The Lake Lothing (Lowestoft) Third Crossing Order 201[*]

Lake Lothing THIRD CROSSING

Document 7.5: Design Report

Planning Act 2008

Infrastructure Planning

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

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Foreword

This Design Report relates to an application ("the Application") submitted by Suffolk County Council ("the Applicant") to the Secretary of State (through the Planning Inspectorate) for a Development Consent Order ("DCO") under the Planning Act 2008.

If made by the Secretary of State, the DCO would grant development consent for the Applicant to construct, operate and maintain a new bascule bridge highway crossing, which would link the areas north and south of Lake Lothing in Lowestoft, and which is referred to in the Application as the Lake Lothing Third Crossing (or "the Scheme").

This Design Report has been prepared in accordance with the requirements of section 37(3)(d) of the Planning Act 2008 and regulation 5(2)(q) of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 ("the APFP Regulations"), and in compliance with relevant guidance.

Executive Summary

This Design Report ("DR") has been prepared to accompany an application for a Development Consent Order ("DCO") on the Lake Lothing Third Crossing (the "Scheme") in Lowestoft.

The Scheme is located central to the current two crossings over Lake Lothing in Lowestoft; Mutford Bridge in the west, and the A47 Bascule Bridge in the east at the inner harbour entrance. The existing crossings do not meet the current and future traffic demands, with congestion and delays to journeys being common place in Lowestoft. The height of the current bascule bridge requires it to raise for any vessel, which also adds to delays. The distance between these two crossings can make journeys unnecessarily long and inconvenient for pedestrians and cyclists.

The DR provides a summary of the approach to good design, and demonstrates the response to the Vision, constraints, and considerations of the site in the reference design. The DR explains have the design evolved through various iterations and consideration of alternatives. It aims to describe in clear terms, how the design team arrived at the proposals submitted in DCO, the rationale and level of detail included.

The DR concludes by introducing the Design Guidance Manual, which outlines the approach to be taken for components of the Scheme through detailed design. It also summarises the compliance with the overall vision for the Scheme and the design narrative.

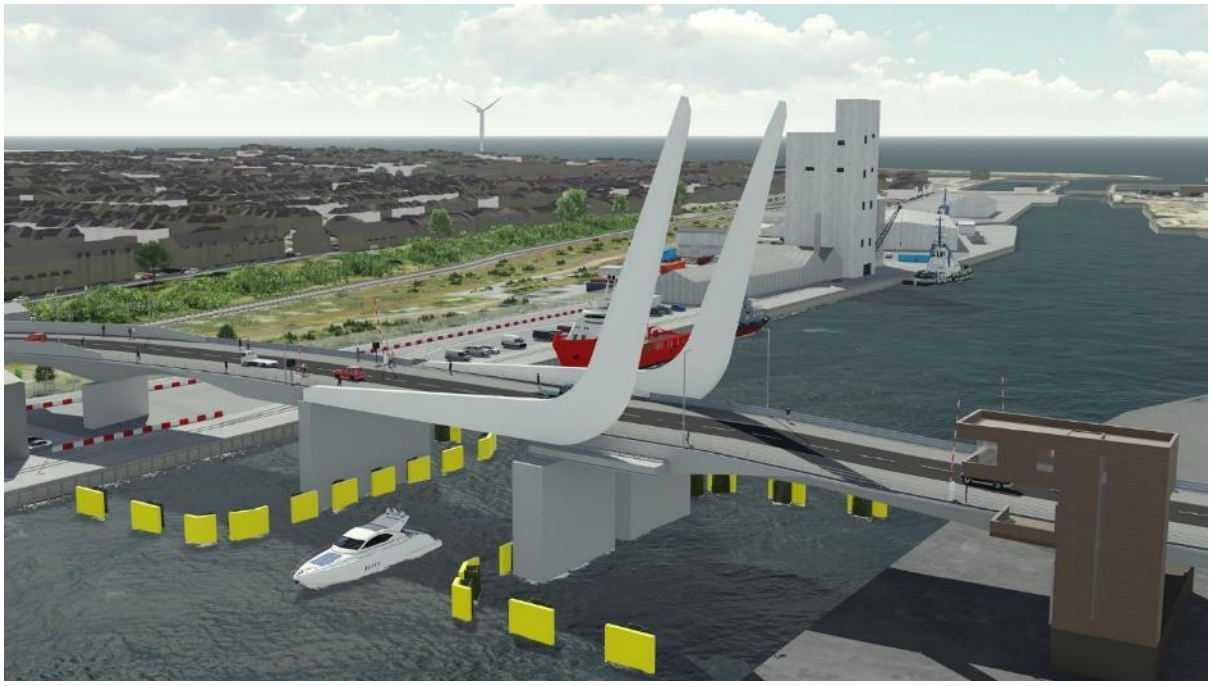


Figure 1: Artists' impression of the Scheme with bridge lowered

Figure 2: Artists' impression of the Scheme with bridge raised

Contents

Acronyms

ABP	Associated British Ports
AIP	Approval in principle
BEE	Built environment expert
CCTV	Closed-circuit television
CftS	Case for the Scheme
CORE	Centre for Offshore Renewable Energy
DAS	Design and access statement
DCC	Design Council CABE
DCO	Development consent order
DfT	Department for Transport
DGM	Design Guidance Manual
DMRB	Design Manual for Roads and Bridges
DR	Design report
EIA	Environmental impact assessment
ES	Environmental statement
GI	Ground investigation
HAT	Highest astronomical tide
HGV	Heavy goods vehicle
HMLR	Her Majesty's Land Registry
HVM	Hostile vehicle mitigation
ITS	Intelligent transport systems
LAT	Lowest astronomical tide
LED	Light-emitting diode
LPA	Local planning authority
LTP	Local Transport Plan
OAIP	Outline approval in principle
OBC	Outline business case
OMH	Open Mosaic Habitat on Previously Developed Land
OSEAF	Outline strengthened earthworks appraisal form
NIDP	National Infrastructure Delivery Plan

NMU	Non-motorised user
NNNPS	National Policy Statement for National Networks
NSIP	Nationally Significant Infrastructure Project
OAIP	Outline approval in principle
PEIR	Preliminary environmental information report
PNPS	The National Policy Statement for Ports
RSA	Road safety audit
SCC	Suffolk County Council
SEP	Strategic Economic Plan
SoS	Secretary of State
SRN	Strategic road network
SSP	Strategic site proposal
SuDS	Sustainable drainage system
TA	Transport assessment
TAA	Technical approval authority
TEN-T	Trans European Network–Transport
TUBA	Transport user benefit appraisal
VMS	Variable message sign
WDC	Waveney District Council

Tables

Figures

1 Introduction

1.1 Description of the Scheme

1.1.1 The Scheme involves the construction, operation and maintenance of a new bascule bridge highway crossing linking the areas north and south of Lake Lothing in Lowestoft, hereafter referred to as the Lake Lothing Third Crossing ("the Scheme").

