in Chapter 6 concludes that there will be a **negligible** effect to air quality from vehicle emissions;
- The assessment in Chapter 7 concludes that there will be a **neutral** to **large adverse** effect on noise and vibration depending on location and proximity to the Scheme and routes which will experience increased traffic;
- The assessment in Chapter 11 concludes that there will be **neutral** to **large adverse** effects on surface/groundwater receptors. Most receptors will see a **neutral** or **slight adverse** effect, with the River Yare seeing a **moderate adverse** effect and surface water ponds seeing a **large adverse** effect;
- The assessment from Chapter 12 concludes that there will be a **slight adverse** to **moderate beneficial** effect on flood risk, depending on receptor location;
- The assessment in Chapter 14 concludes that there will be a **moderate beneficial** effect to community severance, and a **moderate beneficial** effect to driver stress;
- The assessment in Chapter 16 concludes that there will be **neutral** effects to controlled waters, the River Yare, the Principal aquifer, and the Secondary A aquifer. The assessment also concludes that there will be a

neutral effect on human health from contaminated soils and the build-up of gases;

- The assessment in Chapter 17 concludes that there will be a **moderate beneficial** effect to fear and intimidation; and
- The assessment in Chapter 18 concludes that there is a significant risk from flood risk and industrial and urban accidents during the operation of the Scheme.

19.5.23 There are both adverse and beneficial effects anticipated to human health across the topics. The nature of the effect from different topics vary due to location. Additionally, people and communities and traffic and transport anticipate significant beneficial effects to human health. Therefore, the anticipated effect interaction on human health during the operational phase is anticipated to be **neutral** (not significant).

19.5.24 No mitigation is proposed. Therefore, the residual effect interaction remains as **neutral** (not significant).

Amenity

19.5.25 This section identifies any potential effect interactions the Scheme could have to amenity.

19.5.26 Some chapters have directly assessed effect on amenity receptors, these are as follows:

- Setting of historical assets is assessed in Chapter 9; and
- Visual amenity has been assessed in Chapter 10.

19.5.27 Other effects to amenity from the construction phase have been identified, they are as follows:

- Reduction in air quality from construction activities (dust plumes affect visibility and amenity) in Chapter 6;
- Increased noise due to construction activities in Chapter 7; and
- Removal of trees and green infrastructure in the Detailed Arboriculture Report (Appendix 8H, document reference 6.2).

19.5.28 Other effects to amenity from the operation phase have been identified, they are as follows:

- Reduction in air quality from vehicle emissions during operation in Chapter 6;

- Increased noise from additional operational traffic in Chapter 7; and
- Planting and growth of trees and green infrastructure in the Detailed Arboriculture Report (Appendix 8H, document reference 6.2).

19.5.29 The assessment of effects on amenity during the construction phase is informed by the following assessments of effects taken from the signposted chapters:

- The assessment in Chapter 6 concludes that there will be a **negligible** effect on air quality from construction activities;
- The assessment in Chapter 7 concludes that there will be a **neutral** to **large adverse** effect on noise and vibration depending on location and proximity to the Scheme;
- The assessment in Chapter 9 concludes that there will be a **moderate adverse** effect on the setting of historical assets (Nelson's Monument and the Gas Holder);
- The assessment in Chapter 10 concludes that there will be a **neutral** to **moderate adverse** effect on visual amenity, depending on viewpoint; and
- The Detailed Arboriculture Report (Appendix 8H, document reference 6.2) reports that the construction phase will involve the removal of moderate quality trees and tree groups which are regarded as having sufficient value and act as screening, resulting in a short-term adverse effect.

19.5.30 Adverse effects are anticipated to amenity in different topics. The identified adverse effects from the different topics will be temporary, and effect from noise and vibration will potentially be intermittent. Additionally, where adverse effects to amenity have been identified within the topics the nature of the effect varies depending on location. Therefore, the anticipated effect interaction on amenity during the construction phase is anticipated to be **slight adverse** (not significant).

19.5.31 No mitigation is proposed. Therefore, the residual effect interaction remains as **slight adverse** (not significant).

19.5.32 The assessment of effect on amenity during the operation phase is informed by the following assessments of effects taken from the signposted chapters:

- The assessment in Chapter 6 concludes that there will be a **negligible** effect on air quality from vehicle emissions;
- The assessment in Chapter 7 concludes that there will be a **neutral** to **large adverse** effect on noise and vibration depending on location,

proximity to the Scheme and routes which will experience increased traffic;

- The assessment in Chapter 10 concludes that there will be **slight adverse** to **moderate beneficial** effects on visual amenity, depending on viewpoint and length of time since the Scheme opening (planting); and
- The Detailed Arboriculture Report (Appendix 8H, document reference 6.2) reports that the introduction of new feature trees into the local area has the potential to mitigate the loss of trees over the medium to long term, and especially once they become established, start to mature and attain a reasonable size.

19.5.33 There are both adverse and beneficial effects anticipated to amenity across the topics. The nature of the effects from the different topics vary due to location. Additionally, visual effects from the Scheme and the removal of trees are anticipated to be adverse during the opening year, however as the planting proposed as part of the Scheme matures, effects to amenity are anticipated to be beneficial. Therefore, anticipated effect interaction on amenity during the construction phase is anticipated to be **neutral** (not significant).

19.5.34 No mitigation is proposed. Therefore, the residual effect interaction remains as **neutral** (not significant).

Summary of Effect Interactions Assessment

19.5.35 This section provides a summary of the above tables (19.11 and 19.12), and the effect interactions assessment on health and amenity. Of the ten receptors considered at Step B, eight were considered to have some potential for cumulative effects resulting from the construction or operation of the Scheme. Of these receptors in the construction phase, all saw a **slight adverse** (not significant) effect interaction. In the operation phase, most saw a **neutral** (not significant) effect interaction while motorised and non-motorised users saw a **slight beneficial** (not significant) effect interaction and surface and groundwater saw a **slight adverse** (not significant) effect interaction.

Construction

19.5.36 The residual effect interaction on residents, recreational facilities and users, motorised vehicle users, non-motorised vehicle users, surface and ground water, community facilities and users, human health, and amenity are anticipated to be **slight adverse** (not significant). No additional mitigation measures are required.

Operation

19.5.37 The residual effect interaction on residents, recreational facilities and users, community facilities and users, human health, and amenity is anticipated to be **neutral** (not significant). The residual effect interaction on motorised vehicle users and non-motorised vehicle users are anticipated to be **slight beneficial** (not significant). The residual effect interaction on surface and groundwater are anticipated to be **slight adverse** (not significant). No additional mitigation measures are required.

19.6 In-combination Effects

Stages 1 and 2

19.6.1 Information gathered to form the basis of this in-combination effect assessment is presented in Appendix 19B (document reference 6.2) and shown in Figure 19.1. The ZOIs for the individual environmental topics are listed in Table 19.13 below. The long list of other developments considered during Stage 1 and Stage 2 are included in Table 19.15 below.

19.6.2 The ZOI for each environmental topic is based on the study areas outlined within each respective chapter, and is defined by relevant institutional guidelines. As discussed in Table 19.13 it was not practicable to consider the full study area for Climate Change and Materials, and therefore these ZOIs were reduced.

Zone of Influence

Table 19.13: ZOI for Assessment of In-combination Effects

Environmental Topic	Zone of Influence
Air Quality	**Regional Air Quality Assessment** The regional air quality assessment consists of the road network in Great Yarmouth town and small segments of road to the south and west of Great Yarmouth, extending as far Hopton in the south and further west along the A47 leaving Great Yarmouth. Note that this assessment considers emissions only, no receptors are involved. **Ecological Assessment** The ecological assessment covers Breydon Water immediately to the west of Great Yarmouth.

Environmental Topic	Zone of Influence
Noise and Vibration	**Noise ZOI** The construction noise ZOI covers 300m from around the Application Site. The operational noise ZOI comprises the entirety of central Great Yarmouth and Runham in the north. The ZOI partially encompasses the area of a Noise Important Area (NIA ID 4987). In this case the entirety of the NIA is included in the ZOI. **Vibration ZOI** The construction vibration ZOI covers 100m from the Application Site. The operational vibration ZOI comprises the entirety of central Great Yarmouth and Runham in the north.
Nature Conservation	**Main ZOI** The main ZOI is 500m from the Application Site. This ZOI has been used for the assessment of habitat suitability for protected species. **Broad ZOI** 2km from the Application Site. This ZOI is used for a desk study of international and national statutory nature conservation designations, non-statutory nature conservation designations and records of protected and/or notable habitats and species. **Extended ZOI** Up to 30km from the Application Site. This ZOI is used to extend the Broad ZOI where there are potential hydrological connections present and to take into account international nature conservation designations where bats are listed as a qualifying species.
Cultural Heritage	The ZOI for Cultural Heritage varies depending on the type of heritage asset. Buffers are as follows: • Designated Heritage Assets – 1km from the Principal Application Site; • Non-designated Heritage Assets – 500m from the Principal Application Site; and

Environmental Topic	Zone of Influence
	• All heritage assets (VMS locations) – 250m from Satellite Application Sites.
Townscape and Visual	The ZOI for Townscape and Visual comprises a 3km study area from the Scheme (not including the sea beyond the immediate coastline). This covers most of Great Yarmouth town (excluding the far north and far south) and extends into the Broads National Park. The viewpoints and photomontage locations are concentrated within the immediate vicinity of the Scheme, with one at the harbour mouth and two further north (within Great Yarmouth).
Water Environment	**Surface Water** The surface water ZOI comprises a 1km buffer from the Scheme and Order Limits. This includes central Great Yarmouth up to Runham. **Groundwater** The groundwater ZOI comprises a 2km buffer from the Scheme and Order Limits. This includes the entirety of Great Yarmouth and extends westwards into the Broads National Park.
Flood Risk	The Flood Risk ZOI encompasses the entirety of Great Yarmouth (from the harbour entrance in the south to Runham in the north) and extends westward to encompass all of Breydon Water.
Climate Change	**Greenhouse Gas (GHG) Assessment** The GHG assessment is not restricted by geographical area. It includes any increase or decrease in emissions as a result of the Scheme. This includes: • Construction emissions in the Scheme footprint but also related to the transport of materials to and from the Application Site, their manufacturing and disposal (this may be far from the Scheme location e.g. emissions for manufacture of concrete and steel). • Operational emissions (or reduction in emissions) which result from the end-use of the, and any shifts in, transport modes, or patterns which may occur. Such emissions include those for traffic using the

Environmental Topic	Zone of Influence
	Scheme as well as the surrounding regional road network. **Climate Resilience** The assessment of vulnerability of the Scheme to impacts from climate change considers regional scale information on historic and projected change in climate variables. The UK Climate Projections 2018 (UKCP18) provide data on projected change in climate variables for the study area of the Scheme, the East of England. The assessment of the full study area is considered impractical due to the large spatial extent. For the CEA, the ZOI has been reduced to incorporate much of eastern and northern Norfolk and Suffolk. Where practicable, baseline data for projected baseline arisings has been scaled to align with the proposed construction and operational years of the Scheme. Where County Councils, Borough Councils and the Environment Agency have published projections, the data typically incorporates anticipated infrastructure and population forecasts. As such, where practicable, the assessment has inherently considered cumulative impacts of 'other developments'.
People and Communities	There are multiple ZOIs corresponding to different study areas of the People and Communities assessment. • Non-motorised users and Community Severance – up to 500m from the Principal Application Site; • Vehicle travellers – Principal Application Site; • Demand for local services (construction only) – unknown, dependant of the location of construction workers' places of residence; • Physical Assets: Residential properties, commercial properties and community assets – the land within and immediately adjacent to the Principal Application Site; • Economy and Employment (construction only) – divided into two tiers, 'local level' comprising Great Yarmouth Borough and 'regional level' comprising Norfolk County; and

Environmental Topic	Zone of Influence
	• Recreational Activities – up to 500m from the Principal Application Site.
Materials	The ZOI comprises the whole Application Site. The secondary study area extends to the availability of construction and recovered material resources within the East of England (Hertfordshire, Bedfordshire, Cambridgeshire, Essex, Norfolk and Suffolk) and the UK, and the capacity of waste recovery and waste management facilities in the East of England. The assessment of the full study area is considered impractical. For the CEA the ZOI has been reduced to incorporate much of eastern and northern Norfolk and Suffolk. Where practicable, baseline data for projected baseline arisings has been scaled to align with the proposed construction and operational years of the Scheme. Where County Councils, Borough Councils and the Environment Agency have published projections the data typically incorporates anticipated infrastructure and population forecasts. As such, where practicable, the assessment has inherently considered cumulative impacts of 'other developments'.
Geology and Soils	The ZOI comprises a 43ha area focused around the Principal Application Site. It incorporates most of the Principal Application Site and small areas of Great Yarmouth's urban centre and the River Yare.
Traffic and Transport	An assessment area of most of central and northern Great Yarmouth (through a Paramics model) has been applied for the following receptors: • Driver delay; and • Public transport users. An assessment area of the entirety of Great Yarmouth Borough excluding the area north of Rollesby, extending southwards to the north of Lowestoft and westwards to Lingwood (through a SATURN model) has been applied for the following receptors: • Air Quality; • Noise; • Driver Stress; • Collision and safety; and

Environmental Topic	Zone of Influence
	• Fear and Intimidation.
Major Accidents and Disasters	An assessment area of a 1km buffer from the boundary of the Principal Application Site has been applied for both the construction and operation phases.

Consultation Undertaken to Date

19.6.3 Consultation with NCC has been undertaken regarding the in-combination assessment. Specifically, regarding the long-list and short-list of committed developments. A summary of consultation details is outlined in Table 19.14 below.

Table 19.14: Summary of Consultation Undertaken to Date

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
Norfolk County Council	Principal Planner, Planning Services, NCC	04/02/2019 WSP email contact seeking approval of short-list and long-list of committed developments. 11/02/2019 NCC initial response received requesting timeframes for the response. 21/02/2019 NCC response received requesting a skype conversation to clarify the ZOI. 21/02/2019 WSP email providing further clarification and agreeing to conference call.	Acknowledgement of acceptance and notification of the need to pass through internal consultees. A commitment to a two-week turnaround period was made on 12/02/2019. Conference call agreed to further discuss the ZOI, was held on 22/02/2019.

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
Norfolk County Council	Principal Planner, Planning Services, NCC	22/02/2019 WSP and NCC conference call to discuss the ZOI and thresholds used to establish long-list of committed developments.	Acknowledgement of the ZOI and thresholds used. A commitment to provide a response by 27/02/2019 was made.
Norfolk County Council	Head of Planning, NCC	26/02/2019 NCC email consultation response received.	Information provided was a response to the request above: Provided information regarding the stages of application for Sizewell C Nuclear Power Station, East Anglia ONE North and East Anglia TWO. Provided further information on North Denes Middle School, Hazardous Waste Transfer Station, Welcome Pit, and South Denes enterprise zone. Provided a list of Minerals, Waste and County Council developments for consideration in the CEA. Suggestion that we may want to include the Crown Estate Windfarm extension developments. Requested that developments listed in the CEA are kept under review as they progress, or in some cases refused or withdrawn.

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
			Requested that the CEA clearly identifies the ZOI used and the ZOI for individual topics.
Great Yarmouth Borough Council	Head of Planning and Growth, GYBC	28/02/2019 WSP email contact seeking approval of short-list and long-list of committed developments. 11/03/2019 GYBC email consultation response received.	Agreement that the methodology and criteria used to establish the short list of 'other developments' is appropriate. Provided further information on Beacon Park Enterprise Zone, South Denes Business Park, South Denes Enterprise Zone, and Great Yarmouth Energy Park, and suggested that allowance should be made for some development within these areas. Provided information on two additional sites, Bradwell and Middlegate Estate Regeneration, for which planning applications are expected, and suggested that these should be considered. Provided further information on Northgate Hospital, and the Great Yarmouth Housing Deal, and agreed these developments can be scoped out. Provided further information on the Marina Centre Re-development,

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
			and suggested that it should be considered.
Great Yarmouth Borough Council	Head of Planning and Growth, GYBC	11/03/2019 WSP email seeking further information on the Beacon Park 20ha extension. 11/03/2019 GYBC email response providing information. 21/03/2019 WSP email sent with Marine Centre Redevelopment wording for comment. 21/03/2019 GYBC email response received requesting alterations to wording.	The weblink to the masterplan report for the Beacon Park 20ha was received. The weblink to a committee report and article regarding the Marina Centre Redevelopment was received. A request that wording regarding the status of funding for the Marina Centre Redevelopment could be reviewed before the Chapter is published.
Norfolk County Council	Economic Development Manager	11/03/2019 WSP email seeking further information on planned developments within South Denes Enterprise Zone, Energy Park and Business Park. 12/03/19 WSP arrange conference call for 14/03/2019 to discuss.	Request and acceptance of a conference call with the Economic Development Manager to discuss in detail.
Norfolk County Council	Economic Development Manager	14/03/2019 WSP and NCC conference call.	Detailed discussion and information provided on the Energy Park.