1.1.2 The Scheme would provide a new single-carriageway road crossing of Lake Lothing, consisting of a multi-span bridge with associated approach roads, and would comprise:

- an opening bascule bridge over the Port of Lowestoft, in Lake Lothing;
- on the north side of Lake Lothing, a bridge over Network Rail's East Suffolk Line, and a reinforced earth embankment joining that bridge, via a new roundabout junction, to the C970 Peto Way, between Rotterdam Road and Barnards Way; and
- on the south side of Lake Lothing, a bridge over the northern end of Riverside Road including the existing access to commercial property (Nexen Lift Trucks) and a reinforced earth embankment (following the alignment of Riverside Road) joining this bridge to a new roundabout junction with the B1531 Waveney Drive.

1.1.3 The Scheme would be approximately 1 kilometre long and would be able to accommodate all types of vehicular traffic as well as non-motorised users (“NMUs”), such as cyclists and pedestrians.

1.1.4 The opening bascule bridge design would allow large vessels to continue to use the Port of Lowestoft.

1.1.5 A new control tower building would be located immediately to the south of Lake Lothing, on the west side of the new highway crossing, to facilitate the operation of the opening section of the new bascule bridge.

1.1.6 The Scheme would also entail:

- the following changes to the existing highway network:
  - the closure of Durban Road to vehicular traffic at its junction with Waveney Drive;
  - the closure of Canning Road at its junction with Riverside Road, and the construction of a replacement road between Riverside Road and Canning Road to the west of the Registry Office; and
  - a new Access Road from Waveney Drive west of Riverside Road, to provide access to property at Riverside Business Park;
  - improvements to Kimberley Road at its junction with Kirkley Run; and
  - part-signalisation of the junction of the B1531 Victoria Road / B1531 Waveney Drive with Kirkley Run;
- the provision of a pontoon for use by recreational vessels, located to the east of the new highway crossing, within the Inner Harbour of Lake Lothing; and
- works to facilitate the construction, operation and maintenance of the Scheme,

including the installation of road drainage systems; landscaping and lighting; accommodation works for accesses to premises; the diversion and installation of utility services; and temporary construction sites and access routes.

1.1.7 The works required for the delivery of the Scheme are set out in Schedule 1 to the draft DCO (application document reference 3.1), where they are referred to as "the authorised development", with their key component parts being allocated reference numbers, which correspond to the layout of the numbered works as shown on the Works Plans (application document reference 2.4). The General Arrangement Plans (application document reference 2.2) illustrate the key features of the Scheme.

1.1.8 Figure 3 below provides a diagrammatic representation of the Scheme:

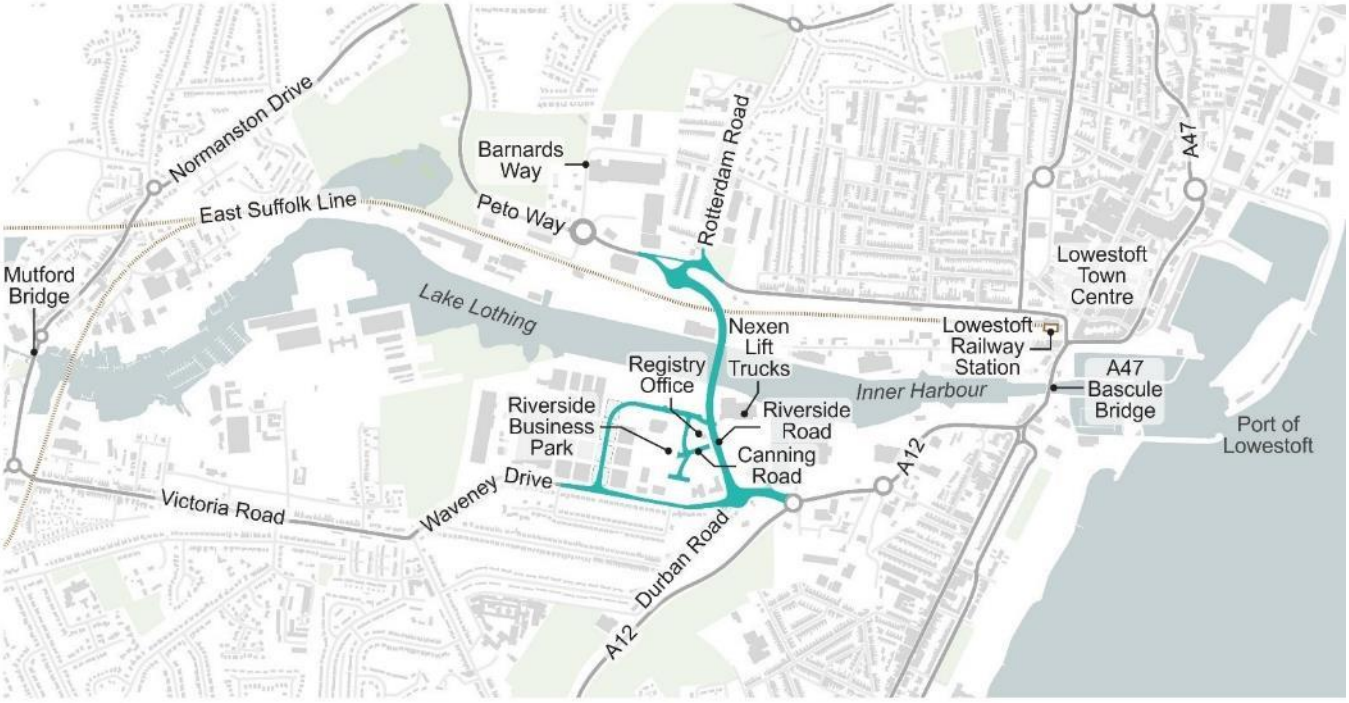


Figure 3: Location of the Scheme in Lowestoft

1.2 Background to the Scheme

1.2.1 The need for the Scheme is comprehensively documented in the Case for the Scheme ("CftS") (application document reference 7.1). In brief, the Scheme is a response to longstanding issues of congestion and severance within Lowestoft, associated with the inadequacy of north to south links across Lake Lothing. This in turn creates constraints to sustainable development in the town.