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
			Detailed discussion and information provided on 3 proposed developments within the South Denes Enterprise Zone.

19.6.4 Table 19.15 lists the other developments within the ZOI that resulted from the desk study search and consultation with GYBC and NCC. As part of the desk study both NSIPs and non-NSIPs were considered to have the potential to have in-combination cumulative effects with the Scheme. However, due to the size of the ZOI, it was not considered proportionate for the desk study search for non-NSIPs to go beyond the boundary of Great Yarmouth Borough.

19.6.5 When considering other developments, particular consideration has been given to the following special areas, all of which have been included in the long-list:

- South Denes Enterprise Zone;
- South Denes Business Park;
- Great Yarmouth Energy Park; and
- Beacon Park Enterprise Zone.

19.6.6 These areas were the focus of part of the consultation processes and any developments identified during consultation have been taken forward for further assessment.

19.6.7 It is acknowledged that there are discrepancies between other developments considered within the short-list (see Table 19.16) and those included within the Transport Assessment (TA) (document reference 7.2). Many of these discrepancies are due to the TA (document reference 7.2) only being able to model operational traffic, which is subsequently excluded from this assessment (see paragraph 19.6.13). The justification for these developments not being included in the operational assessment is outlined below:

- Developments 3, 6, 27, 28, 29, 30 and 49 were not included as no operational effects were anticipated;

- Developments 7, 8, 9, 31, 32, 33 and 34 were not included due to falling outside of the model study areas;
- Development 11 was not included due to the anticipated traffic impacts falling within the summer period which was excluded from the TA (document reference 7.2) modelling; and
- Developments 16, 36 and 51 were not included due to not meeting the certainty criteria used in the TA (document reference 7.2).

Other Developments: Long-List and Short-List

19.6.8 Tables 19.15 and 19.16 contain the long-list and short-list of other developments based on the information gathering conducted in stages 1 and 2.

Table 19.15: Long List of Other Developments Considered in the In-combination Effects Assessment

ID	Reference Number	Other Development Name	Description of Other Development	Status	Tier (Certainty)	Distance from the Application Site (closest point)
1	EN010077	East Anglia ONE North Windfarm	Offshore windfarm forming part of the East Anglia Array is a wind farm development that consists of four phases.	Pre-application – consultation ended 26th March 2019	Tier 2	Windfarm: 32km south east
2	EN010078	East Anglia TWO Windfarm	Offshore windfarm forming part of the East Anglia Array is a wind farm development that consists of four phases.	Pre-application – consultation ended 26th March 2019	Tier 2	Windfarm: 35km south east
3	EN010056	East Anglia THREE Windfarm	Offshore windfarm forming part of the East Anglia Array is a wind farm development that consists of four phases.	Decided	Tier 1	Windfarm: 59km east, substation, 75km south west, Landfall: 68km south west
4	n/a	Great Yarmouth Waterfront Area	Allocated area for mixed-use development including North Quay, The Conge, Bure Harbour Quay and Ice House Quay.	n/a	Tier 3	0.8km north
5	n/a	Great Yarmouth Tidal Barrier	Proposal for a flood barrier and tidal energy station.	n/a	Tier 3	Unknown
6	n/a	Epoch 2 of the Great Yarmouth Flood Defence Improvements	Proposal to improve current flood defences.	Potential Scheme at appraisal stage	Tier 3	Adjacent - along the River Yare
7	TR010040	A47 Burlingham-Blofield dualling	Dualling of the A47 to fill a gap in the dual carriageway section between Norwich and Acle Straight.	Pre-application	Tier 2	17km north west
8	TR010037	A47 Thickthorn junction improvements	Improvement of the interchange between the A47 and A11, improving access into Norwich.	Pre-application	Tier 2	34km west
9	TR010038	A47 Easton-North Tuddenham dualling	Dualling of the single carriageway section of the A47 between Norwich and Dereham, linking together two existing sections of dual carriageway.	Pre-application	Tier 3	43km north west
10	n/a	North Lowestoft Garden Village	Draft Allocation in the Waveney Local Plan, for 1,300 dwellings, and 8ha of employment land.	n/a	Tier 3	8.3km south
11	06/17/0218/O	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	Permitted leisure development south of Pleasure Beach, Great Yarmouth, which includes a new hotel, restaurant and car parking, and an outline permission for a proposed casino plus cinema, bars and restaurants etc.	Approved permission October 2017	Tier 1	0.5km south east
12	06/16/0064/D 06/13/0643/F 06/13/0703/O	Bradwell South	3 approved planning applications for residential dwellings, 28 dwellings on Kings Drive, 127 residential dwellings on Wheatcroft Farm, and 130 dwellings on Meadowland Drive.	Approved permission	Tier 1	3km south west

ID	Reference Number	Other Development Name	Description of Other Development	Status	Tier (Certainty)	Distance from the Application Site (closest point)
13	06/16/0391/SU	Beacon Park	Outline permission for up to 231 residential units (5.88 Hectares). And full permission for 56 residential units. Area is allocated under CYBC Policy CS18 for approx. 1,000 new dwellings.	Approved December 2017	Tier 1	3.4km south west
14	06/15/0737/F	Former Claydon High School	Permission for a residential development including 113 dwellings.	Approved January 2018	Tier 1	0.8km south west
15	06/17/0469/F	90 and 102 Regent Road	Permission for a mixed-use development incorporating 15 three bed houses, 8 one and two-bedroom flats, leisure area and 10 retail units.	Approved July 2018	Tier 1	1.5km north east
16	Y/6/2018/6003	North Denes Middle School	Demolition of existing school building and erection of new 420 place pupil primary school.	Yet to be determined	Tier 1	4km north east
17	06/16/0583/O	Land west of Yarmouth Road	Permission for a development including 93 dwellings.	Approved June 2016	Tier 1	11km north west
18	06/17/0339/O	Land south east of Hopton	Permission for a residential development (up to 200 dwellings) and open space/associated works including allotments.	Approved May 2018	Tier 1	6.2km south
19	06/15/0486/F	Former mushroom farm, Martham	Full permission for 100 new dwellings.	Approved August 2017	Tier 1	14km north west
20	06/14/0817/O	Land north of Hemsby Road	Outline permission for a residential development (103 dwellings).	Approved November 2016	Tier 1	14km north west
21	06/15/0309/F	Pointers East, west of Ormesby Road	Permission for the construction of 189 dwellings.	Approved June 2017	Tier 1	8km north
22	C/6/2017/6004	Berths 1-4, Hazardous Waste Transfer Station	Permission for the retention of the hazardous waste transfer station and minor alterations.	Approved September 2018	Tier 1	0.5km south east
23	06/12/0061/O	Halls Riverside Road	Demolition of all existing buildings and erection of 104 dwellings, 3 office blocks, associated works and open space.	Approved August 2013	Tier 1	1.3km south
24	06/18/0582/F	Northgate Hospital	Pending application for the construction of 76 residential dwellings.	Granted February 2019	Tier 1	2.5km north
25	06/18/0149/O	Repps Road	Pending outline application for a residential development comprising 144 dwellings.	Undecided	Tier 1	14.5km north west
26	C/6/2018/6003	Welcome Pit	EIA Screening Opinion for the proposed extension to the quarry.	EIA Scoping Opinion submitted	Tier 3	3.5km south west
27	EN010079	Norfolk Vanguard	A proposed offshore windfarm with an approximate capacity of 1,800 MW.	Examination	Tier 1	Windfarm: 50km NE, Substation: 64km west, Landfall: 28km north east

ID	Reference Number	Other Development Name	Description of Other Development	Status	Tier (Certainty)	Distance from the Application Site (closest point)
28	EN010087	Norfolk Boreas	Offshore windfarm with a maximum capacity of 1.8 GW.	Pre-application	Tier 2	Windfarm: 60km north east, Substation: 64km west, Landfall: 28km north east
29	EN010099	TIGRE Project 1	Development and deployment of gas-fired power station facilities offshore integrated with existing late-life gas fields.	Pre-application	Tier 3	Windfarm: 100km north
30	EN010080	Hornsea Project Three	Offshore windfarm with an approximate capacity of up to 2,400MW.	Examination	Tier 1	Windfarm: 140km north west, Substation 30km west, Landfall: 55km north west
31	EN010060	Progress Power Station	A gas-fired power station with a nominal generating capacity of up to 299 MW.	Decided	Tier 1	50km south west
32	EN010012	Sizewell C Nuclear Power Station	New nuclear power station.	Pre-application – stage 3 consultation ended 29th March 2019	Tier 2	43km south west
33a & 33b	EN020002	Bramford to Twinstead Overhead Line	Electricity Line which will enable grid connection to Sizewell C.	Pre-application/on hold	Tier 2	83km south west
34	TR010023	Lake Lothing Third River Crossing	A new highway crossing of Lake Lothing, Lowestoft, connecting Riverside Road to the south of Lake Lothing with Peto Way to the north of Lake Lothing.	Examination	Tier 1	13km south
35a & 35b	n/a	A47 Great Yarmouth Junction Improvements – Gapton and Vauxhall Roundabouts	Planned improvements to Gapton Roundabout and Vauxhall Roundabout.	Planned – scoping report to be submitted	Tier 1	Gapton Roundabout – 1km north west. Vauxhall Roundabout 2.4km north west
36	n/a	A47 Great Yarmouth Junction Improvements – Harfreys Roundabout	Proposed improvements to Harfreys Roundabout.	Unknown	Tier 3	Adjacent to the west
37	n/a	Thanet Offshore Windfarm Extension	Proposed extension to existing offshore windfarm facility.	No application, HRA to be completed before applicants are granted lease in summer 2019, developers to then commence application process.	Tier 3	Offshore from Margate, 125km south.
38	n/a	Greater Gabbard Windfarm Extension	Proposed extension to existing offshore windfarm facility.	No application, HRA to be completed before applicants are granted lease in summer 2019, developers to then commence application process.	Tier 3	Offshore, ~63km south.

ID	Reference Number	Other Development Name	Description of Other Development	Status	Tier (Certainty)	Distance from the Application Site (closest point)
39	n/a	Galloper Windfarm Extension	Proposed extension to existing offshore windfarm facility.	No application, HRA to be completed before applicants are granted lease in summer 2019, developers to then commence application process.	Tier 3	Offshore, ~63km south.
40	n/a	Sheringham Shoal Windfarm Extension	Proposed extension to existing offshore windfarm facility.	No application, HRA to be completed before applicants are granted lease in summer 2019, developers to then commence application process.	Tier 3	Offshore, ~65km north-west.
41	n/a	Dudgeon Windfarm Extension	Proposed extension to existing offshore windfarm facility.	No application, HRA to be completed before applicants are granted lease in summer 2019, developers to then commence application process.	Tier 3	Offshore, ~65km north-west.
42	n/a	Race Bank Windfarm Extension	Proposed extension to existing offshore windfarm facility.	No application, HRA to be completed before applicants are granted lease in summer 2019, developers to then commence application process.	Tier 3	Offshore, ~89km north-west.
43	n/a	Southern Terminal Expansion (South Denes Enterprise Zone)	Proposal to utilise the southern terminal so the outer harbour can accommodate an additional offshore windfarm project. Peels Ports has modelled 10ha of additional space and 300m working quay on southern terminal.	Proposed	Tier 3	2km south east
44	06/17/0234/LDO	South Denes Business Park	Allocated with the aim to provide easy access to the river port and outer harbour. Currently one development – 06/17/0234/LDO Construction of offices and warehousing, ancillary car park, transit areas, security fences and gates.	Permitted Development	Tier1	0.6km south-east
45	n/a	Great Yarmouth Energy Park	A 50-acre port industrial area, with a focus on offshore energy businesses. No current developments.	No planned developments	n/a	0.2km south
46	Policy GN5-dp	Beacon Park Enterprise Zone	An area allocated for development for energy businesses providing a simplified planning process, including a 20ha extension in the emerging Great Yarmouth Local Plan Park 2 August 2018. The area is designated until at least 2030.	n/a	Tier 3	3.8km south.
47	n/a	Great Yarmouth Selective Licensing Scheme	Great Yarmouth Borough Council has recently introduced a selective licensing scheme within selected locations within the town. This is expected to lead to some current HMO properties coming onto the market and the Council may have	No application, undergoing feasibility study	Tier 3	n/a

ID	Reference Number	Other Development Name	Description of Other Development	Status	Tier (Certainty)	Distance from the Application Site (closest point)
			to purchase some of these to maintain market rent stocks within the town.			
48	n/a	The Conge/Town Centre Masterplan	Phased redevelopment of the Conge to create a residential-led thoroughfare linking the train station to the market-place.	No application, undergoing feasibility study	Tier 3	1.8km north
49	n/a	Marina Centre Redevelopment	Demolition of existing Marina Centre to be redeveloped as a new sports and leisure centre	Application likely to be submitted later in 2019	Tier 3	1.2km north-east
50	n/a	Winter Garden Restoration	Restoration of Grade II* Listed Building	No application, undergoing feasibility study	Tier 3	0.8km north-east
51	n/a	Bradwell	Hybrid application for up to 600 dwellings, construction will be phased over 12 years at an average rate of 50 dwellings per year.	Scoping Report submitted. Application likely to be submitted in Q2-Q3 2019	Tier 3	2.9km south-west
52	n/a	Middlegate Estate Regeneration	Regeneration of a 1950s housing estate in largely Council ownership	No application, undergoing feasibility study	Tier 3	0.5km north
53	n/a	Multi User Operation and Maintenance Facility (South Denes Enterprise Zone)	Proposal to construct an operations and maintenance campus for offshore windfarms and other users. Project will see quay restoration, pontoon placement, road realignment and opportunity for land reclamation to expand the site.	Proposed	Tier 3	1.8km south
54	n/a	Proposed Manufacturing Facility (South Denes Enterprise Zone)	Proposal to construct a manufacturing facility.	Proposed	Tier 3	1km south
55	EN010106	Sunnica Energy Farm	Construction of a solar farm on Sunnica East and Sunnica West with a 500MW capacity, and associated infrastructure for connection to the national grid, including an extension to the Burwell National Grid Substation	Pre-application	Tier 2	89km south-west
56	EN020003	Kings Lynn B Connection Project	A 2.8km (400kV) overhead transmission line to the south of King's Lynn. The development will comprise of lattice towers, overhead line and require temporary construction works and highway closures.	Approved	Tier 1	92km north-west
57	EN010039	Palm Paper 3 CCGT Power Station King's Lynn	A natural gas fired combined cycle gas turbine plant, with thermal capacity (162MW) to provide electricity and steam for internal use within the Paper Mill.	Approved	Tier 1	91km north-west

19.6.9 Table 19.16 provides a summary of the in-combination effects assessment for Stage 1 and Stage 2, based on Matrix 1 published in Appendix 1 for Advice Note 17 (Ref 19.1).

Table 19.16: Summary of the In-Combination Effects Assessment Stage 1 and Stage 2

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
1	East Anglia ONE North Windfarm	Yes	Yes	No, construction to start in 2026	n/a	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, construction of the Scheme will be completed before construction on this development commences.
2	East Anglia TWO Windfarm	Yes	Yes	No, construction to start in 2025	n/a	It has been assumed that the windfarm will be constructed, operated, and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, construction of the Scheme will be completed before construction on this development commences.
3	East Anglia THREE Windfarm	Yes	Yes	Yes, construction to start 2020	Construction: • noise and vibration • nature conservation • cultural heritage • water environment • people and communities • materials • traffic and transport Operation: • nature conservation • cultural heritage • water environment	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'. Operational phase effects from this project are not considered significant due to the distance from the Scheme.	**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
4	Great Yarmouth Waterfront Area	Yes	Yes	Yes, area allocated until at least 2030	n/a	There are no planned developments within this site.	**No**, there are no planned developments within the area.
5	Great Yarmouth Tidal Barrier	n/a	No due to level of uncertainty	Unknown	n/a	Due to early stage of design and development, effects cannot be considered at this time.	**No**, there is a high level of uncertainty as funding has not been secured for this project.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
6	Epoch 2 of the Great Yarmouth Flood Defence Improvements	Yes	No due to level of uncertainty	Yes, construction is set to commence between 2019 and 2021 and will be completed sometime after 2021	n/a	The Applicant is working with the Environment Agency (EA) to ensure a co-ordinated approach with Epoch 2 of the Great Yarmouth Flood Defence Improvements. However, due to early stage of design and development, effects cannot be considered at this time.	**No**, given the nature and uncertainty for this development.
7	A47 Burlingham-Blofield dualling,	Yes	Yes	Yes, construction in 2021-2022	Construction: • people and communities • materials • traffic and transport Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
8	A47 Thickthorn junction improvements	Yes	Yes	Yes, construction in 2021-2023	Construction: • people and communities • materials Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
9	A47 Easton-North Tuddenham dualling	Yes	Yes	Yes, construction in 2021-2022	Construction: • people and communities • materials Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
10	North Lowestoft Garden Village	Yes	Yes	No, development not expected to start until 2026	n/a	This is a site allocated for development. At this time there is no submitted application to proceed with a development.	**No**, construction of the Scheme will be completed before construction on this development commences.
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	Yes	Yes	Yes, planning permission will expire October 2020	Construction: • nature conservation • cultural heritage • townscape and visual		**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Stage 2 Include in Shortlist and Progress to Stage 3 /4?
					• water environment • flood risk • people and communities • materials • traffic and transport • major accidents and disasters Operation: • nature conservation • cultural heritage • townscape and visual • water environment • flood risk • people and communities • major accidents and disasters		
12	Bradwell South	Yes	Yes	Yes, planning permission will expire during construction of the Scheme	Construction: • townscape and visual • people and communities • materials • traffic and transport Operation: • Townscape and visual		**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
13	Beacon Park	Yes	Yes	Yes, planning permission will expire December 2020	Construction: • people and communities • materials • traffic and transport Operation:		**Yes**, construction of the Scheme will overlap with construction of this development.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
					• n/a		
14	Former Claydon High School	Yes	Yes	Yes, planning permission will expire January 2021	Construction: • cultural heritage • townscape and visual • water environment • flood risk • people and communities • materials • traffic and transport Operation: • cultural heritage • townscape and visual • water environment • flood risk • major accidents and disasters		**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
15	90 and 102 Regent Road	Yes	No, small scale	Yes, planning permission will expire July 2021	n/a		**No**, given the small scale and unlikely to have any cumulative effects with the Scheme.
16	North Denes Middle School	Yes	Yes	Yes, if permission is granted it is likely to expire in 2022	Construction: • people and communities • materials • traffic and transport Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
17	Land west of Yarmouth Road	Yes	No, small scale and distance	Yes, reserved matters must be submitted by June 2019, if approved permission	n/a		**No**, given the small scale of the development and distance from the Scheme it is unlikely to have any cumulative effects with the Scheme.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
				will expire after 2 years			
18	Land south east of Hopton	Yes	Yes	Yes, planning permission will expire May 2021	Construction: • people and communities • materials • traffic and transport Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
19	Former mushroom farm, Martham	Yes	No, small scale and distance	Yes, planning permission will expire August 2020	n/a		**No**, given the small scale of the development and distance from the Scheme it is unlikely to have any cumulative effects with the Scheme.
20	Land north of Hemsby Road	Yes	No, small scale and distance	Yes, reserved matters must be submitted by November 2019, if approved planning permission will expire after 2 years	n/a		**No**, given the small scale of the development and distance from the Scheme it is unlikely to have any cumulative effects with the Scheme.
21	Pointers East, west of Ormesby Road	Yes	Yes	Yes, planning permission will expire June 2019	Construction: • people and communities • materials • traffic and transport Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
22	Berths 1-4, Hazardous Waste Transfer Station	Yes	No, lack of change compared to baseline conditions	Yes	n/a		**No**, given the nature of the development (retention with minor amendments) it is unlikely to have any cumulative effects with the Scheme.
23	Halls Site, Riverside Road	Yes	No, small scale	Yes	n/a		**No**, given the small scale and unlikely to have any cumulative effects with the Scheme.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
24	Northgate Hospital	Yes	No, small scale	Yes, planning permission will expire in February 2022.	n/a		**No**, given the small scale and unlikely to have any cumulative effects with the Scheme.
25	Repps Road	Yes	No, small scale and distance	Yes, if approved planning permission is likely to expired in 2022	n/a		**No**, given the small scale of the development and distance from the Scheme it is unlikely to have any cumulative effects with the Scheme.
26	Welcome Pit	Yes	Yes	No – extraction in extension area will commence in 2025	n/a		**No**, construction of the Scheme will be completed before construction on this development commences.
27	Norfolk Vanguard	Yes	Yes	Yes, construction in 2020-2027	Construction: • noise and vibration • nature conservation • historic environment • townscape and visual • water environment • people and communities • materials • traffic and transport Operation: • nature conservation • cultural heritage • water environment	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
28	Norfolk Boreas	Yes	Yes	Yes, Construction in 2020-2027	Construction: • noise and vibration • nature conservation	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Stage 2 Include in Shortlist and Progress to Stage 3 /4?
					• historic environment • townscape and visual • water environment • people and communities • materials • traffic and transport Operation: • nature conservation • cultural heritage • water environment		
29	TIGRE Project 1	Yes	Yes	Yes, aspiration for development to be operational in 2022	Construction: • noise and vibration • nature conservation • historic environment • townscape and visual • water environment • people and communities • materials • traffic and transport Operation: • nature conservation • cultural heritage • water environment	It has been assumed that the development will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
30	Hornsea Project Three	Yes	Yes	Yes, construction to start in 2020	Construction: • noise and vibration • nature conservation • historic environment • townscape and visual • water environment • people and communities • materials • traffic and transport Operation: • nature conservation • cultural heritage • water environment	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
31	Progress Power Station	Yes	Yes	Yes, preliminary works underway but construction on hold	Construction: • materials Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
32	Sizewell C Nuclear Power Station	Yes	Yes	Yes, construction proposed to start in 2021	Construction: • materials Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
33a (Bramford) & 33b (Twinstead)	Bramford to Twinstead Overhead Line	Yes	Yes	Yes, construction potentially in early 2020s	Construction: • materials Operation: • n/a		**Yes**, construction of the Scheme will overlap with construction of this development.
34	Lake Lothing Third River Crossing	Yes	Yes	Yes, construction in 2019-2022	Construction: • materials Operation:		**Yes**, construction of the Scheme will overlap with construction of this development.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
					• n/a		
35a (Gapton Roundabout) 35b (Vauxhall Roundabout)	Gapton and Vauxhall Junction Improvements	Yes	Yes	Yes, construction 2019-2022	Construction: • cultural heritage • townscape and visual • water environment • flood risk • people and communities • materials • traffic and transport • major accidents and disasters Operation: • cultural heritage • townscape and visual • water environment • flood risk • major accidents and disasters		**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
36	Harfreys Junction Improvement	Yes	Yes	Unknown	Construction: • noise and vibration • nature conservation • cultural heritage • townscape and visual • water environment • flood risk • people and communities • materials • traffic and transport	This scheme is a likely alternative to the Gapton and Vauxhall junction improvements and has been included due to its proximity to the Scheme.	**Yes**, given the proximity of this development to the Scheme, and factors surrounding its certainty there are likely construction and operational cumulative effects with the Scheme.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
					• major accidents and disasters Operation: • nature conservation • cultural heritage • townscape and visual • water environment • flood risk • people and communities • major accidents and disasters		
37	Thanet Offshore Windfarm Extension	Yes	No due to level of uncertainty	Unknown	n/a	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, there is a high level of uncertainty for this development given no application has been made.
38	Greater Gabbard Windfarm Extension	Yes	No due to level of uncertainty	Unknown	n/a	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, there is a high level of uncertainty for this development given no application has been made.
39	Galloper Windfarm Extension	Yes	No due to level of uncertainty	Unknown	n/a	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, there is a high level of uncertainty for this development given no application has been made.
40	Sheringham Shoal Windfarm Extension	Yes	No due to level of uncertainty	Unknown	n/a	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, there is a high level of uncertainty for this development given no application has been made.
41	Dudgeon Windfarm Extension	Yes	No due to level of uncertainty	Unknown	n/a	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, there is a high level of uncertainty for this development given no application has been made.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
42	Race Bank Windfarm Extension	Yes	No due to level of uncertainty	Unknown	n/a	It has been assumed that the windfarm will be constructed, operated and maintained from Great Yarmouth to assess a 'worst case scenario'.	**No**, there is a high level of uncertainty for this development given no application has been made.
43	Southern Terminal Expansion (South Denes Enterprise Zone)	Yes	Yes	Aspiration to start construction in 18 months. Construction programme would take 9 months	Construction: • townscape and visual • water environment • people and communities • materials • traffic and transport Operation: • townscape and visual • water environment	There is a market demand for this development, and funding is likely to be granted.	**Yes**, given the proximity of this development to the Scheme, and factors surrounding its certainty there are likely construction and operational cumulative effects with the Scheme.
44	South Denes Business Park, Offices on South Beach Parade	Yes	No, small scale	Yes	n/a		**No**, given the small scale and unlikely to have any cumulative effects with the Scheme.
45	Great Yarmouth Energy Park	Yes	No	Unknown	n/a		**No**, there are no planned developments within the area.
46	Beacon Park Enterprise Zone	Yes	Yes	Yes	Construction: • people and communities • materials • traffic and transport Operation: • n/a	No current applications, however masterplan exists and some development could be potentially completed by 2022.	**Yes**, construction of the Scheme will overlap with construction of this development.
47	Great Yarmouth Selective Licensing Scheme	Yes	No, small scale	Unknown	n/a	The number of dwellings is currently unknown, but it is unlikely to reach the 150 dwelling threshold by 2022	**No**, given the small scale and unlikely to have any cumulative effects with the Scheme.

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
48	The Conge/Town Centre Masterplan	Yes	No, small scale	Unknown	n/a	The number of dwellings is currently unknown, but it is unlikely to reach the 150 dwelling threshold by 2022	**No**, given the small scale and unlikely to have any cumulative effects with the Scheme.
49	Marina Centre Redevelopment	Yes	Yes	Planning application expected to be submitted later in 2019, with an aspiration to open the development in summer 2021	Construction: • townscape and visual • water environment • people and communities • materials • traffic and transport Operation: • townscape and visual • water environment	Based on information provided by GYBC, it is assumed that the development will have the necessary funding to be built.	**Yes**, given the proximity of this development to the Scheme, and factors surrounding its certainty there are likely construction and operational cumulative effects with the Scheme.
50	Winter Garden Restoration	Yes	No	Unknown	n/a		**No**, there is a high level of uncertainty as funding has not been secured for this project.
51	Bradwell Residential (Beccles Road)	Yes	Yes	Yes, construction is anticipated to be 2019-2021	Construction: • townscape and visual • people and communities • materials • traffic and transport Operation: • townscape and visual		**Yes**, construction of the Scheme will overlap with construction of this development, and there are likely cumulative operational effects.
52	Middlegate Estate Regeneration	Yes	No	Unknown	n/a	A limited number of additional properties are possible, but this is not certain at present.	**No**, given the small scale it is unlikely to have any cumulative effects with the Scheme.
53	Multi User Operations and Maintenance Facility	Yes	Yes	Construction to begin in Q4 2019	Construction: • townscape and visual	There is market interest in these facilities and funding is likely.	**Yes**, given the proximity of this development to the Scheme, and factors surrounding its certainty there are likely construction and

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
	(South Denes Enterprise Zone)				• environment • flood risk • people and communities • materials • traffic and transport Operation: • townscape and visual • water environment • flood risk		operational cumulative effects with the Scheme.
54	Proposed Manufacturing Facility (South Denes Enterprise Zone)	Yes	Yes	Yes Q4 2021-Q2 2022	Construction: • cultural heritage • townscape and visual • water environment • flood risk • people and communities • materials • traffic and transport • major accident and disasters. Operation: • cultural heritage • townscape and visual • water environment • flood risk • major accidents and disasters	Dependencies on choice by client and government, waiting for government action.	**Yes**, given the proximity of this development to the Scheme, and factors surrounding its certainty there are likely construction and operational cumulative effects with the Scheme.
55	Sunnica Energy Farm	Yes	No	Yes Q1 2022-Q1 2025	n/a		**No**, due to the pre-application stage, the nature of the proposed works, the distance of the development from the Scheme and the limited construction overlap, it is unlikely to have any

ID	'Other Development' Name	Stage 1 Within ZOI?	Stage 1 Progress to Stage 2?	Stage 2 Overlap in temporal scope?	Stage 2 Likely Significant Effects	Stage 2 Other Factors	Include in Shortlist and Progress to Stage 3 /4?
							cumulative effects with the Scheme.
56	Kings Lynn B Connection Project	Yes	No	Unknown, Consent was granted in December 2013 so there is unlikely to be significant overlap	n/a		**No**, due to relatively small nature of the works and the distance of the development from the Scheme and the limited likely construction overlap, it is unlikely to have any cumulative effects with the Scheme.
57	Palm Paper 3 CCGT Power Station King's Lynn	Yes	No	18 months, unknown start date	n/a		**No**, due to nature of the works and the distance of the development from the Scheme, it is unlikely to have any cumulative effects with the Scheme.

Stages 3 and 4

19.6.10 Information gathered to support Stage 3 of the assessment is presented in Appendix 19C (document reference 6.2). As stated in Section 19.3 the assessment of in-combination cumulative impacts is reliant on the availability of information relating to the identified projects and the assessment is therefore based upon the degree of information that is available at the time of chapter preparation.

19.6.11 Stage 4 has entailed undertaking the in-combination CEA for the shortlist of developments for each of the relevant environmental topics. The results of this assessment are reported in a matrix format, consistent with Appendix 2 of Advice Note 17 (Ref 19.1), for each topic in Table 19.17.

19.6.12 Some Chapters, or elements of Chapters, are not included in the assessment. This is due to the assessment results being negligible for all assessed residual effects and on all assessed receptors. The excluded elements due to this are as follows:

- Chapter 6: Air Quality – Construction;
- Chapter 13: Climate Change – Construction and Operation;
- Chapter 15: Materials – Operation;
- Chapter 16: Geology and Soils – Construction and Operation;

19.6.13 Some Chapters, or elements of Chapters, are not included in the assessment due to the assessment within these chapters already considering future developments. The excluded elements due to this are as follows:

- Chapter 6: Air Quality – Operation;
- Chapter 7: Noise and Vibration – Operation; and
- Chapter 17: Traffic and Transport – Operation.