1.2.2 Lake Lothing is a saltwater waterbody linking the North Sea to The Broads National Park on an east-west axis which divides Lowestoft north to south by a water feature of up to 200m wide.

1.2.1 This area has suffered greatly from the decline of shipbuilding and traditional industries, and is a key area for regeneration. The Scheme will support regeneration by improving access to the area and by relieving congestion in, and around, the town centre.

1.2.2 Currently, there are two road crossings of Lake Lothing; Mutford Bridge (a lifting bridge over the Mutford lock on the A1117) to the west and the A47 Bascule Bridge (a lifting bridge on the A47) to the east. Mutford Bridge is the responsibility of Suffolk County Council ("SCC") as the local highway authority, while the A47 Bascule Bridge, being on the Strategic Road Network ("SRN"), is the responsibility of Highways England. The bridges are separated by a distance of approximately 3km.

1.2.3 The A47 Bascule Bridge, one of the few lifting bridges on the SRN, is a major obstacle for strategic traffic travelling on the A47 from the southeast to Great Yarmouth, as it regularly experiences congestion. This delay to journeys is exacerbated when the bridge needs to be raised for passing vessels or maintained. Both the Mutford Bridge and the A47 Bascule Bridge have limited facilities for cyclists and pedestrians.

1.2.4 Suffolk County Council are both the promoter and a statutory consultee as the local authority, hereby referred to as ("the Applicant") and ("SCC") respectively. These functions are kept separate to ensure appropriate governance of the Scheme.

1.2.5 In 2015 the Applicant received funding to develop an Outline Business Case ("OBC") (document reference 7.4) for a third crossing of Lake Lothing. Following a comprehensive options appraisal, a central alignment with a central lifting section was identified as the preferred option. It was this Scheme that subsequently secured funding from the Department for Transport, and a direction under section 35 of the Planning Act 2008 ("PA 2008") requiring the Applicant to apply for a development consent order ("DCO") to deliver the Scheme.

1.3 Purpose of the report

1.3.1 This Design Report ("DR") has been prepared to accompany the Applicant's application for development consent under the Planning Act 2008 for the Scheme in Lowestoft. The purpose of the DR is to explain the use of good design, the response to the physical, environmental and socio-economic context of the crossing, informed by appropriate consultation that has defined the reference design for the Scheme.

1.3.2 The evolution of the Scheme design has been an iterative process, with good design achieved through the study of best practice, a multi-disciplinary design team, and exploration of alternative solutions for each component of the design.

1.3.3 The National Networks National Policy Statement ("NNNPS") is the primary planning policy document against which the application for development consent will be tested. In accordance with this document, good design has been at the core of the evolution of the Scheme.

1.3.4 In preparation for the DCO application, a "reference design" has been developed. This is a design that is intended to demonstrate a feasible solution for the Scheme while recognising the need to include flexibility for further development in detailed design within the parameters of the Environmental Statement ("ES") (document reference 6.1) and Limits of Deviation ("LoD") provided for in the DCO.

1.3.5 The DR explains how the design has responded to the Vision for the Scheme, as well as the local environment, site constraints, consultation feedback, planning policy, and

technical guidance to arrive at the design for the Scheme (the "reference design") for which development consent is sought.

1.3.6 The report demonstrates how the need for good design has been considered, to ensure a Scheme that contributes to the town beyond the economic and transport related objectives.

1.3.7 The DR also explains how the reference design will subsequently be taken forward at the detailed design stage, and how good design will be secured through the DCO, if granted by the Secretary of State ("SoS") for Transport.

1.3.8 This report should be read in conjunction with the drawings and documents contained within the suite of application documents, in particular Schedule 1 to the draft DCO and the works plans.

1.4 Structure of the report

1.4.1 This report is structured in the following way:

1 Introduction

Provides a background to the Scheme and introduces the design process undertaken in the development of the reference design.

2 The Vision

Outlines the aim, objectives, design principles, and design narrative (collectively referred to as the "Vision") that underpin the Scheme design.

3 Policy and guidance context

Summarises policy relevant to the development of the reference design of the Scheme. A comprehensive analysis of planning policy and planning compliance can be found in the CftS. This section also outlines the technical guidance that relates to the construction of the Scheme.

4 Scheme context

Captures analysis undertaken of the area in which the Scheme is located, and the wider context. This includes townscape, connectivity and movement. A full assessment can be found in the ES.

5 Consultation and engagement

This section summarises the influence of public consultation, engagement with affected parties, and the outcomes of this process on the reference design. The full consultation process and outcomes is reported in the Consultation Report.

6 Scheme constraints and considerations

An explanation of the constraints and considerations on the Scheme which inform the reference design.

7 Scheme proposals: reference design evolution

Explores the reference design with consideration to the overarching Vision, constraints, the compliance with the design policies contained in the NNNPS, and the application of good design. For the purpose of this report, the Scheme has been divided geographically into three areas for ease of understanding.