Table 19.17: Stage 3 / 4 Assessment Matrix

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
Noise and Vibration				
3	East Anglia THREE Windfarm	As discussed in Chapter 7 the Scheme will have **moderate** to **very large significant adverse** effects as a result of construction noise and vibration. The development ES assessment results anticipate that construction traffic noise will have a **slight adverse** effect. The potential for cumulative effects will be heavily dependent on the timing and phasing of the Scheme and the interaction with construction traffic associated with the windfarm, details of which are not known. Construction traffic was not determined to have a **not significant** effect on traffic and transport (see Traffic and Transport section of this table). Based on this, on a qualitative basis, there will be a **not significant** in-combination effect.	None Required	Construction: not significant Operation: n/a
27	Norfolk Vanguard	As discussed in Chapter 7 the Scheme will have **moderate** to **very large significant adverse** effects as a result of construction noise and vibration. The development ES assessment results anticipate that construction traffic noise will have a **slight adverse** effect. The potential for cumulative effects will be heavily dependent on the timing and phasing of the Scheme and the interaction with construction traffic associated with the windfarm, details of which are not known. Construction traffic was not determined to have a **not significant** effect on traffic and transport (see Traffic and Transport section of this table). Based on this, on a qualitative basis, there will be a **not significant** in-combination effect.	None Required	Construction: not significant Operation: n/a
28	Norfolk Boreas	As discussed in Chapter 7 the Scheme will have **moderate** to **very large significant adverse** effects as a result of construction noise and vibration. The development PEIR anticipates that construction traffic noise will have a **slight adverse** effect. The potential for cumulative effects will be heavily dependent on the timing and phasing of the Scheme and the interaction with construction traffic associated with the windfarm, details of which are not known. Construction traffic was not determined to have a **not significant** effect on traffic and transport (see Traffic and Transport section of this table). Based on this, on a qualitative basis, there will be a **not significant** in-combination effect.	None Required	Construction: not significant Operation: n/a
29	TIGRE Project 1	As discussed in Chapter 7 the Scheme will have **moderate** to **very large significant adverse** effects as a result of construction noise and vibration. The potential for cumulative effects will be heavily dependent on the timing and phasing of the Scheme and the interaction with construction traffic associated with the windfarm, details of which are not known. Construction traffic was not determined to have a **not significant** effect on traffic and transport (see Traffic and Transport section of this table). Based on this, on a qualitative basis, there will be a **not significant** in-combination effect.	None Required	Construction: not significant Operation: n/a
30	Hornsea Project Three	As discussed in Chapter 7 the Scheme will have **moderate** to **very large significant adverse** effects as a result of construction noise and vibration.	None Required	Construction: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		The development ES assessment results anticipates that construction traffic noise will have a **slight adverse** effect. The potential for cumulative effects will be heavily dependent on the timing and phasing of the Scheme and the interaction with construction traffic associated with the windfarm, details of which are not known. Construction traffic was not determined to have a **not significant** effect on traffic and transport (see Traffic and Transport section of this table). Based on this, on a qualitative basis, there will be a **not significant** in-combination effect.		Operation: n/a
36	A47 Great Yarmouth Junction Improvements – Harfreys Roundabout	As discussed in Chapter 7 the Scheme will have **moderate** to **very large significant adverse** effects as a result of construction noise and vibration. The potential for cumulative effects will be heavily dependent on the timing and phasing of the Scheme and the interaction with construction traffic associated with Harfreys Roundabout improvements, details of which are not known. Subsequently, on a qualitative basis, the resulting in-combination effect is anticipated to be **not significant**.	None Required	Construction: not significant Operation: n/a
Nature Conservation				
3	East Anglia THREE Windfarm	As discussed in Chapter 8 the Scheme will have a **slight adverse** effect on water voles and bats during elements of construction; all other receptors will see **negligible** effects. During the operation phase the Scheme will have a **slight adverse** effect on bats; all other receptors will see **negligible** effects. The development ES assessment results anticipate **no impact** on water voles associated with the landfall and substation elements of the development, and **minor adverse** effects as a result of the onshore cable element of the development. However, these elements of the development fall outside of the ZOI for the Scheme so there is no potential in-combination effect. No assessment of construction effects of the offshore elements on water voles was carried out. It is assumed that construction traffic (both road-based and maritime) will be present within 500m of the Scheme on route to Great Yarmouth Harbour to facilitate the construction of the offshore elements of the development. As a result, there is the potential for an in-combination effect on water voles from the movement of construction traffic. This is anticipated to be **minor adverse** (not significant) due to the development construction traffic only being likely to add to the potential disturbance (noise and vibration) and accidental spillage risk. The development ES assessment results anticipate **no impact** on bats associated with the landfall element of the development, and **minor adverse** effects as a result of the onshore cable (to commuting and foraging bats only) and the substation elements of the development. As stated earlier these elements are outside of the ZOI and thus will be assessed no further. No assessment of construction effects of the offshore elements on bats was carried out and the same assumptions apply as per water voles above. As a result, there is the potential for an in-combination effect on bats from the movement of construction traffic. This activity has the potential to kill or injure bats, resulting in a **minor adverse** in-combination effect. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 500m of the Scheme, it is anticipated the activities will be of a low volume, resulting in a **minor adverse** (not significant) in combination effect.	None Required	Construction: minor adverse (not significant) Operation: minor adverse (not significant)

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		It is assumed a number of mitigation measures will be included in the development in order to reach the residual effects concluded. These are licenced conservation protection works, receptor site enhancements, habitat permeability design, and appropriate translocation where required.		
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 8 the Scheme will have a **slight adverse** effects on water voles and bats during elements construction; all other receptors will see **negligible** effects. During the operation phase the Scheme will have a **slight adverse** effects on bats; all other receptors will see **negligible** effects. The development Preliminary Environmental Report (PER) reports little suitable habitat within or in the vicinity of the development for use by protected species, though it may be important to certain bird species (particularly sea birds). Additionally, no record of protected or rare species exist on the site of the development but important bird species are known to use the estuary directly adjacent (north-west) of the site. No further survey work was thought necessary. Based on the site conditions it can be assumed that the presence of water voles and bats are unlikely. There is a lack of pathways to the River Yare and potential bat roost locations, resulting in an anticipated **not significant** in-combination effect in both the construction and operation phases.	None Required	Construction: not significant Operation: not significant
27	Norfolk Vanguard	As discussed in Chapter 8 the Scheme will have a **slight adverse** effect on water voles and bats during elements construction; all other receptors will see **negligible** effects. During the operation phase the Scheme will have a **slight adverse** effect on bats; all other receptors will see **negligible** effects. The development ES assessment results anticipate **no impact** on bats as a result of landfall elements of the development, **negligible** residual effects due to the onshore cable route (with potential significant effect on un-surveyed areas) and **moderate adverse** effects as a result of the substation and extension. The effects on water voles are anticipated to be **no impact** as a result of landfall elements, **no impact-medium impact** as a result of the cable route, a **moderate adverse** effect as a result of the substation and a **minor adverse** effect as a result of the substation extension. These elements all fall outside of the ZOI for the Scheme, as a result there is no potential in-combination effect. No assessment of construction effects of the offshore elements on bats or water voles was carried out, it has been assumed that construction traffic (both road and marine based) will be present within 500m of the Scheme on route to Great Yarmouth Harbour. As a result, there is the potential for an in-combination effect on both water voles and bats due to the proximity of suitable habitat/roost locations. This activity has the potential to disturb both water voles and bats, leading to a **minor adverse** (not significant) in-combination effect. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 500m of the Scheme, it is anticipated the activities will be of a sufficiently low volume to result in a **not significant** in combination effect. It is assumed a number of mitigation measures will be included in the development in order to reach the residual effects concluded. These are licenced conservation protection works, receptor site enhancements, habitat permeability design, appropriate translocation where required for water voles.	None Required	Construction: minor adverse (not significant) Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
28	Norfolk Boreas	As discussed in Chapter 8 the Scheme will have a **slight adverse** effect on water voles and bats during elements construction; all other receptors will see **negligible** effects. During the operation phase the Scheme will have a **slight adverse** effect on bats; all other receptors will see **negligible** effects. The development Preliminary Environmental Information Report (PEIR) assesses two different development scenarios for all effect assessment. For bats **no impact** is anticipated as a result of the landfall elements of the development for both scenarios, **negligible** effect in scenario 1 and potential **high impact** in scenario 2 as a result of the onshore cable elements. **No impact-medium impact** is anticipated for both scenarios as a result of the substation, a **moderate adverse** effect as a result of the substation extension for scenario 2 and a **minor adverse** effect in scenario 1. For water voles the PEIR assessment results in **no impact** as a result of landfall elements of the development (both scenarios), **low impact** as a result of the substation (both scenarios), **no impact-medium impact** in scenario 2 and **no impact** in scenario 1 as a result of the onshore cable, a **minor adverse** effect in scenario 2 and **no impact** in scenario 1 as a result of the substation extension. These elements all fall outside of the ZOI for the Scheme, as a result there is no potential in-combination effect. No assessment of construction effects of the offshore elements on bats or water voles was carried out, it has been assumed that construction traffic (road and maritime) will be operating within 500m of the Scheme on route to Great Yarmouth Harbour. There is a potential for an in-combination effect as a result of these activities. The movement of construction traffic, due to its proximity to suitable water vole habitat and bat roost locations, has the potential to disturb these species. Alongside the Scheme's adverse effects this will result in a **minor adverse** (not significant) in-combination effect. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 500m of the Scheme, it is anticipated the activities will be of a sufficiently low volume to result in a **not significant** in combination effect. It is assumed a number of mitigation measures will be included in the development in order to reach the residual effects concluded. These are licenced conservation protection works, receptor site enhancements, habitat permeability design, and appropriate translocation where required for water voles.	None Required	Construction: minor adverse (not significant) Operation: not significant
29	TIGRE Project 1	As discussed in Chapter 8 the Scheme will have a **slight adverse** effect on water voles and bats during elements construction; all other receptors will see **negligible** effects. During the operation phase the Scheme will have a **slight adverse** effect on bats; all other receptors will see **negligible** effects. Information on the development at the time of writing is very limited and no assessments have been carried out on potential effect. However, due to the nature of the development it is anticipated that the potential source of an in-combination effect, construction traffic to facilitate the installation of new gas turbines, will be of a low duration and volume resulting in a **minor adverse** (not significant) in-combination effect on the killing or injuring of water voles and bats. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 500m of the Scheme, it is anticipated the activities will be of a low volume, resulting in a **minor adverse** (not significant) in combination effect.	None Required	Construction: minor adverse (not significant) Operation: minor adverse (not significant)

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
30	Hornsea Project Three	As discussed in Chapter 8 the Scheme will have a **slight adverse** effect on water voles and bats during elements construction; all other receptors will see **negligible** effects. During the operation phase the Scheme will have a **slight adverse** effect on bats; all other receptors will see **negligible** effects. The development ES assessment anticipates a **negligible** effect on water voles and a **minor adverse** effect on bats as a result of onshore construction activities. The assessment of effects of offshore construction activities has not been carried out. The UK port servicing the development has yet to be determined, due to the nature and proximity of Great Yarmouth to the development it has been assumed, for the purpose of this assessment, that Great Yarmouth port will be used to facilitate construction. Large volumes of construction traffic (both maritime and road based) would be required and there is the potential for this to take place within 500m of the Scheme. As a result of these activities there is the potential for an in-combination effect on the potential disturbance water voles and bats. These effect is anticipated to be **minor adverse** (not significant) The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 500m of the Scheme, it is anticipated the activities will be of a low volume, resulting in a **minor adverse** (not significant) in combination effect.	None Required	Construction: minor adverse (not significant) Operation: minor adverse (not significant)
36	Harfreys Junction Improvement	As discussed in Chapter 8 the Scheme will have a **slight adverse** effect on water voles and bats during elements construction; all other receptors will see **negligible** effects. During the operation phase the Scheme will have a **slight adverse** effect on bats; all other receptors will see **negligible** effects. Additionally, during the construction phase the Scheme is anticipated to have **minor adverse** effects on arboriculture (amenity) and **minor beneficial** effects during the operation phase. At the time of writing there is very limited information available on the development other than location, directly adjacent to the Scheme. Due to the nature of the development there will likely be similar construction activities for the road elements as that of the Scheme. During the construction phase there is a potential for an in-combination effect on arboriculture and bats due to the proximity of the development to the scheme and the similar nature of activities. During the construction phase this is anticipated to result in a **minor adverse** (not significant) effect on both bats and arboriculture. There is anticipated to be a **not significant** effect on water voles due to the distance of the development from suitable habitat. During the operation phase there is the potential for an in-combination effect on Arboriculture. Assuming similar landscaping and planting measures as that of the Scheme, this is anticipated to result in a **minor beneficial** (not significant) effect. The operational in-combination effect on bats is deemed to be **not significant** due to the lack of change from baseline conditions.	None Required	Construction: minor adverse (not significant) for bats and arboriculture; not significant for water voles. Operation: minor beneficial (not significant) for arboriculture; not significant for bats.
Cultural Heritage				
3	East Anglia THREE Windfarm	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme.	None Required	Construction: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		Direct The boundaries of the development and the Scheme do not overlap, and therefore the anticipated direct in-combination effects to heritage assets will be **not significant**. Indirect There is a potential indirect effect to heritage assets as it is assumed that the development will use Great Yarmouth Port during construction and operation, increasing construction traffic within 1km of the Scheme. The ES for the development concludes that the potential effects from the base port construction traffic attraction (personnel), and base port operational attraction (personnel) are likely to be **neutral**. The Applicant will also work with the chosen port to ensure worker related traffic is minimised and consult with the relevant authorities with regard to their Travel Plan requirements. No assessment was undertaken for the effect of HDVs to the base port, however it is anticipated that these will be of sufficiently low volume to result in a **not significant** in-combination effect to heritage assets during both the construction and operation phases of the development.		Operation: not significant
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. The Heritage Statement for the development concludes that the development will have **no effect** on the Grade II listed Gas Holder, and the effect on the Grade I listed Nelson's Monument will be **neutral**. As a result, the in-combination effect during operation will be **not significant**. No assessment has been undertaken for effects to heritage assets during the construction phase. It is assumed that there will be a combination of construction related infrastructure, traffic, noise and vibration, and dust during the construction phase which could have an in-combination effect with the Scheme on heritage assets. However, it is anticipated that these effects will be temporary and reduced by best practice mitigation measures; as a result the in-combination effect during operation will be **not significant**.	None Required	Construction: not significant Operation: not significant
14	Former Claydon High School	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. No assessment has been undertaken for the developments effect to heritage assets during both construction and operation. The development is over 1km from the Grade I listed Nelson's Monument and the Grade II listed Gas Holder, it is therefore considered that the development will have no effect on the setting of these heritage assets. As a result, it is anticipated that the in-combination effect during both construction and operation will be **not significant**.	None Required	Construction: not significant Operation: not significant
27	Norfolk Vanguard	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. Direct The boundaries of the development and the Scheme do not overlap, and therefore there are no anticipated direct in-combination effects to heritage assets.	None Required	Construction: not significant Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		Indirect There is a potential indirect effect to heritage assets as it is assumed that the development will use Great Yarmouth Port during construction and operation, increasing construction traffic within 1km of the Scheme. The ES for the development considers that the origin port may be used for the import of materials during the construction phase, increasing the volume of construction traffic, which could have an indirect effect on the setting of historical assets. The scale of this is currently unknown, however it is anticipated that the strategic road network will be used to minimise effect, resulting in a **not significant** in-combination effect. No assessment for operational traffic from the origin port has been undertaken, however it is anticipated that these will be of sufficiently low volume to result in a **not significant** in-combination effect to heritage assets during the operational phase of the development.		
28	Norfolk Boreas	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. Direct The boundaries of the development and the Scheme do not overlap, and therefore there are no anticipated direct in-combination effects to heritage assets. Indirect There is a potential indirect effect to heritage assets as it is assumed that the development will use Great Yarmouth Port during construction and operation, increasing construction traffic within 1km of the Scheme. The ES for the development considers that the origin port may be used for the import of materials during the construction phase, increasing the volume of construction traffic, which could have an indirect effect on the setting of historical assets. The scale of this is currently unknown, however it is anticipated that the strategic road network will be used to minimise effect, resulting in a **not significant** in-combination effect. No assessment for operational traffic from the origin port has been undertaken, however it is anticipated that these will be of sufficiently low volume to result in a **not significant** in-combination effect to heritage assets during the operational phase of the development.	None Required	Construction: not significant Operation: not significant
29	TIGRE Project 1	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. Direct No assessment has been undertaken for the developments effect for heritage assets. The project is based entirely offshore so there will be no overlap in boundary for direct effects to heritage assets, resulting in a **not significant** direct in-combination effect. Indirect It has been assumed that both construction and operation traffic from the development will be within the Scheme's ZOI, which could have a potential indirect effect on the setting of historic assets. The nature and the scale of these activities is	None Required	Construction: not significant Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		currently unknown. However, it is anticipated that these will be of sufficiently low volume to result in a **not significant** in-combination effect to heritage assets during both the construction and operation phases of the development.		
30	Hornsea Project Three	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. <u>Direct</u> The boundaries of the development and the Scheme do not overlap, and therefore there are no anticipated direct in-combination effects to heritage assets. <u>Indirect</u> It has been assumed that both construction and operation traffic from the development will be within the Scheme's ZOI, which could have a potential indirect effect on the setting of historic assets. The nature and the scale of these activities is currently unknown. However, it is anticipated that these will be of sufficiently low volume to result in a **not significant** in-combination effect to heritage assets during both the construction and operation phases of the development.	None Required	Construction: not significant Operation: not significant
35a & 35b	A47 Great Yarmouth Junction Improvements – Gapton and Vauxhall Roundabouts	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. No assessment has been undertaken for the developments effect to heritage assets during both construction and operation. The development is over 1km from the Grade I listed Nelson's Monument and the Grade II listed Gas Holder, it is therefore considered that the development will have no effect on the setting of these heritage assets. As a result, it is anticipated that the in-combination effect during both construction and operation will be **not significant**.	None Required	Construction: not significant Operation: not significant
36	Harfreys Junction Improvement	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. No assessment has been undertaken for the developments effect to heritage assets during both construction and operation. The design and construction methodology of this development is currently unknown, however given the distance of the development from the historic assets (approx. 650m from the Gas Holder and 950m from Nelson's Monument), and the extent of buildings in-between which block viewpoints, it is not anticipated that this development will have an effect on the setting of either Nelson's Monument or the Gas Holder. As a result, it is anticipated that the in-combination effect during both construction and operation will be **not significant**.	None Required	Construction: not significant Operation: not significant
54	Proposed Manufacturing Facility (South Denes Enterprise Zone)	As discussed in Chapter 9 the Scheme will have a **moderate adverse** effect on the setting of Grade I listed Nelson's Monument (NHLE 1246057) and the Grade II listed Gas Holder (NHLE 1096789) during both the construction phase and operation of the Scheme. No assessment has been undertaken for the developments effect to heritage assets during both construction and operation. The development is over 1km from the Grade II listed Gas Holder, and therefore no effects are anticipated. The development is approximately 540m south of the Grade I listed Nelson's Monument. There is currently no design for the	None Required	Construction: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		development and the site is predominately vacant land, however due to the buildings directly in-between Nelson's Monument and the development it is not anticipated that the development will have an effect on its setting. As a result, it is anticipated that the in-combination effect during both construction and operation will be **not Significant.**		Operation: not significant
Townscape and Visual				
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The development would see alterations to the character boundary. This is the only element of the development with the potential for an in-combination effect. However, the effects on the character boundary (TCA 7) in question for the Scheme are **not significant** for construction and operation. As a result, the anticipated In-combination effect for all elements and phases is **not significant**.	None Required	Construction: not significant Operation: not significant
12	Bradwell South	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The development will result in an increase to the residential character of the area (TCA 5), and a decrease in open greenspace. This is identified as the only potential area for an in-combination effect. The effects of the Scheme in both construction and operation on TCA 5 are **not significant**. As a result, the anticipated in-combination effect is also **Not Significant**.	None Required	Construction: not significant Operation: not significant
14	Former Claydon High School	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The development will result in an increase to the residential character of the area (TCA 5), and a decrease in open greenspace. This is identified as the only potential area for an in-combination effect. The effects of the Scheme in both construction and operation on TCA 5 are **not significant**. As a result, the anticipated in-combination effect is also **not significant**.	None Required	Construction: not significant Operation: not significant
35a & 35b	Gapton and Vauxhall Junction Improvements	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint.	None Required	Construction: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		The development is in close proximity to the Scheme. As a result, it is anticipated that any construction activities will not alter the visual or townscape in any significant way compared to that of the Scheme in isolation. Subsequently, the construction phase in-combination effect will be **not significant**. The operational phase effects are not anticipated to alter the visuals or townscape character in any significant way in comparison to baseline conditions, therefore the in-combination effect will be **not significant**.		Operation: not significant
36	Harfreys Junction Improvement	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The development is in close proximity to the Scheme. As a result, it is anticipated that any construction activities will not alter the visual or townscape in any significant way compared to that of the Scheme in isolation. Subsequently, the construction phase in-combination effect will be **not significant**. The operational phase effects are not anticipated to alter the visuals or townscape character in any significant way in comparison to baseline conditions, therefore the in-combination effect will be **not significant**.	None Required	Construction: not significant Operation: not significant
43	Southern Terminal Expansion (South Denes Enterprise Zone)	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The development area is currently derelict land, as a result the works would lead to increasing the footprint of the existing character area (industrial and port TCA 1). It would also lead to a defined contrast between TCA 1 and TCAs 2 and 7. The resulting in-combination effect on visuals is anticipated to be **minor adverse** (not significant) (construction and operation). As the development would not alter, but rather add to, existing character areas, the townscape in-combination effect is anticipated to be **not significant** (construction and operation).	None Required	Construction: not significant for Townscape, minor adverse (not significant) for Visual Operation: not significant for Townscape, minor adverse (not significant) for Visual
49	Marina Centre Redevelopment	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint.	Not Significant	Construction: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		The development will add to the character of the existing townscape character area (TCA 7). This is identified as the only potential area for an in-combination effect. The effects of the development in both construction and operation on TCA 7 are **not significant**. As a result, the anticipated in-combination effect is also **not significant**.		Operation: not significant
51	Bradwell Residential (Beccles Road)	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The development will result in an increase to the residential character of the area (TCA 5), and a decrease in open greenspace. This is identified as the only potential area for an in-combination effect. The effects of the development in both construction and operation on TCA 5 are **not significant**. As a result, the anticipated in-combination effect is also **not significant**.	None Required	Construction: not significant Operation: not significant
53	Multi User Operations and Maintenance Facility (South Denes Enterprise Zone)	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The completed development would lead to an increase in the footprint of the existing character area (industrial and port TCA 1). As the development would not alter, but rather add to, existing character areas. The townscape and visual in-combination effect is anticipated to be **not significant** (construction and operation).	None Required	Construction: not significant Operation: not significant
54	Proposed Manufacturing Facility (South Denes Enterprise Zone)	As discussed in Chapter 10, the Scheme would have effects in the construction phase of **neutral** to **slight adverse** on townscape and neutral **to moderate adverse** on visual receptors. The effect on the operation phase year 1 would be **slight adverse** to **slight beneficial** on townscape and **neutral to moderate adverse** on visual receptors. In year 15 there would be **slight beneficial** to **slight adverse** effects on townscape and **slight adverse** to **moderate beneficial** effects depending on viewpoint. The completed development would lead to an increase in the footprint of the existing character area (industrial and port TCA 1). As the development would not alter, but rather add to, existing character areas, the townscape and visual in-combination effect is anticipated to be **not significant** (construction and operation).	None Required	Construction: not significant Operation: not significant
Water Environment				
3	East Anglia THREE Windfarm	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The Development ES assessment results anticipate **neutral** to **slight adverse** effects (depending on receptor) on surface water associated with the onshore cable, landfall and substation elements of the development. However, these elements of	None Required	Construction: minor adverse (not significant)

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		the development fall outside of the ZOI for the Scheme, and so the waterbodies considered in the assessment are also outside of the ZOI for the Scheme area; as such there is no potential in-combination effect. No assessment of construction effects of the offshore elements on surface water was undertaken. It is assumed that construction traffic (both road-based and maritime) will be present within 1km of the Scheme on route to Great Yarmouth Harbour to facilitate the construction of the offshore elements of the development. As a result, there is the potential for an in-combination effect on surface water from pollution due to increased construction traffic. This activity has the potential to result in accidental spillage of pollutants such as oil, fuel and concrete resulting in the polluting of surface water, resulting in a **minor adverse** (not significant) in-combination assessment. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 1km of the Scheme, it is anticipated the activities will be of a sufficiently low volume to result in a **not significant** in-combination effect.		Operation: not significant
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development is situated on the coast of the North Sea, and the River Yare is approximately 600m west of the development. No assessment of construction effects of the development on surface water was undertaken. It is anticipated that construction activities on site could pose a pollution risk to the North Sea adjacent to the development. Furthermore, it is assumed that construction traffic will be present within 1km of the Scheme on route to the coast to facilitate the construction of the development. As a result, there is the potential for an in-combination effect on surface water, including the IDB watercourse network and the River Yare, from pollution due to increased construction traffic. It is expected that an appropriate Construction Environmental Management Plan (CEMP) will be implemented for the development, which will detail the controls and measures, such as spillage/dust management and runoff control, to be adopted during construction. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on surface water during the construction phase. Due to the favourable below ground infiltration conditions at the site, the surface water drainage strategy for the development proposes the use of Sustainable Urban Drainage (SuDS) in the form of permeable pavement and/or soakaways to avoid surface water discharge into existing Anglian Water (AW) combined sewer and/or watercourses. With respect to foul water drainage, it is proposed to provide a combined piped gravity and pumped foul drainage system for the development to transfer flows to existing AW combined sewer. Consultation with AW has confirmed that their assets have capacity to accommodate foul water flows from the full development. As such, the development is not expected to effect on any existing sewers and assets, including sewage treatment system and pumping stations, in the surrounding area and therefore no potential in-combination effect on these assets is predicted during operation. Given the development is not proposing to discharge surface water runoff into watercourses, there are no potential in-combination pollution effects to the River Yare and/or local watercourses and IDB drains within the study area. However, there is the potential for surface water runoff from the development to overflow into the beach and potentially effect on water quality in the North Sea. Appropriate pollution prevention measures will be provided through the permeable pavement and soakaways, and oil	None required	Construction: minor adverse (not significant) Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		separators will be installed to contain larger quantities of spilled pollution. Hence significant effects to water quality in the North Sea is not expected. Based on the above, it is predicted that the in-combination effect on surface water during the operational phase will be **not significant**.		
14	Former Claydon High School	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. There are no waterbodies within the boundary of the development; the River Yare is situated approximately 800m east of the development and there are a series of drainage ditches approximately 100m north. These ditches feed into the IDB watercourse network within the Principal Application Site. No assessment of construction effects of the development on surface water was undertaken. However, there is the potential for an in-combination pollution effect on the IDB watercourse network due to construction activities from the development and the Scheme. It is anticipated that an appropriate CEMP will be implemented for the development, which will detail the controls and measures, such as spillage/dust management and runoff control, to be adopted during construction. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on the IDB watercourse network during the construction phase. Given the distance to the River Yare, in-combination effects on this waterbody are considered **not significant**. Site investigation completed for the development has revealed suitable soil conditions to adopt infiltration type SuDS for the management of surface water runoff from the site. Therefore, drainage via infiltration using soakaways, permeable pavement and/or infiltration basin has been proposed as part of the surface water drainage strategy for the development, as opposed to discharge to watercourses and/or existing sewer system within the surrounding area. As such, in-combination pollution effects to the IDB watercourse network and/or the River Yare are predicted to be **not significant** during the operational phase.	None Required	Construction: minor adverse (not significant) for IDB Watercourse; not significant for River Yare Operation: not significant
27	Norfolk Vanguard	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The Development ES assessment results anticipate **negligible** to **moderate adverse** effects (depending on receptor) on surface water associated with the onshore cable, landfall and substation elements of the development. However, these elements of the development fall outside of the ZOI for the Scheme, and so the waterbodies considered in the assessment are also outside of the ZOI for the Scheme area, and so there is no potential in-combination effect. No assessment of construction effects of the offshore elements on surface water was undertaken. It is assumed that construction traffic (both road-based and maritime) will be present within 1km of the Scheme on route to Great Yarmouth Harbour to facilitate the construction of the offshore elements of the development, and on route to the onshore construction sites. As a result, there is the potential for an in-combination effect on surface water from pollution due to increased construction traffic. This activity has the potential to result in accidental spillage of pollutants such as oil,	None Required	Construction: minor adverse (not significant) Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		fuel and concrete resulting in the polluting of surface water, resulting in a **minor adverse** (not significant) in-combination effect. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 1km of the Scheme, it is anticipated the activities will be of a sufficiently low volume to result in a **not significant** in combination effect.		
28	Norfolk Boreas	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development PEIR assessment results anticipate **negligible** to **moderate adverse** effects on the water environment. However, the receptors assessed fall outside of the ZOI for the Scheme, resulting in no potential in-combination effect. No assessment of construction effects for offshore elements of the development has been undertaken. It is assumed that construction traffic (both road-based and maritime) will be present within 1km of the Scheme on route to Great Yarmouth Harbour to facilitate the construction of the offshore elements of the development, and on route to the onshore construction sites. As a result, there is the potential for an in-combination effect on surface water from pollution due to increased construction traffic. This activity has the potential to result in accidental spillage of pollutants such as oil, fuel and concrete resulting in the polluting of surface water, resulting in a **minor adverse** (not significant) in-combination effect. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 1km of the Scheme, it is anticipated the activities will be of a sufficiently low volume to result in a **not significant** in combination effect.	None Required	Construction: minor adverse (not significant) Operation: not significant
29	TIGRE Project 1	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. Information on the development at the time of writing is very limited and no assessments have been carried out on potential effects. However, due to the nature of the development it is anticipated that the potential source of an in-combination effect, construction traffic to facilitate the installation of new gas turbines, will be of a low duration and volume. This activity has the potential to result in accidental spillage of pollutants to surface water. As a result, a **minor adverse** (not significant) in-combination effect is anticipated. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 1km of the Scheme, it is anticipated the activities will be of a sufficiently low volume to result in a **not significant** in combination effect.	None Required	Construction: minor adverse (not significant) Operation: not significant
30	Hornsea Project Three	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction;	None Required	Construction: minor

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development ES assessment of construction effect for onshore elements anticipated minor adverse effects on all water receptors. As these assessed receptors fall outside of the Scheme ZOI no potential in-combination effect is considered. No assessment of construction effects for offshore elements of the developments has taken place. It is assumed that construction traffic (both road-based and maritime) will be present within 1km of the Scheme on route to Great Yarmouth Harbour to facilitate the construction of the offshore elements of the development, and on route to the onshore construction sites. As a result, there is the potential for an in-combination effect on surface water from pollution due to increased construction traffic. This activity has the potential to result in accidental spillage of pollutants such as oil, fuel and concrete resulting in the polluting of surface water, resulting in a **minor adverse** (not significant) in-combination effect. The nature and scale of the operational activities is currently not known. In a worst-case scenario where maintenance vehicles are in operation within 1km of the Scheme, it is anticipated the activities will be of a sufficiently low volume to result in a **not significant** in combination effect.		adverse (not significant) Operation: not significant
35a & 35b	Gapton and Vauxhall Junction Improvements	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. No assessment of the development's construction effects on surface water have been undertaken. The Gapton element of the development (35a) is approximately 800m west of the River Yare, and surrounded by drainage ditches. These ditches, together with those located within and in the vicinity of the Principal Application Site, form part of the IDB catchment that contributes to the network of dykes and watercourses that drains through the marshland south of Breydon Water. The preferred route option for this development states that there will be no structural effect on the existing drain and culvert. However, construction activities on site could pose a pollution risk to these drainage ditches, and contaminants released could be transported downstream to effect on the water quality in the watercourse network within the marshland. The Vauxhall element of the development (35b) is located between Breydon Water and the River Bure and the proposed improvement works will include the widening of the existing A47 railway bridge, enlarging the existing Vauxhall Roundabout and realignment of existing highway. Similarly, construction works on site could pose a pollution risk to the River Bure and Breydon Water, which could extend downstream to effect on the River Yare. Furthermore, it is assumed that construction traffic will be present within 1km of the Scheme on route to facilitate the construction of both the Gapton and Vauxhall elements of the development. As a result, there is the potential for an in-combination effect on surface water from pollution due to increased construction traffic. It is anticipated that an appropriate CEMP will be implemented for the development, which will detail the controls and measures, such as spillage/dust management and runoff control, to be adopted during construction. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on surface water environment during the construction phase.	None Required	Construction: minor adverse (not significant) Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		The improvement works associated with the Gapton Roundabout will include the installation of traffic signals and provision for non-motorised users. No structural improvements to the highway are currently proposed. Hence, changes to traffic flows and subsequently highway runoff at the junction are not expected during operation. Improvements to the Vauxhall Roundabout could alter (potentially increase) traffic flows through the junction. Widening of the railway bridge and associated highway works could increase runoff and subsequently contaminants discharging into the receiving waterbodies. However, the magnitude of change is expected to be small with pollutants dispersed and diluted prior to discharge to the River Yare. Therefore, there is likely to be a **not significant** in-combination effect on surface water during the operation phase.		
36	Harfreys Junction Improvement	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development is located directly adjacent to the Scheme and as a result has the potential for an in-combination effect. The nature and extent of improvement works associated with the Harfreys Roundabout are currently unknown but construction works on site could potentially effect on surface water, in particular the IDB drains located adjacent to the roundabout and within the Principal Application Site. Furthermore, it is assumed that construction traffic will be present within the Principal Application Site to facilitate the improvement works of the roundabout. As a result, there is the potential for an in-combination effect on surface water from pollution due to increased construction traffic. It is anticipated that an appropriate Construction Environmental Management Plan (CEMP) will be implemented for the development, which will detail the controls and measures, such as spillage/dust management and runoff control, to be adopted during construction. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on surface water during the construction phase. The improvement works associated with the Harfreys Roundabout could increase traffic flows through the junction and potentially through the Scheme. Increasing the impermeable road area could increase runoff and subsequently contaminants discharging into the receiving waterbodies. However, the magnitude of change is expected to be small. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on surface water during the operation phase.	None Required	Construction: minor adverse (not significant) Operation: minor adverse (not significant)
43	Southern Terminal Expansion (South Denes Enterprise Zone)	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development is on the coast of the North Sea and adjacent to the mouth of the River Yare. No assessment of construction effects of the development on surface water was undertaken, however it is expected that construction activities on site could cause adverse effects on the North Sea and the River Yare. Furthermore, it is assumed that construction traffic will be present within 1km of the Scheme on route to the coast to facilitate the construction of the development. As a result, there is the potential for an in-combination effect on surface water, including the IDB watercourse network, from	None Required	Construction: minor adverse (not significant) Operation: minor adverse (not significant) for River Yare; not