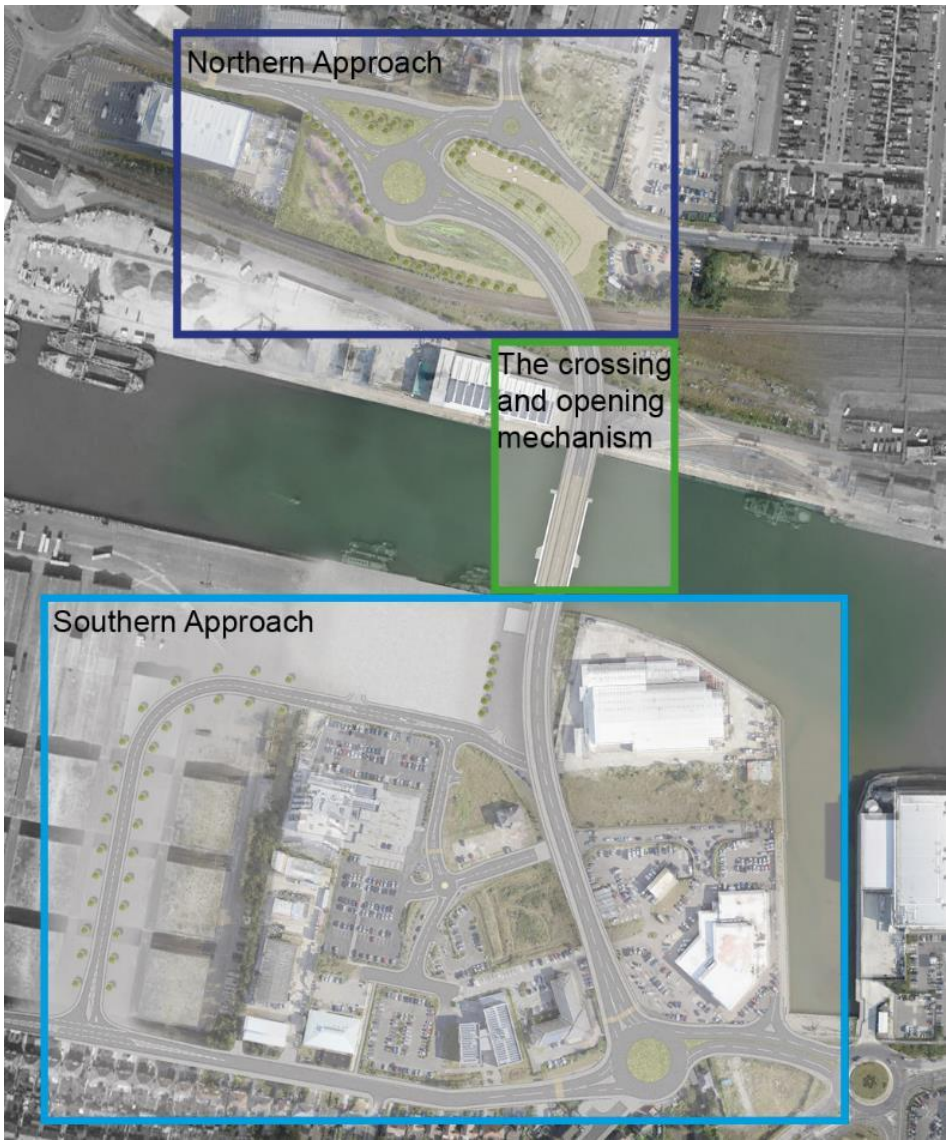


Figure 4: Three areas of the reference design described by the DR

These areas (as shown in Figure 4) include:

- Northern approach
- The crossing and opening mechanism
- Southern Approach

It provides explanation of the components of the reference design and alternative solution that were explored through the design process. This section aims to explain technical information about the Scheme in clear terms.

8 Scheme proposals: reference design

Displays the reference design for the Scheme through images derived from a digital 3D model to communicate the how the Scheme could look.

This section also provides a tabulated summary of how the reference design responds to the design principles set out for the Scheme, Design Council CABE Principles, and the Scheme considerations and constraints.

9 Approach to detailed design

The DR concludes by explaining the role of the Design Guidance Manual ("DGM") (document reference 7.6) for the Scheme. The DGM will provide clear guidance about the components of the reference design that are fixed in principle and those that require further development, within certain criteria.

The purpose of the DGM is to ensure that expectations for contractor commitments in the detailed design process are clearly communicated and understood. The DGM therefore provides a mechanism for safeguarding the principles of good design that are embedded within the reference design throughout the detailed design and construction.

1.4.2 The draft Development Consent Order includes a requirement that the Scheme is to be designed and implemented in general accordance with the General Arrangement plans and the Design Guidance Manual.

1.4.3 The Design Guidance Manual is being developed by the Applicant in consultation with Waveney District Council and Suffolk County Council. The Applicant's intention is to continue to develop the Design Guidance Manual to reflect those discussions such that a final version will be submitted prior to the close of the Examination.

2 The Vision

2.1 Summary of the Scheme

2.1.1 The proposal ("the Scheme") is for a new single carriageway road crossing of Lake Lothing, consisting of a multi-span bridge and roundabout junctions at the northern and southern approaches to the bridge, connecting to the local highway network. An opening section of the bridge provides 12m air-draught when lowered, and unlimited air-draught while raised, within a 32m navigable width in the centre of Lake Lothing for vessels. The opening section operates by means of a 'rolling bascule' mechanism, operated from a nearby control tower building.

2.1.2 The Scheme includes the closure of Durban Road at its junction with Waveney Drive; a new Access Road from Waveney Drive west of Riverside Road; a dedicated provision for cyclists and pedestrians which tie into existing networks; associated changes, modifications and/or improvements to the existing local highway network; and works to facilitate the construction of these elements.

2.1.3 The aim and objectives, design principles, and the design narrative provide a set of criteria and aspirations that design alternatives and decisions, and the Scheme as a whole must align with. This is hereby referred to collectively as ("the Vision").

2.2 Aim and objectives

2.2.1 The CftS (document reference 7.1) comprehensively explains the Scheme's relevance and anticipated contribution to the region, and the SRN.

The aim of the Scheme is as follows:

To stimulate regeneration, sustain economic growth, and enhance Lowestoft as a place to live and work in, and to visit.

The specific objectives of the Scheme are as follows:

- To open up opportunities for regeneration and development in Lowestoft.
- To provide the capacity needed to accommodate planned growth.
- To reduce community severance between north and south Lowestoft.
- To reduce congestion and delay on the existing bridges over Lake Lothing.
- To reduce congestion in the town centre and improve accessibility.
- To encourage more people to walk and cycle, and reduce conflict between cycles, pedestrians and other traffic.
- To improve bus journey times and reliability.
- To reduce accidents.

2.2.2 The aim and objectives were developed with stakeholders in the preparation of the OBC for the Scheme. They have been considered throughout the development of the reference design, and will continue to influence decision making through to construction.

2.3 Design principles

2.3.1 As part of ongoing collaborative workshops with relevant officers from Suffolk County Council ("SCC") and Waveney District Council ("WDC") local planning authorities (hereafter referred to as the "LPAs") design principles were developed for the Scheme. This ensured there was a shared understanding of the principles that have been embedded throughout the development of the reference design.

2.3.2 The design principles were composed collectively through numerous iterations by the Applicant and LPAs until a consensus was reached.

2.3.3 Section 8 of the DR presents a summary of how the reference design for the Scheme complies with the following design principles for the Scheme.