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		pollution due to increased construction traffic. It is expected that an appropriate CEMP will be implemented for the development, which will detail the controls and measures, such as spillage/dust management and runoff control, to be adopted during construction. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on surface water during the construction phase. No assessment of operational effects on surface water has been undertaken but there is the potential for the development to effect on the North Sea, both in terms of coastal processes and water quality. However, the effects of the Scheme on this receptor are considered to be insignificant, therefore the in-combination effect is likely to be **not significant**. Given no local watercourses and/or IDB drains are identified in the vicinity of the development, no in-combination effect is predicted to these surface water features. Due to the close proximity of the River Yare, there is the potential for the development to effect on the watercourse but the effects are expected to be localised and unlikely to extend upstream to effect on the stretch of the river within and adjacent to the Principal Application Site. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on the River Yare during the operation phase.		significant for North Sea
49	Marina Centre Redevelopment	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development is on the coast of the North Sea and the River Yare is approximately 700m west. No assessment of construction effects of the development on surface water was undertaken. It is anticipated that construction/demolition activities on site could pose a pollution risk to the North Sea adjacent to the development. Furthermore, it is assumed that construction traffic will be present within 1km of the Scheme on route to the coast to facilitate the construction of the development. As a result, there is the potential for an in-combination effect on surface water, including the IDB watercourse network and the River Yare, from pollution due to increased construction traffic. However, it is expected that an appropriate CEMP will be implemented for the development, which will detail the controls and measures, such as spillage/dust management and runoff control, to be adopted during construction. Therefore, there is likely to be a **minor adverse** (not significant) in-combination effect on surface water during the construction phase. No assessment of operational effects on surface water has been undertaken but there is the potential for the development to effect on the North Sea, in particular associated with polluted surface water runoff entering the coastal waters. However, it is expected that an appropriate surface water drainage strategy will be developed to manage runoff from the site, therefore the in-combination effect on the North Sea is deemed **Not Significant**. Given no local watercourses and/or IDB drains are identified in vicinity of the development, no in-combination effect is predicted to these surface water features. The distance between the development and the River Yare means the operational effects on this waterbody are likely to be insignificant. As a result, the in-combination effect to the River Yare during the operational phase is considered to be **not significant**.	None Required	Construction: minor adverse (not significant) Operation: not significant
53	Multi User Operations and Maintenance Facility	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on	Assuming similar mitigation measures to that of the Scheme are	Construction: minor adverse (not significant)

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
	(South Denes Enterprise Zone)	surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development is on the coast of the North Sea at the mouth of the River Yare. No assessment of construction effects of the development on surface water was undertaken, however it is expected that construction activities on site could cause adverse effects on the North Sea and the River Yare. Furthermore, it is assumed that construction traffic will be present within 1km of the Scheme on route to the coast to facilitate the construction of the development. As a result, there is the potential for an in-combination effect on surface water, including the IDB watercourse network, from pollution due to increased construction traffic. It is expected that an appropriate CEMP will be implemented for the development, which will detail the controls and measures, such as spillage/dust management, runoff control and procedures for in-channel works, to be adopted during construction. However, given the construction works will occur within the River Yare, there is likely to be a **minor adverse** (not significant) in-combination effect on this receptor during construction. As for the IDB watercourse and the North Sea, there is likely to be a **minor adverse** (not significant) in-combination effect during the construction phase. The proposed development will see land reclamation to expand the site into the River Yare. This will result in the permanent narrowing of the river mouth, which may effect on the tidal/hydromorphological characteristics of the estuary and coastal processes of the North Sea due to the constriction caused of the development site. Furthermore, due to the close proximity of the operations and maintenance facility to the river mouth, any contaminants released into the watercourse due to spillages could be easily transported upstream and downstream by natural processes. Therefore, it is predicted there will be a **moderate adverse** (significant) in-combination effect on the River Yare. With respect to the North Sea, the effects of the Scheme on this receptor are considered to be insignificant therefore the in-combination effect is likely to be **not significant**.	adopted, no additional mitigation is required	for River Yare; minor adverse (not significant) for IDB watercourse and North Sea Operation: moderate adverse (significant) for River Yare; not significant for North Sea
54	Proposed Manufacturing Facility (South Denes Enterprise Zone)	As discussed in Chapter 11 the Scheme will have a **neutral** to **slight adverse** effect on surface water receptors (including the River Yare and ditches and watercourses within the urban area of Great Yarmouth) due to pollution during construction; groundwater will see **neutral** to **slight adverse** effects. The Scheme will also have a **neutral** to **large adverse** effect on surface water receptors (the River Yare seeing a moderate adverse effect and surface water ponds seeing a large adverse effect) due to pollution or water loss during operation; groundwater will see **negligible** effects. The development is on the South Denes peninsula with the River Yare approximately 50m west, and the North Sea approximately 100m east. No assessment of construction effects of the development on surface water was undertaken, however it is expected that construction activities on site could cause adverse effects on the River Yare and the North Sea. Furthermore, it is assumed that construction traffic will be present within 1km of the Scheme on route to facilitate the construction of the development. As a result, there is the potential for an in-combination effect on surface water, including the IDB watercourse network, from pollution due to increased construction traffic. It is expected that an appropriate CEMP will be implemented for the development, which will detail the controls and measures, such as spillage/dust management, and runoff control, to be adopted during construction. However, given the construction works will occur adjacent to the River Yare and due to the proximity of the Scheme, there is likely to be a **minor adverse** (not significant) in-combination effect on this receptor during construction. As for the IDB watercourse and the North Sea, there is likely to be a **minor adverse** (not significant) in-combination effect during the construction phase.	None required	Construction: minor adverse (not significant) for River Yare; minor adverse (not significant) for IDB watercourse and North Sea Operation: minor adverse (not significant) for River Yare; not

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		No assessment of operational effects on surface water has been undertaken but due to the close proximity of the River Yare, there is the potential for the development to effect on this receptor during operation, in particular pollution effects due to spillages from the manufacturing facility. Hence there is likely to be a **minor adverse** (not significant) in-combination effect on the River Yare during the operation phase. A **not significant** in-combination effect is predicted for the North Sea. Given no local watercourses and/or IDB drains are identified in vicinity of the development, no in-combination effect is predicted to these surface water features.		significant for North Sea
Flood Risk				
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 12, the Scheme will have a **slight adverse** to **moderate beneficial** effect on flood risk, depending on the receptor in question. The effects will be the same in both the construction and operational phases. As a result, there is the potential for an in-combination effect to occur in relation to tidal flood risk. An FRA has been completed for the development; it concluded that there is a low risk of both tidal and groundwater flooding at the site. The Preliminary Environment Assessment does not state whether the development has been designed to not increase flood risk elsewhere but it is a requirement of an FRA to do this. The development site is not predicted to flood in the present day tidal flooding scenario assessed for the Scheme but is predicted to flood in the 0.1% AEP climate change flood event (representing sea level rise in 2140). Given that the development site is only predicted to flood in a future extreme scenario, and the development buildings will be raised above this flood risk level, the in-combination effect is considered **not significant** for both construction and operation.	None Required	Construction: not significant Operation: not significant
14	Former Claydon High School	As discussed in Chapter 12, the Scheme will have a **slight adverse** to **moderate beneficial** effect on flood risk, depending on the receptor in question. The effects will be the same in both the construction and operational phases. As a result, there is the potential for an in-combination effect to occur in relation to tidal flood risk. The development site is not predicted to flood in the present-day scenario for any of the flood events considered in this ES. A very small proportion of the north-east corner of the site is predicted to flood in the 5% AEP event for the climate change scenario investigated in the ES (representing sea level rise in 2140). An FRA was not available for review for this development but as the plans have been approved, it is assumed that the development has been designed in such a way as to not increase flood risk elsewhere (which is a requirement of the FRA process). As such a small part of the site is predicted to flood in the scenario, the cumulative effect of the development and the Scheme can be considered **not significant** for both construction and operation.	None Required	Construction: not significant Operation: not significant
35a & 35b	Gapton and Vauxhall Junction Improvements	As discussed in Chapter 12, the Scheme will have a **slight adverse** to **moderate beneficial** effect on flood risk, depending on the receptor in question. The effects will be the same in both the construction and operational phases. As a result, there is the potential for an in-combination effect to occur in relation to tidal flood risk. Vauxhall Roundabout is outside of the study area for the Scheme FRA, therefore there is no scope for in-combination effects. The Gapton Roundabout is within the study area and is predicted to flood in the 0.1% AEP tidal flood event in the present-day scenario. Gapton Roundabout is predicted to flood in the 5% AEP event and higher for the climate change scenario (representing sea level rise in 2140). However, the junction improvement plans at Gapton do not include a change in road layout and state that there will be no changes to the existing drain and culvert at the roundabout. The modelling undertaken as part of the ES for the Scheme has shown that the effect of the Scheme at Gapton Roundabout is actually to	None Required	Construction: not significant Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		reduce flood depths in the 0.5% AEP climate change event by up to 0.1m. The cumulative effect of the development and the Scheme is **not significant** for both construction and operation.		
36	Harfreys Junction Improvement	As discussed in Chapter 12, the Scheme will have a **slight adverse** to **moderate beneficial** effect on flood risk, depending on the receptor in question. The effects will be the same in both the construction and operational phases. As a result, there is the potential for an in-combination effect to occur in relation to tidal flood risk. At the time of writing there is little information on the development, as a result an assessment on potential in-combination effects is difficult to conduct. If the improvements involve a change to the road layout, an FRA will be required and it is assumed that as a result the development will be designed to not increase flood risk elsewhere in line with FRA requirements. Based on this, it is assumed that the cumulative effect of the development and the Scheme would be **not significant** in both the construction and operation stages.	None proposed	Construction: not significant Operation: not significant
53	Multi User Operations and Maintenance Facility (South Denes Enterprise Zone)	As discussed in Chapter 12, the Scheme will have a **slight adverse** to **moderate beneficial** effect on tidal flood risk, depending on the receptor in question. The effects will be the same in both the construction and operational phases. As a result, there is the potential for an in-combination effect to occur in relation to tidal flood risk. The development is on the inside bend of the River Yare mouth and therefore is at risk of tidal flooding in both the present day and climate change scenarios. Given the location and size of the development, an FRA will be required and it is assumed that the development will be designed to not increase flood risk elsewhere in line with FRA requirements. The cumulative effects associated with this development and the scheme are therefore considered to be **not significant** in both the construction and operation stages.	None required, the development should not increase flood risk elsewhere.	Construction: not significant Operation: not significant
54	Proposed Manufacturing Facility (South Denes Enterprise Zone)	As discussed in chapter 12, the Scheme will have a **slight adverse** to **moderate beneficial** effect on flood risk, depending on the receptor in question. The effects will be the same in both the construction and operational phases. As a result, there is the potential for an in-combination effect to occur in relation to tidal flood risk. The development is adjacent to the northern end of the outer harbour between South Denes Road and South Beach Parade. The development location is not predicted to flood in the present-day scenario but flooding is predicted for both the 0.5% and 0.1% AEP climate change events. Given the location and size of the development, an FRA will be required and it is assumed that the development will be designed to not increase flood risk elsewhere in line with FRA requirements. The cumulative effects associated with this development and the Scheme are therefore considered to be **not significant** in both the construction and operation stages.	None required, the development should not increase flood risk elsewhere.	Construction: not significant Operation: not significant
People and Communities				
3	East Anglia THREE Windfarm	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. The development ES assessment results anticipates that the onshore construction phase will have a **medium beneficial** effect, and the offshore construction phase will have a **high beneficial** effect on employment. As the port of entry is yet to be determined, these results are for a regional study area. No assessment for effects to employment at a local scale was undertaken. It has been assumed that the port of entry will be Great Yarmouth, and therefore local jobs will be created as a	None required	Construction: minor beneficial (not significant) Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		result of the construction phase. However, it is anticipated that due to the type of development the majority of construction workers would be specialist and therefore be relocated from outside the study area during the construction period. As a result, there is a potential for an in-combination effect on employment during the construction phase. This development has the potential to create jobs in the construction sector within Great Yarmouth and the surrounding areas, resulting in a **minor beneficial** (not significant) significance in-combination effect at both the regional and local scale. It is anticipated that the development would not have a significant effect on traffic flows within 500m of the Scheme, and therefore effects on vehicle users, community severance as well as access to businesses and recreational activities have not been considered within the cumulative assessment.		
7	A47 Burlingham-Blofield dualling	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. The development scoping report anticipated that the construction phase could have a **slight beneficial** effect on employment if it results in new employment. It is currently unknown if workers for this development would be drawn from the Local Impact Area (250m from the development) or Wider Impact Area (Broadland District), both of which are within the regional ZOI for the Scheme, but not the local ZOI. As a result, there is a potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the regional area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
8	A47 Thickthorn junction improvements	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. The development scoping report anticipated that the construction phase could have a **slight beneficial** effect on employment if it results in new employment. It is currently unknown if workers for this development would be drawn from the Local Impact Area (250m from the development) or Wider Impact Area (South Norfolk District), both of which are within the regional ZOI for the Scheme, but not the local ZOI. As a result, there is a potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the regional area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
9	A47 Easton-North Tuddenham dualling	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the developments effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from, given the distance of the development from the Scheme, it is assumed that the employment area would be within the Schemes region ZOI, but not the local ZOI.	None required	Construction: minor beneficial (not significant) Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		As a result, there is a potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the regional area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.		
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	<u>Construction</u> As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. An Economic Appraisal Report and Transport Assessment have been prepared for the development. The Economic Appraisal Report indicates that the development will create 84 full time equivalent jobs per annum during the construction phase. As a result, there is a potential in-combination effect on employment during the construction phase, if the construction periods overlap. The development will be phased over 3 years as follows: • Phase 1 (October 2017) • Phase 2 (October / November 2018) • Phase 3 (2023 -2024) The construction of the two developments could therefore result in a **minor beneficial** (not significant) in-combination effect. The Transport Assessment for the development anticipates that the strategic road network will be used as far as possible, and access routes to and from the site that would be used by heavy goods vehicles (HGVs) will be agreed with NCC and GYBC prior to initiation of the clearance and construction programme. This would be to minimise disruption to the road and pedestrian network. The Traffic Assessment indicates that if the construction of the proposed development overlaps with the construction of the Scheme then a construction Steering Group (CSG) could be set up. The CSG could meet / liaise on a regular basis and engage in cross site discussions. The site managers of sites could aim to schedule key works at different times to ensure disruption is minimised. In addition to this the contractors could, where possible, share procurement practices, delivery schedules and vehicle loads (where possible) to help minimise the number of vehicles on the road network. The CSG would ensure that any cumulative effect on the surrounding road network is minimised. There is a potential for an in-combination effect on NMUs, community severance, vehicle travellers and access to recreational facilities during the construction phase. However, due to the type of development it is anticipated that road closures would not be required for the construction of the development and measures would be put in place to limit disruption caused by construction traffic. It is therefore anticipated that the development has the potential to increase disruption within the ZOI, resulting in a **minor adverse** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) to employment; minor adverse (not significant) to NMUs, community severance, vehicle travellers and access to recreational facilities Operation: moderate beneficial (significant) to recreational facilities; minor beneficial (not significant) to local economy

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		<u>Operation</u> As discussed in Chapter 14, the Scheme will have a **minor** to **moderate beneficial** effect to community severance, and recreational activities. The development would include a cinema, restaurants and/or bars, an Indoor Play Centre and 'Large' casino and therefore would be recognised as a recreational facility. The Scheme would provide improved access to this recreational facility, resulting in a **moderate beneficial** (significant) in-combination effect. The development would include an 81-bedroom Premium Inn hotel and a Beefeater restaurant as well as the facilities listed above. Within the Economic Appraisal Report it is estimated that the development would generate 326 full time equivalent local jobs. The Scheme would improve connectivity and provide economic opportunities for Great Yarmouth. When considering both schemes in-combination they would have a **minor beneficial** (not significant) effect on the local economy during operation.		
12	Bradwell South	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. The development ES (NTS) anticipates that the development will have a **major beneficial** effect on local employment when considering both the construction and operational phase combined. The anticipated effect for just the construction effect is not available. It is assumed that local jobs will be created as part of the construction phase. As a result, there is potential for AN in-combination effect on employment during the construction phase. This development has the potential to create construction jobs within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
13	Beacon Park	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the developments effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from, given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
14	Former Claydon High School	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers	None required	Construction: minor beneficial (not significant)

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.		Operation: n/a
16	North Denes Middle School	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
18	Land south east of Hopton	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
21	Pointers East, west of Ormesby Road	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
27	Norfolk Vanguard	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase.	None required	Construction: minor beneficial