The design principles are as follows:

The Lake Lothing Third Crossing will improve connectivity for everyone in Lowestoft; it will be symbolic of Lowestoft rising to meet the aspirations for economic prosperity and embrace the proud maritime history of the town.

- The Scheme shall enhance the identity, culture, character, and nature of Lowestoft and make a positive aesthetic and actual contribution to the conservation and enhancement of Lowestoft's natural, historic and built environment
- The design shall acknowledge its role in place making and promoting regeneration particularly through its relationship to adjacent land
- There shall be a cohesive design narrative bringing together the distinct elements of the Scheme, the primary and secondary structures, including the control tower
- The design shall respond to the external constraints imposed by statutory bodies and internal constraints including capital and maintenance costs
- The Scheme shall result in a positive user experience for all users, be it vehicular, pedestrians, cyclists or less abled individuals, and water borne vessels through its own design and its practical connectivity to the existing network.
- The design shall strive to minimise impacts on amenity and seek sustainability in its use of materials, and inclusion of multi-functional green infrastructure which encourages health and wellbeing.

2.3.4 Whilst the aim and objectives consider strategic and functional requirements of the Scheme, it was important to ensure design principles inform how the vision is delivered through good design and offer wider benefits to the town and the community.

2.4 Design narrative

2.4.1 The Applicant has sought to development an overarching design narrative to, to ensure a good quality design that is appropriate to the context of Lowestoft.

2.4.2 Existing bridges from around the world of a similar size and setting, were analysed and discussed with the LPAs to obtain an understanding of their views on what themes they considered to be appropriate for Lowestoft.

2.4.3 Discussions with the LPAs highlighted that the *reliability* of any proposed bridge was a key priority over its appearance or decoration. This sentiment was reinforced by statutory consultation responses from residents and businesses. Consultation feedback responding to the Scheme can be found in the Consultation Report.

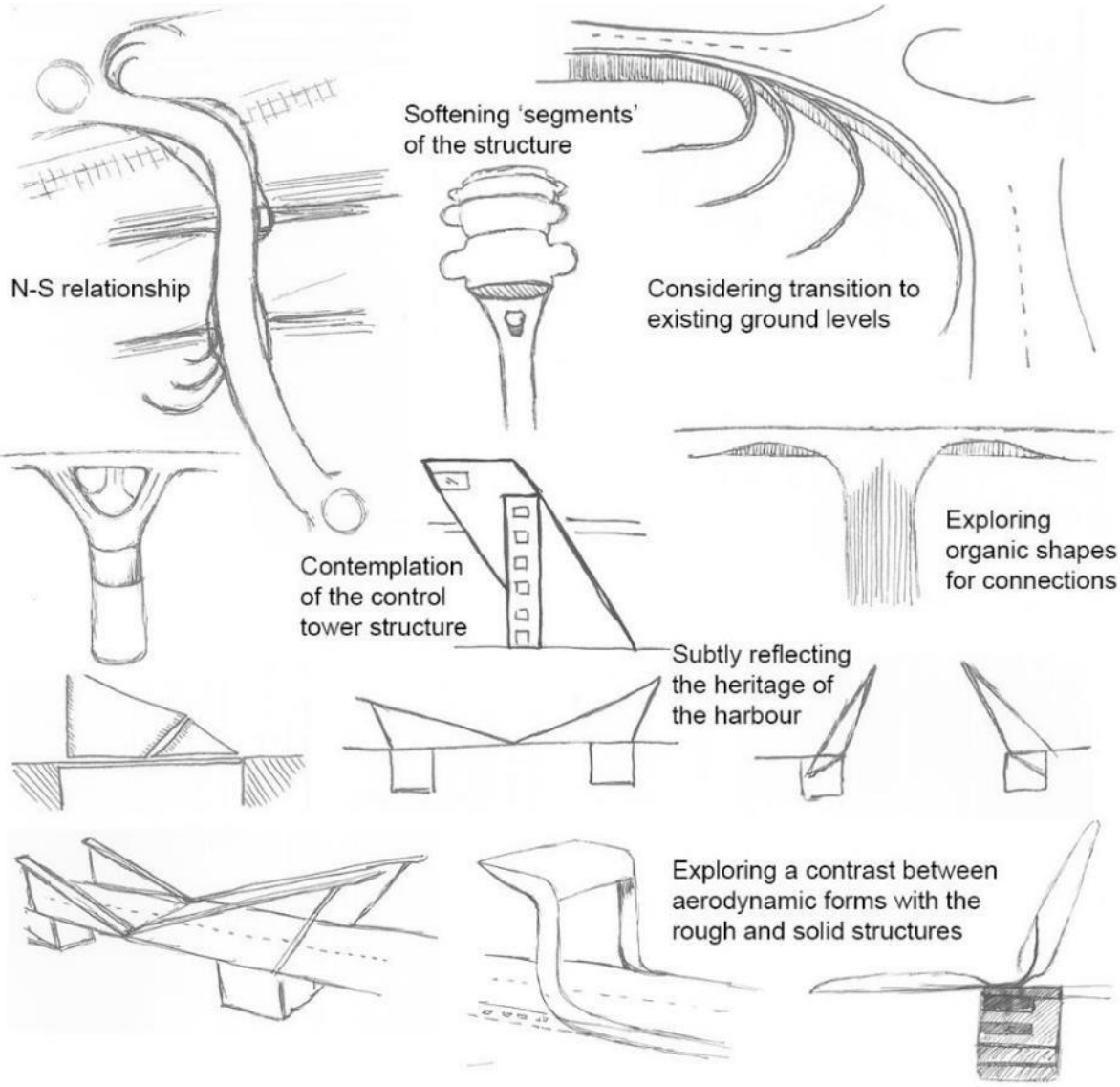


Figure 5: Assorted sketches illustrating application of possible narratives applied to components of the Scheme

2.4.4 Whilst the Scheme would be a prominent feature in the town, consultation feedback confirmed that the visual appearance of the bridge was not a top priority and that there was little desire locally for investing in an unnecessarily ornate or decorative design for the Scheme.

2.4.5 The Applicant and LPAs considered that the most appropriate design for the Scheme would be a simplistic and honest design. The design should achieve uniformity and coherence across the entirety of the Scheme expressed through the engineered components of the design and by reference to the local context. It was considered

unnecessary to clad or disguise any components of the bridge or its functionality.

2.4.6 Conceptual sketches were prepared to explore the possible overarching narratives for application to components of the reference design of the Scheme (as shown in Figure 5 and 6). Key themes drawn from Lowestoft's heritage and local context, including the port industries and natural world, were applied to the initial engineered design for the Scheme to explore a range of narratives.

2.4.7 Through further discussion with the LPAs, it was considered appropriate to draw inspiration from Lowestoft's future as an emerging centre for the renewable energy industry in the UK. The design therefore needed to acknowledge the past, present, and future of the town and its identity.

2.4.8 The term 'marine tech' was coined to describe the design narrative for the Scheme. This concept is manifested in the design, particularly of the opening mechanism, through the reflection of invisible forces enabling movement of a contemporary, sleek form - as seen on the wind turbines offshore and 'Gulliver' at Ness Point.

Figure 6: Early conceptual sketch of the design narrative for the Scheme

2.4.9 Figure 7 and 8 reflect the 'marine tech' narrative for the Scheme, as it captures the functionality and durability of Lowestoft's working port, with the simplicity and elegance of the innovative technology resting temporarily upon it. The port operations and movement of the wind turbine parts is reflected in the Scheme's own functionality and the ability for the central span to move.

2.4.10 The crossing itself, and particularly the opening mechanism being the 'main event' contributing to and animating the skyline of the town, would therefore be the feature itself; exposing its functionality through its form.

2.4.11 It is this meeting of ideas, pure functionality and innovation that inspired the design development of the Scheme as a whole, in each of its primary components.

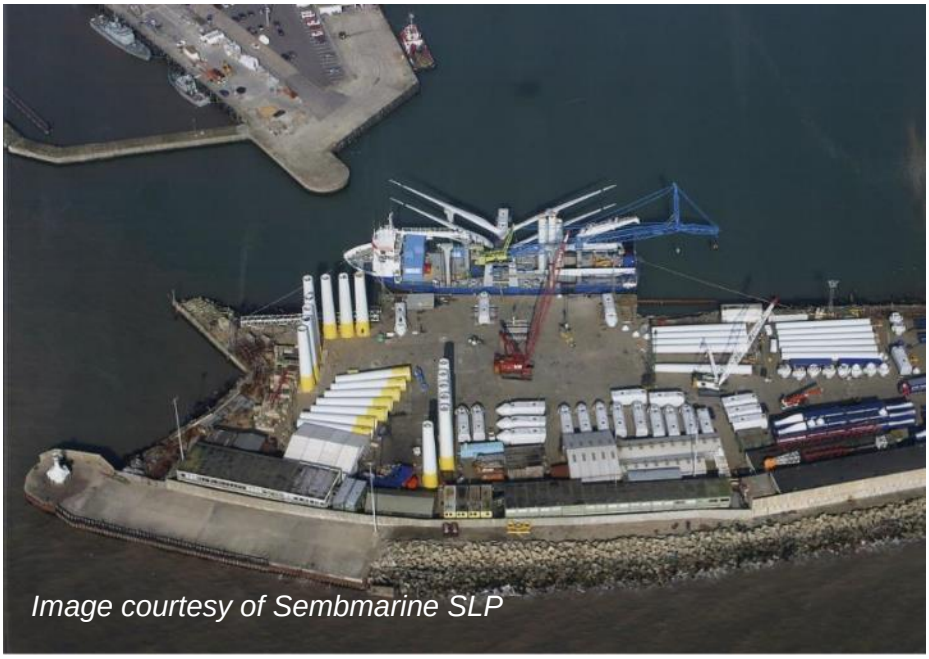


Figure 7: Renewable energy apparatus being prepared for shipping in Lowestoft Harbour

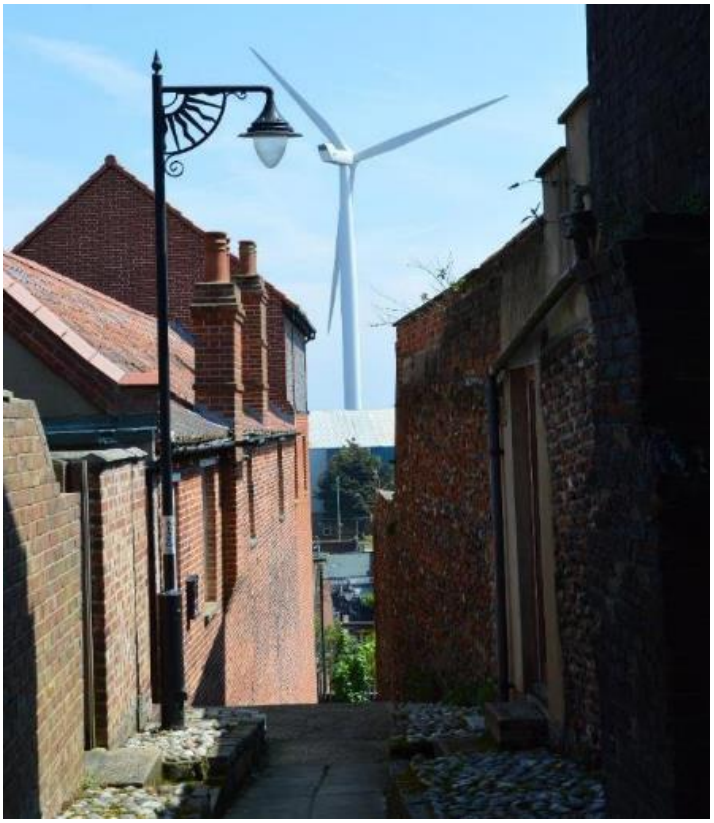


Figure 8: Wind turbine 'Gulliver' a symbol of the town's future through conservation area

3 Policy and guidance context

3.1 Introduction

3.1.1 The CftS (document reference 7.1) explains the national, regional, and local policy that is relevant to the Scheme.

3.1.2 The DR references relevant policy and guidance that influences the reference design for the Scheme.

3.1.3 Where relevant policy and guidance has been referred to throughout the DR, it is framed by a dashed box in this manner.

3.2 National policy

The National Policy Statement for National Networks

3.2.1 The National Policy Statement for National Networks[1] ("NNNPS") (2014) is used as the primary basis for making decisions on DCO applications for transport related NSIPs in England.

3.2.2 It is intended for use by the Applicant and local authority and: *"provides guidance and imposes requirements on matters such as good Scheme design, as well as the treatment of environmental impacts."* (Paragraph 1.20)

3.2.3 The conformity of the Scheme with the NNNPS is demonstrated and a full assessment of the Scheme against the requirements and criteria, is in the CftS.