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		The development ES assessment results anticipate that the onshore and offshore construction phase will have a **moderate beneficial** effect on the New Anglia labour market. As the port of entry is yet to be determined, these results are for a regional study area. It is anticipated that due to the type of development the majority of construction workers would be specialist meaning there would be limited local employment opportunities generated. Nevertheless, there is potential for an in-combination effect on regional scale employment during the construction phase. This development has the potential to create jobs in the construction sector within New Anglia, resulting in a **minor beneficial** (not significant) in-combination effect at the regional scale. It is anticipated that the development would not have a significant effect on traffic flows within 500m of the Scheme, and therefore effects on vehicle users, community severance as well as access to businesses and recreational activities have not been considered within the cumulative assessment.		(not significant) Operation: n/a
28	Norfolk Boreas	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. The development PEIR assessment results anticipate that the onshore and offshore construction phase will have a **major beneficial** effect on the New Anglia labour market. It is anticipated that due to the type of development the majority of construction workers would be specialist meaning there would be limited local employment opportunities generated. Nevertheless, there is potential for an in-combination effect on regional scale employment during the construction phase. This development has the potential to create jobs in the construction sector within New Anglia, resulting in a **minor beneficial** (not significant) in-combination effect at the regional scale. It is anticipated that the development would not have a significant effect on traffic flows within 500m of the Scheme, and therefore effects on vehicle users, community severance as well as access to businesses and recreational activities have not been considered within the cumulative assessment.	None required	Construction: minor beneficial (not significant) Operation: n/a
29	TIGRE Project 1	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from. It has been assumed that the port of entry will be Great Yarmouth, and therefore local jobs will be created as a result of the construction phase. However, it is anticipated that due to the type of development the majority of construction workers would be specialist and therefore be relocated from outside the study area during the construction period. As a result, there is a potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within Great Yarmouth and the surrounding areas, resulting in a **minor beneficial** (not significant) in-combination effect at both the local and regional scale. It is anticipated that the development would not have a significant effect on traffic flows within 500m of the Scheme, and therefore effects on vehicle users, community severance as well as access to businesses and recreational activities have not been considered within the cumulative assessment.	None required	Construction: minor beneficial (not significant) Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
30	Hornsea Project Three	As discussed in Chapter 14, the scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. The development ES assessment results anticipates that the onshore and offshore construction will have a **minor beneficial** effect. As the port of entry is yet to be determined, these results are for a regional study area. No assessment for effects to employment at a local scale was undertaken. It has been assumed that the port of entry will be Great Yarmouth, and therefore local jobs will be created as a result of the construction phase. However, it is anticipated that due to the type of development the majority of construction workers would be specialist and therefore have to be relocated from outside the study area during the construction period. As a result, there is a potential for an in-combination effect on employment during the construction phase. This development has the potential to create jobs in the construction sector within Great Yarmouth and the surrounding areas, resulting in a **minor beneficial** (not significant) in-combination effect at both the regional and local scale. It is anticipated that the development would not have a significant effect on traffic flows within 500m of the Scheme, and therefore effects on vehicle users, community severance as well as access to businesses and recreational activities have not been considered within the cumulative assessment.	None required	Construction: minor beneficial (not significant) Operation: n/a
35a & 35b	A47 Great Yarmouth Junction Improvements – Gapton and Vauxhall Roundabouts	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
36	A47 Great Yarmouth Junction Improvements – Harfreys Roundabout	<u>Construction</u> As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) for employment; moderate adverse (significant) for NMUs, vehicle travellers,

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		No assessment has been undertaken for the development's effects to NMUs, vehicle travellers, terrestrial businesses and associated activities, community severance, and access to recreational facilities during the construction phase. Due to the short distance between the development and the Scheme, and the type of development which would require temporary road closures and diversions, there is a potential for in-combination effects during the construction phase. The development has the potential to increase disruption within the ZOI, resulting in a **moderate adverse** (significant) in-combination effect on NMUs, vehicle travellers, terrestrial businesses, community severance and access to recreational facilities. <u>Operation</u> As discussed in Chapter 14, the Scheme will have a **slight** to **moderate beneficial** effect on NMUs, vehicle travellers, community severance, and recreational activities. No assessment has been undertaken for the development's effect to NMUs, vehicle travellers, terrestrial businesses, community severance, and access to recreational facilities. It has been assumed that the development will provide safe NMU crossing points and footways as well as reduce journey times once in operation, resulting in a **minor beneficial** (not significant) in-combination effect for the local economy, and a **moderate beneficial** (significant) effect for NMUs, vehicle travellers, community severance and recreational activities.		terrestrial businesses, community severance, and access to recreational facilities Operation: minor beneficial (not significant) for the local economy; moderate beneficial (significant) for NMUs, vehicle travellers, community severance and recreational activities
43	Southern Terminal Expansion (in South Denes Enterprise Zone)	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
46	Beacon Park Enterprise Zone	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase.	None required	Construction: minor beneficial

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.		(not significant) Operation: n/a
49	Marina Centre Redevelopment	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
51	Bradwell Residential (Beccles Road)	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
53	Multi User Operations and Maintenance Facility (South Denes Enterprise Zone)	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI.	None required	Construction: minor beneficial (not significant) Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.		
54	Proposed Manufacturing Facility (South Denes Enterprise Zone)	As discussed in Chapter 14, the Scheme will have a **moderate beneficial** effect to local employment, and a **slight beneficial** effect to regional employment during the construction phase. No assessment has been undertaken for the development's effect to employment. It has been assumed that the development will require construction workers, which could result in new employment. It is unknown where these workers would be sourced from; given the distance of the development from the Scheme, it is assumed that the employment area would be within the Scheme's local ZOI. As a result, there is potential for an in-combination effect on employment during the construction phase. This development has potential to create jobs in the construction sector within the local area of the Scheme, resulting in a **minor beneficial** (not significant) in-combination effect.	None required	Construction: minor beneficial (not significant) Operation: n/a
Materials				
3	East Anglia THREE Windfarm	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. A materials and waste assessment has not been undertaken for the East Anglia THREE Windfarm. The development will require materials and create waste during construction. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. As a result, it is likely that there will be cumulative effects. Due to the size and nature of the Scheme and the development, the likely cumulative effects are expected to be **minor adverse** (not significant) for both materials and waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
7	A47 Burlingham-Blofield dualling,	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. A materials and waste assessment has not been undertaken for the A47 Burlingham-Blofield dualling. The scoping report states that while there is potential for significant adverse effects from the use of materials and generation of waste, with the implementation of best practice and appropriate mitigation measures during construction, the use of materials and generation of waste is unlikely to result in significant direct or indirect effects. Due to the scale of the development (4km of road dualling), the requirement of similar materials and the disposal of waste, the likely cumulative effects with the Scheme are expected to be **minor adverse** for materials and **moderate adverse** for waste.	None proposed	Construction: minor adverse for materials and moderate adverse for waste Operation: n/a
8	A47 Thickthorn junction improvements	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. A materials and waste assessment has not been undertaken for the A47 Thickthorn junction improvements. The scoping report states that while there is potential for significant adverse effects from the use of materials and generation of waste,	None proposed	Construction: not significant for materials

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		with the implementation of best practice and appropriate mitigation measures during construction, the use of materials and generation of waste is unlikely to result in significant direct or indirect effects. Considering the scale and nature of the improvement works, the requirement of similar materials and the disposal of waste, the likely cumulative effects with the Scheme are expected to be **not significant** for materials and **minor adverse** (not significant) for waste.		and minor adverse (not significant) for waste Operation: n/a
9	A47 Easton-North Tuddenham dualling	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently no publicly available information regarding material consumption and waste disposal for the A47 Easton-North Tuddenham dualling. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development, the likely requirement of similar materials and the disposal of waste, the likely cumulative effects with the Scheme are expected to be **minor adverse** (not significant) for materials and **moderate adverse** (significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and moderate (significant) adverse for waste Operation: n/a
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for the proposed leisure centre. The Preliminary Environmental Report does not include consideration for the effects arising from material consumption and waste disposal. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
12	Bradwell South	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. A materials and waste assessment has not been undertaken for the Bradwell South development. The Environment Statement does not include consideration for the effects arising from material consumption and waste disposal. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials.	None proposed	Construction: minor adverse (not significant) for materials and waste

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.		Operation: n/a
13	Beacon Park	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for Beacon Park development. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
14	Former Claydon High School	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently no publicly available information regarding material consumption and waste disposal for the redevelopment of the former Claydon High School. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
16	North Denes Middle School	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently no publicly available information regarding material consumption and waste disposal for the north denes middle school development. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale of the development, the requirement of similar materials and the disposal of waste (mainly from the demolition of the existing school building), the likely cumulative effects are expected to be **minor adverse** (not significant) for materials and **moderate adverse** (significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and moderate adverse (significant) for waste Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
18	Land south east of Hopton	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for proposed residential development south east of Hopton. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
21	Pointers East, west of Ormesby Road	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for proposed pointers east development. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
27	Norfolk Vanguard	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. The environmental statement for proposed Norfolk vanguard offshore windfarm includes a waste assessment report. This outlines additional mitigation to reduce the effect on materials and waste. The development has the potential for significant adverse effects from the use of materials and generation of waste. With the identified mitigation measures implemented, the cumulative effect is expected to be **not significant** for both materials and waste.	None required	Construction: not significant for materials and waste Operation: n/a
28	Norfolk Boreas	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. The peir for proposed Norfolk Boreas offshore windfarm includes a waste assessment report. This outlines additional mitigation to reduce the effect on materials and waste. The development has the potential for significant adverse effects from the use of materials and generation of waste. With the identified mitigation measures implemented, the cumulative effect is expected to be **not significant** for both materials and waste.	None required	Construction: not significant for materials and waste Operation: n/a.
29	TIGRE Project 1	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste.	None proposed	Construction: minor

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		There is currently limited publicly available information regarding material consumption and waste disposal for proposed TIGRE Project 1 development. The development has been designed to utilise any existing facilities and infrastructure where possible, reducing the materials consumption and waste generated. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development, the likely requirement of some similar materials and the generation of waste for disposal, the likely cumulative effects are expected to be **minor adverse** (not significant) for both materials and waste.		adverse (not significant) for materials and waste Operation: n/a.
30	Hornsea Project Three	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for proposed Hornsea Project Three offshore windfarm development. However, the DCO application includes a SWMP which outlines how waste will be managed and materials re-used. The development has the potential for significant adverse effects from the use of materials and generation of waste. With the identified mitigation measures implemented, the cumulative effect is expected to be **not significant** for both materials and waste.	None required	Construction: not significant for materials and waste Operation: n/a.
31	Progress Power Station	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. The Environmental Statement for proposed Progress Power Station concludes that the development would have no effect to human health from waste. The assessment does not consider the availability of material resources and/or landfill capacity. The development has the potential for significant adverse effects from the use of materials and generation of waste. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development, the likely requirement of some similar materials and the generation of waste for disposal, the likely cumulative effects are expected to be **minor adverse** (not significant) for both materials and waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
32	Sizewell C Nuclear Power Station	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for proposed Sizewell C Nuclear Power Station development. However, the scoping report states that an MMP will be produced and a waste assessment will be undertaken as part of the EIA. With the identified MMP and further mitigation measures implemented through the EIA process, the cumulative effects are expected to be **not significant** for both materials and waste.	None required	Construction: not significant for materials and waste Operation: n/a
33a & 33b	Bramford to Twinstead Overhead Line	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste.	None required	Construction: not significant for

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		There is currently no publicly available information regarding material consumption and waste disposal for proposed Bramford to Twinstead Overhead Line development. Due to the scale and nature of the development, the likely cumulative effects are expected to be **not significant** for both materials and waste.		materials and waste Operation: n/a
34	Lake Lothing Third River Crossing	As discussed in Chapter 15 the Scheme will have a **Slight Adverse** effect to materials and waste. The Lake Lothing Environmental Statement (ES) sets out mitigation measures and the assessment for materials and waste. The assessment concludes that the development will have a **negligible** effect on materials, and a **slight adverse** effect on waste. As a result, the cumulative effects are expected to be **not significant** for materials and **minor adverse** (not significant) for waste.	None proposed	Construction: not significant for materials and minor adverse (not significant) for waste. Operation: n/a
35a & 35b	A47 Great Yarmouth Junction Improvements – Gapton and Vauxhall Roundabouts	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently no publicly available information regarding material consumption and waste disposal for the proposed A47 Great Yarmouth Junction Improvements – Gapton and Vauxhall Roundabouts. Due to the scale and nature of the improvements, the likely cumulative effects are expected to be **not significant** for both materials and waste.	None required	Construction: not significant for materials and waste Operation: n/a
36	A47 Great Yarmouth Junction Improvements – Harfreys Roundabout	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently no publicly available information regarding material consumption and waste disposal for the proposed A47 Great Yarmouth Junction Improvements – Harfreys Roundabout. Due to the scale and nature of the improvements, the likely cumulative effects are expected to be **not significant** for both materials and waste.	None required	Construction: not significant for materials and waste Operation: n/a
43	Southern Terminal Expansion (in South Denes Enterprise Zone)	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently no publicly available information regarding material consumption and waste disposal for the proposed Southern Terminal Expansion. Due to the scale and nature of the improvements, the likely cumulative effects are expected to be **not significant** for both materials and waste.	None required	Construction: not significant for materials and waste Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
46	Beacon Park Enterprise Zone	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for proposed Beacon Park Enterprise Zone development. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
49	Marina Centre Redevelopment	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently no information publicly available regarding material consumption and waste disposal for the proposed Marina Centre Redevelopment. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale of the development, the requirement of similar materials and the disposal of waste (mainly from the demolition of existing buildings), the likely cumulative effects are expected to be **minor adverse** (not significant) for both materials and waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
51	Bradwell Residential (Beccles Road)	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for the proposed Bradwell Residential development. The Scoping report scopes out the need for a waste assessment as no demolition is taking place and it is not anticipated that there will be any need for significant cut and fill during construction. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
53	O&M facility and land reclamation (in South Denes Enterprise Zone)	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for the proposed O&M facility and land reclamation development. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect.	None proposed	Construction: minor adverse (not significant) for materials and