3.2.4 Sections of the NNNPS which directly concern the reference design have been indicated in the DR to reiterate compliance with the policy.

3.2.5 Section 4 'Assessment principles' of the NNNPS is the most relevant for discussion in the DR and includes:

- *Alternatives (paragraphs 4.26 to 4.27):*

Section 7 of this report describes the reference design, explains alternatives that were considered for components of the design, and why they were discounted for the reference design. Alternatives are also considered in more detail in Chapter 3 of the ES (document reference 6.1) and in the CftS.

- *Criteria for 'good design' for national network infrastructure (paragraphs 4.28 to 4.35)*

The DR explains the approach taken to 'good design' for the Scheme and how the reference design complies with the Vision

- *Accessibility (paragraphs 3.19 to 3.22), Safety (paragraphs 3.9 to 3.10), and Security considerations (paragraphs 4.74 to 4.78)*

The DR explains how the reference design has been developed using DMRB to

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/387222/npsnn-print.pdf

ensure accessibility, safety and comfort for all users.

- *Biodiversity and ecological conservation (paragraphs 5.20 to 5.26)*

The DR explains the consideration given to taking advantage of opportunities to conserve and enhance biodiversity. The environmental impacts of the Scheme on ecology are assessed in the ES.

- *Landscape and visual impact*

The ES contains a Landscape and Visual Impact assessment. The DR explains consideration of this through the development of the reference design ensuring the Scheme's appropriateness to the surrounding context.

The National Policy Statement for Ports

3.2.6 The National Policy Statement for Ports[2] ("PNPS") (2012) sets out the framework for making decisions for new port development. Whilst the Scheme does not propose new port development, it does cross Lake Lothing in the Inner Harbour and interfaces with the Port of Lowestoft. There is also a need in the PNPS to demonstrate consideration of alternatives and the use of 'good design'. An assessment of the Scheme against relevant paragraphs of the PNPS is provided in the CftS.

3.3 Adopted local policy

The Approach to Future Development in Waveney to 2021: Core Strategy

3.3.1 The Approach to Future Development in Waveney to 2021: Core Strategy[3] (the "Core Strategy") (adopted in January 2009) sets out in strategic terms, WDC's overall approach to future development.

3.3.2 Policy CS02 'High Quality and Sustainable Design' of the Core Strategy is relevant to the Scheme design, it states:

All development proposals must demonstrate a high quality and sustainable design that positively improves the character, appearance and environmental quality of an area and the way it functions. In particular, proposals should:

- *create places and spaces for people*
- *reflect local character and distinctiveness*
- *protect local amenity*
- *consider opportunities for a mix of uses*
- *consider opportunities for public art*

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/3931/national-policy-statement-ports.pdf

[3] http://www.eastsuffolk.gov.uk/assets/Planning/Waveney-Local-Plan/Adopted-Core-Strategy/Adopted-Core-Strategy.pdf

- *create safe, healthy and accessible environments*
- *make good provision for access by all transport modes*
- *ensure accessible environments that give priority to pedestrian and cycle access and provide linkages and integration with surrounding housing, employment, services, facilities and spaces*
- *deliver higher densities in places with good public transport accessibility*
- *protect historic character and integrate historic buildings and features where these occur*
- *provide, conserve and enhance biodiversity and create linkages between green spaces and wildlife corridors*

All development proposals will be expected to seek to minimise carbon dioxide emissions through sustainable design and construction, energy efficiency and the incorporation of renewable energy technology as appropriate. Proposals should also seek to minimise the use of water resources and the production of waste. Most proposals, including all proposals dealing with historic sites, should be accompanied by a Design and Access Statement.

Waveney District Council: Development Management Policies

3.3.3 Waveney District Council's Development Management Policies[4] (adopted January 2011) provide detailed criteria based policies to help make decisions on planning applications.

3.3.4 Paragraph 3.3 of the Development Management Policies states:

"With the emphasis in the Core Strategy on redeveloping sites within existing built-up areas, the importance of achieving design, which respects and enhances its setting, is paramount. However, where there is an opportunity to create new places and spaces, on larger sites, such as the Lake Lothing and Outer Harbour Area Action Plan area in Lowestoft, innovative design will be encouraged."

3.3.5 Design Principles explained in paragraphs 3.5-3.20 of the Core Strategy are of relevance to the Scheme design and include: Amenity, Safety, Access for All, Accessibility, Use of Resources and Environment, Landscaping, Highway Safety.

Lowestoft Lake Lothing & Outer Harbour Area Action Plan

3.3.6 The Lowestoft Lake Lothing & Outer Harbour Area Action Plan[5] ("AAP") (adopted by Waveney District Council in January 2012), is a spatial policy framework for development within the Lake Lothing and the Outer Harbour area of Lowestoft. It is a

[4] Waveney District Council, *Policies to Help Make Decisions on Planning Applications Development Management Policies Development Plan Document*

[5] http://www.eastsuffolk.gov.uk/assets/Planning/Waveney-Local-Plan/Adopted-AAP/Adopted-Area-Action-Plan.pdf

statutory Development Plan Document, and forms part of Waveney's Local Plan, alongside the Core Strategy (Policy CS05) and Development Management Policies.

3.3.7 The AAP contains land allocations, designations, and policies covering employment, housing, tourism, flood risk, transport, social infrastructure, heritage, open space, and energy efficiency.

3.3.8 Paragraph 1.1.3 of the AAP states: *"Planning applications for developments within the AAP area will need to demonstrate compliance with this policy framework in order to be granted approval by the Council."*

3.3.9 Whilst the Scheme is not a planning application submitted for the approval of WDC directly, account has still been taken of the policies in the AAP and the role they plays towards facilitating the revitalisation and regeneration of the outer harbour area.

3.3.10 The AAP makes reference to the Waveney Core Strategy stating the WDC's support for the Scheme and *"will continue to promote the creation of a third crossing across Lake Lothing." (Paragraph 1.2.5)*

3.3.11 The following objectives of the AAP are relevant to the reference design:

Objective 6 – To create a quality environment

Objective 7 – To ensure the highest standards of design

Objective 8 – To encourage people to visit

Objective 9 – To be better connected

Objective 10 – To reduce the need to travel by car

3.3.12 Within the EHC1 policy in the AAP, there is a requirement for all development in the AAP area to be 'good design' with high quality public realm incorporated. This is elaborated in Paragraph 3.4.4: *"The AAP seeks to ensure that all development benefits from high quality architecture, urban design and public realm that responds to the local area and individual site opportunities and constraints."*

3.3.13 The Scheme lies within two Strategic Site Proposals ("SSPs") in the AAP area as shown in Figure 9, including:

SSP3 Kirkley Waterfront and Sustainable Urban Neighbourhood

An underutilised or unoccupied brownfield land with waterfront opportunities for employment, residential community and other integrated land uses.