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		The development will potentially require demolition and extensive excavation/earthworks to take place during construction (namely in connection with the land reclamation element of the development). Due to the scale of the development, the requirement of similar materials and the disposal of waste (mainly from the demolition, excavation and earthworks), the likely cumulative effects are expected to be **minor adverse** (not significant) for materials and **moderate adverse** (not significant) for waste.		moderate adverse for waste Operation: n/a
54	Manufacturing facility (in South Denes Enterprise Zone)	As discussed in Chapter 15 the Scheme will have a **slight adverse** effect to materials and waste. There is currently limited publicly available information regarding material consumption and waste disposal for the proposed Manufacturing facility. It is assumed the applicant will implement best practice design, mitigation and enhancement measures to reduce the effect. Due to the scale and nature of the development and the likely requirement of some similar materials, the likely cumulative effects are expected to be **minor adverse** (not significant) for materials. Due to the scale and nature of the development there will be adverse effects from the disposal of waste. As demolition and large-scale excavation will not be required during construction, the likely cumulative effects are expected to be **minor adverse** (not significant) for waste.	None proposed	Construction: minor adverse (not significant) for materials and waste Operation: n/a
Traffic and Transport				
3	East Anglia THREE Windfarm	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. The ES for the development concludes that the potential effects from the base port construction traffic attraction (personnel) are likely to be **negligible**. The Applicant will also work with the chosen port to ensure worker related traffic is minimised and consult with the relevant authorities with regard to their Travel Plan requirements. No assessment was undertaken for the effect of HGVs to the base port. It is assumed that there will be an increase in HGVs within the Scheme ZOI during the construction of the development, however it is anticipated that these will be of sufficiently low volume and on a temporary, short term basis. As a result, the in-combination effect to traffic flows will be **not significant**.	None required	Construction: not significant Operation: n/a
7	A47 Burlingham-Blofield dualling	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase No assessment has been undertaken for the development's effect to traffic and transport during construction. Due to nature of the development (highway scheme), it is anticipated that the construction phase of the development would cause disruption to traffic flows within the Scheme's ZOI. However, there is limited information on how traffic will be managed during construction, so it is not possible to anticipate the effects of this development on traffic and transport, and therefore it is not possible to anticipate the in-combination effect.	None proposed	Not possible to carry out assessment
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could temporarily effect traffic flows within the Scheme's ZOI. The	None required	Construction: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		TA for the development outlines a number of measures which will be in place to reduce construction traffic, including that a Construction Traffic Management Plan could be required through planning conditions. Additionally, any effects will be temporary and on a short-term basis. As a result, the in-combination effect is anticipated to be **not significant**.		Operation: n/a
12	Bradwell South	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. The Non-Technical Summary for the development (ES not available) concludes that it is considered that there is sufficient capacity on the highway network to accommodate the level of predicted vehicle movements, which are of a temporary nature, associated with the construction phase. The traffic will therefore not have a significant effect, and as a result, the in-combination effect will be **not significant.**	None required	Construction: not significant Operation: n/a
13	Beacon Park	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could temporarily effect traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. Additionally, any effects will be temporary and on a short-term basis. As a result, the in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a
14	Former Claydon High School	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could temporarily effect traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. Additionally, any effects will be temporary and on a short-term basis. As a result, the in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a
16	North Denes Middle School	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. The Construction statement for the development states that vehicle movements will be managed to avoid congestion on the site and highway. Additionally, contractor vehicle site movements will not be allowed at peak periods (to be confirmed with the school on site), and drivers will be required to call in advance to enable the site manager to control vehicle movements. It is anticipated that the volume of construction traffic will be sufficiently low, and temporary, and combined with these measures, the resulting in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a
18	Land south east of Hopton	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could temporarily effect traffic flows within the Scheme's ZOI. It is	None required	Construction: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. Additionally, any effects will be temporary and on a short-term basis. As a result, the in-combination effect will be **not significant**.		Operation: n/a
21	Pointers East, west of Ormesby Road	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could temporarily effect traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. Additionally, any effects will be temporary and on a short-term basis. As a result, the in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a
27	Norfolk Vanguard	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. The ES for the development states that the port of origin chosen will be used for the import of materials for the onshore construction elements, resulting in a temporary increased level of HGV movements in the construction phase. However, it is anticipated that these will be of sufficiently low volume and on a temporary, short term basis and therefore not have a significant effect on traffic flow. As a result, the in-combination effect to traffic flows will be **not significant**.	None required	Construction: not significant Operation: n/a
28	Norfolk Boreas	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. The PEIR for the development states that the port of origin chosen will be used for the import of materials for the onshore construction elements, resulting in a temporary increased level of HGV movements in the construction phase. However, it is anticipated that these will be of sufficiently low volume and on a temporary, short term basis and therefore not have a significant effect on traffic flow. As a result, the in-combination effect to traffic flows will be **not significant**.	None required	Construction: not significant Operation: n/a
29	TIGRE Project 1	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. The development has been designed to be entirely offshore, however it has been assumed that Great Yarmouth Port will be used for construction, creating traffic during construction which could impact traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. As a result, the in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a
30	Hornsea Project Three	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. The ES for the development concludes that the number of HVG movements from the chosen port of entry during construction will not result in any significant effects. Additionally, the Outline CoCP for the development states that a Construction Traffic Management Plan will be implemented to manage and reduce both HVG movements, and construction workforce travel. As a result, the in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
35a & 35b	Gapton and Vauxhall Junction Improvements	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport during construction. Due to nature of the development (highway scheme), it is anticipated that the construction phase of the development would cause disruption to traffic flows within the Scheme's ZOI. However, there is limited information on how traffic will be managed during construction, so it is not possible to anticipate the effects of this development on traffic and transport. Additionally, uncertainty remains over the appropriate mitigation measures to be incorporated into the development, and on if the development itself will go ahead based on the assessment of traffic conditions as a result of the Scheme. Therefore, it is not possible to anticipate the in-combination effect.	None proposed	Not possible to carry out assessment
36	Harfreys Junction Improvement	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport during construction. Due to nature of the development (highway scheme), it is anticipated that the construction phase of the development would cause disruption to traffic flows within the Scheme's ZOI. However, there is limited information on how traffic will be managed during construction, so it is not possible to anticipate the effects of this development on traffic and transport. Additionally, uncertainty remains over the appropriate mitigation measures to be incorporated into the development, and on if the development itself will go ahead based on the assessment of traffic conditions as a result of the Scheme. Therefore, it is not possible to anticipate the in-combination effect.	None proposed	Not possible to carry out assessment
43	Southern Terminal Expansion (in South Denes Enterprise Zone)	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could impact traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. As a result, the in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a
46	Beacon Park Enterprise Zone	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could impact traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. As a result, the in-combination effect will be **not significant.**	None required	Construction: not significant Operation: n/a
49	Marina Centre Redevelopment	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could impact traffic flows within the Scheme's ZOI. It is assumed	None required	Construction: not significant Operation: n/a

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. As a result, the in-combination effect will be **not significant.**		
51	Bradwell Residential (Beccles Road)	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport during the construction phase. It has been assumed the development will create traffic during construction which could impact traffic flows within the Scheme's ZOI. The development will be phased over 12 years, and it is assumed that a Construction Traffic Management Plan will be implemented to reduce effects. As a result, the in-combination effect will be **not significant**.	None required	Construction: not significant Operation: n/a
53	O&M facility and land reclamation (in South Denes Enterprise Zone)	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could impact traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. As a result, the in-combination effect will be **not significant.**	None required	Construction: not significant Operation: n/a
54	Manufacturing facility (in South Denes Enterprise Zone)	As discussed in Chapter 17 the Scheme will have a **slight adverse** effect to traffic and transport during the construction phase. No assessment has been undertaken for the development's effect to traffic and transport. It has been assumed the development will create traffic during construction which could impact traffic flows within the Scheme's ZOI. It is assumed that a Construction Traffic Management Plan will be implemented, reducing the development's effect to traffic and transport. As a result, the in-combination effect will be **not significant.**	None required	Construction: not significant Operation: n/a
Major Accidents and Disasters				
11	Proposed leisure developments south of Pleasure Beach, Great Yarmouth	As discussed in Chapter 18, the potential MA&D effects for consideration are as a result of tidal flood risk, and industrial and urban accidents. Both of these are classified as **significant**. Due to the presence of the development within the ZOI of the Scheme, there is the potential for an in-combination effect. As the development is not anticipated to be significantly affected by a flood event in any scenario except the extreme climate change scenario, and is not located along the same waterbody as the Scheme, the in-combination effect for MA&D tidal flooding is anticipated to be **not significant**. Subsequently the in-combination effect for MA&D industrial/urban accidents is anticipated to be **not significant** for both construction and operation.	None Required	Construction: not significant Operation: not significant
14	Former Claydon High School	As discussed in Chapter 18, the potential MA&D effects for consideration are as a result of tidal flood risk, and industrial and urban accidents. Both of these are classified as s**ignificant**. Due to the presence of the development within the ZOI of the Scheme, there is the potential for an in-combination effect. As the development is not anticipated to be significantly affected by a flood event in any scenario except the extreme climate change scenario, and is not located along the same waterbody as the Scheme, the in-combination effect for MA&D	None Required	Construction: not significant Operation: not significant

ID	Other Development Name	Assessment of Cumulative Effect with the Scheme	Proposed Mitigation applicable to the Scheme including any apportionment	Residual cumulative effect
		tidal flooding is anticipated to be **not significant**. The in-combination effect for MA&D industrial/urban accidents is anticipated to be **not significant** for both construction and operation.		
35a & 35b	Gapton and Vauxhall Junction Improvements	As discussed in Chapter 18, the potential MA&D effects for consideration are as a result of tidal flood risk, and industrial and urban accidents. Both of these are classified as **significant**. Due to the presence of the development within the ZOI of the Scheme, there is the potential for an in-combination effect. Only the Gapton Junction element of the development is within the ZOI of the Scheme; subsequently only the potential in-combination effects on this element have been assessed. Due to the development not altering the land use of the area in comparison to the baseline conditions, and being located 800m from the River Yare, the in-combination effect for MA&D tidal flooding is anticipated to be **not significant**. The development footprint is surrounded by primarily commercial properties and unoccupied land which is not likely to result in an interaction leading to an industrial accident. Subsequently the in-combination effect for MA&D industrial/urban accidents is anticipated to be **not significant** for both construction and operation.	None Required	Construction: not significant Operation: not significant
36	Harfreys Junction Improvement	As discussed in Chapter 18, the potential MA&D effects for consideration are as a result of tidal flood risk, and industrial and urban accidents. Both of these are classified as s**ignificant**. Due to the presence of the development within the ZOI of the Scheme, there is the potential for an in-combination effect. As the development is not anticipated to be significantly affected by a flood event compared to the baseline, the in-combination effect for MA&D tidal flooding is anticipated to be **negligible**. it is directly adjacent to an industrial area with the potential to result in an interaction leading to an industrial accident in the construction phase. It is assumed that the construction methodology of the development will take these risks into account prior to and during works. Subsequently the in-combination effect for MA&D industrial/urban accidents is anticipated to be **not significant** for both construction and operation.	None Required	Construction: not significant Operation: not significant
54	Manufacturing facility (in South Denes Enterprise Zone)	As discussed in Chapter 18, the potential MA&D effects for consideration are as a result of tidal flood risk, and industrial and urban accidents. Both of these are classified as **significant**. Due to the presence of the development within the ZOI of the Scheme, there is the potential for an in-combination effect. The development is not anticipated to be significantly affected by a flood event in any scenario except the extreme climate change scenario, and it is assumed due to the size of the development that it will be designed to not increase flood risk elsewhere. Subsequently, the in-combination effect for MA&D tidal flooding is anticipated to be **not significant**. Construction traffic will potentially pass in close proximity to the site. It is assumed that the developer will be aware of the Scheme construction footprint and route any construction traffic accordingly. Subsequently the in-combination effect for MA&D industrial/urban accidents is anticipated to be **not significant** for the construction phase. The development is surrounded by other industrial facilities which have the potential to result in an interaction leading to an industrial accident. However, it is not anticipated that the nature of activities during operation will constitute a risk of a MA&D event occurring. As a result, the in-combination effect for MA&D industrial/urban accidents is anticipated to be **not significant**.	None Required	Construction: not significant Operation: not significant

Summary of In-combination Assessment

19.6.14 This section provides a summary of the above Table 19.17, the in-combination assessment of the short-list of other developments with the Scheme. Of the environmental topics assessed, Noise and Vibration, Cultural Heritage, Flood Risk, Traffic and Transport, and Major Accidents and Disasters were found to have in-combination effects of **not significance**.

19.6.15 Of the topics reporting in-combination effects, **moderate adverse** (significant) and **moderate beneficial** (significant) were identified for Materials, People and Communities, and Water Environment. The developments that reported **moderate** (significant) in-combination effects (adverse or beneficial) were developments 7, 9, 11, 16, 36, 53 and 54.

19.6.16 No additional mitigation measures have been proposed in relation to in-combination effects. Subsequently all these effects are classified as residual effects.

Construction

19.6.17 During the construction phase the most commonly occurring in-combination effect, other than **not significant**, was **minor adverse** (not significant). These effects occur most frequently for Materials and Waste and Water Environment, with additional **minor adverse** (not significant) effects occurring for Nature Conservation. One development, 43, also saw a **minor adverse** (not significant) effect for Townscape and Visual (visual). As well as **minor adverse** (not significant), many **minor beneficial** (not significant) effects occurred in relation to People and Communities.

19.6.18 The in-combination effect in the construction phase for development 54 saw a **moderate adverse** (significant) in-combination effect for Materials (waste). Additionally, developments 7, 9 and 16 saw **moderate adverse** (significant) effects for Materials (waste); and development 36 saw **moderate adverse** (significant) effects for People and Communities receptors.

Operation

19.6.19 During the operation phase the most commonly occurring in-combination effect, other than **not significant**, was **minor adverse** (not significant). These effects occurred notably less frequently than for the construction phase, due to many topics being excluded from the operation phase assessment. These effects occurred most frequently in relation to Water Environment, with additional effects associated with Nature Conservation, and one development, 43, associated with Townscape and Visual (visual).

As well as **minor adverse** (not significant), many **minor beneficial** (not significant) effects occurred in relation to People and Communities.

19.6.20 The in-combination effects in the operation phase for developments 53 saw a **moderate adverse** (significant) effect on the Water Environment (the River Yare), and developments 11 and 16 saw a **moderate beneficial** (significant) effect on People and Communities receptors.

19.7 Summary of the Assessment of Cumulative Effects

19.7.1 This chapter has assessed the effect interactions between the different environmental topics within the ES, and the in-combination effects between the Scheme and other developments.

19.7.2 The effect interactions assessment followed a step A, B, C methodology to identify common receptors, the likely effect interactions, and the significance of these effects.

19.7.3 The results for the construction phase assessment concluded an anticipated **slight adverse** (not significant) effect interaction on residents, recreational facilities and users, motorised vehicle users, non-motorised vehicle users, surface and ground water, community facilities and users, human health, and amenity. No additional mitigation measures are required; subsequently these are classified as the residual effects.

19.7.4 The results for the operation phase assessment concluded an anticipated **slight beneficial** (not significant) effect interaction on motorised vehicle users and non-motorised vehicle users, and a **neutral** effect interaction on residents, recreational facilities and users, surface and groundwater, community facilities and users, human health, and amenity. No additional mitigation measures are required; subsequently these are classified as the residual effects.

19.7.5 The in-combination effects assessment followed a four-stage methodology as outlined in Advice Note 17 (Ref 19.1).

19.7.6 The results for the construction phase assessment concluded a **moderate adverse** (significant) in-combination effect for Materials (waste) with development 54, 7, 9 and 16; and development 36 saw **moderate adverse** (significant) effects for People and Communities receptors. No additional mitigation measures are proposed; subsequently these are classified as the residual effects.

19.7.7 The results for the operation phase concluded a **moderate adverse** (significant) in-combination effect for Water Environment (River Yare) with development 53. Additionally, developments 11 and 16 saw a **moderate beneficial** (significant) in-combination effect on People and Communities. No additional mitigation measures are proposed; subsequently these are classified as the residual effects.

19.8 Assumptions and Limitations

19.8.1 Effect Interactions:

- The assessment of effect interactions resulting from the Scheme has considered the residual effects on common sensitive receptors in both the construction and operation phases. There is an assumption that mitigation measures outlined in the respective chapters will be fully incorporated to mitigate the corresponding adverse effects resulting from the Scheme; and
- When considering the Scheme, the assessment took consideration of the ES and HRA (document reference 6.11) only, no other non-ES documents were considered.

19.8.2 In-combination Effects:

- The assessment of in-combination effects has been limited to publicly available information at the time of writing and information obtained and highlighted as a result of consultation with GYBC and NCC;
- When considering the Scheme, the assessment took into consideration the ES, HRA (document reference 6.11), FRA (Appendix 12B document reference 6.2), and TA (document reference 7.2) only, no other non-ES documents were considered;
- For the purpose of the assessment, professional judgement and a 'worst case scenario' were used when there was a lack of certainty about a committed development (such as the on-shore construction information for windfarms);
- In some cases, there has not been sufficient information available in relation to a development to conduct the in-combination assessment for some environmental topics. A judgement on this has been provided by a relevant technical specialist and where this is the case this has been stated in the assessment residual effects section of Table 19.17;
- In the absence of information and assessments of other developments for some topics, it was assumed that the applicant would implement

standard practice mitigation measures to reduce the effect of the other development; and

- In the absence of a determined service port for wind farm developments it was assumed the development would be serviced from Great Yarmouth.

19.9 References

Ref 19.1: The Planning Inspectorate (2015). Advice Note 17: Cumulative Effects Assessment.

Ref 19.2: The Environmental Impact Assessment Directive (85/337/EEC) 2009 (as amended).

Ref 19.3: The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

Ref 19.4: Design Manual for Roads and Bridges, Volume 11, Section 5 Assessment and Management of Environmental Effects (HA 205/08) 2008.

Ref 19.5: The Town and Country Planning (Environmental Impact Assessment) Regulations 2017.

Ref 19.6: Ministry of Housing, Communities & Local Government (2019). National Planning Policy Framework.

Ref 19.7: Department for Transport (2012). The National Policy Statement for Ports.

Ref 19.8: The Planning Inspectorate (2018). Advice Note 9: Using the Rochdale Envelope.

Ref 19.9: Royal Haskoning (2015). East Anglia THREE Environmental Statements.

Ref 19.10: The Planning Inspectorate (2017). Scoping Opinion: Proposed East Anglia TWO Offshore Windfarm.

Ref 19.11: The Planning Inspectorate (2017). Scoping Opinion: Proposed East Anglia ONE North Offshore Windfarm.

Ref 19.12: Department for Transport (2014). The National Policy Statement for National Networks.