SSP9 Peto Way/Denmark Road Corridor

On the fringe on residential, industrial and retail, this site is allocated for employment uses with integrated public space.

3.3.14 The CftS explains the relevance of the Scheme for the Spatial Strategies including the AAP, and concludes that the Scheme is not considered to be in conflict with the policy outlined for the adjacent areas (SSP3 and SSP9).

3.3.15 The AAP refers to the design of developments in accordance with the 'Lowestoft Design Guide' 2004 for high quality public realm. The application of this guide will be considered where appropriate in the DGM prepared for the Scheme.

3.3.16 Section 7 of this report describes the reference design in more detail, and the design's compliance with the policies and aspirations made in SSP3 and SSP9 are explained further.

3.3.17 In response to SSP3, WDC developed the "Sustainable Urban Neighbourhood and Kirkley Waterfront Development Brief Supplementary Planning Document". This report contains site specific guidance for the development of this area including spatial allocation and indicative vehicular and cycle networks.

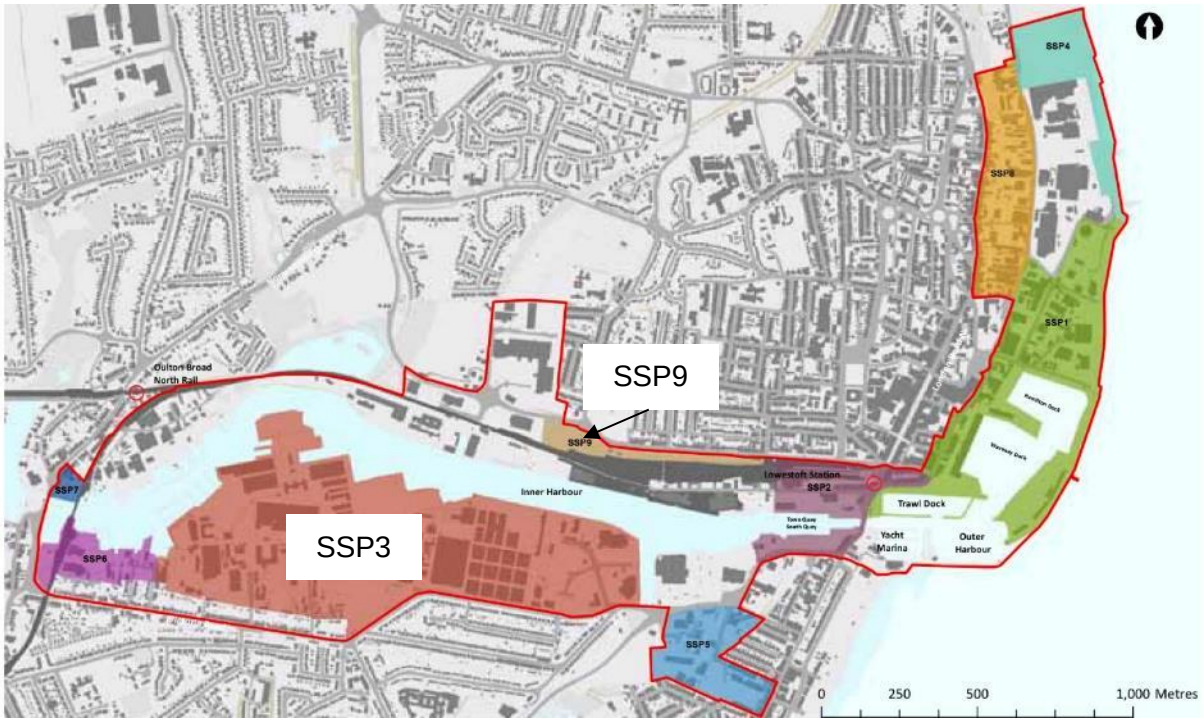


Figure 9: AAP Site allocations

Sustainable Urban Neighbourhood and Kirkley Waterfront Development Brief Supplementary Planning

3.3.18 The Sustainable Urban Neighbourhood and Kirkley Waterfront Development Brief Supplementary Planning Document[6] ("SUN Brief") (adopted in May 2013) provides site specific development guidelines for the SSP3 allocation, as required by Policy IMP4 of the AAP and directs that preparation of a development brief prior to the determination of planning applications.

3.3.19 The SUN Brief sets out:

- The distribution of land uses across the site
- High level street network and transport proposals
- Open space and landscape principles

[6] http://www.eastsuffolk.gov.uk/assets/Planning/Waveney-Local-Plan/Supplementary-Planning-Documents/SUN-and-Kirkley-Waterfront/Development-Brief.pdf

- Flood risk mitigation requirements
- Implementation strategy

3.3.20 Whilst the SUN Brief does not reflect the Scheme directly, it enables consideration of how the Scheme will provide a connection to the proposals.

3.3.21 The following guidance in the SUN Brief is of particular relevance to the development of the reference design:

3.3.22 *Section 5 – Streets and Transport:*

The guidance provided on the vehicular streets is applicable to the new Access Road in particular as it aligns with the 'Indicative Vehicular Network' indicated in Section 5 of the SUN Brief. This application of the design guidance is explained further in Section 7 of this report.

3.3.23 *Section 6 – Open space and Biodiversity*

This guidance coincides with the Scheme's aim for the inclusion of public space and habitat areas where possible as part of the reference design. The SUN Brief states: *"Well designed and maintained open spaces that relate to their surroundings are an important part of a quality public realm."*

3.3.24 *Section 7 - Urban Design Guidance*

Whilst this section provides specific guidance on the use of urban form and future character areas, it is important to consider this in the reference design to ensure future development is not restricted by the Scheme. This also allows the fringe of the Scheme, particularly the new Access Road, to connect to future development and contribute to the character of the area.

3.3.25 *Section 8 – Flood risk management*

This provides guidance on the use of surface water management and Sustainable Drainage Systems ("SuDS"), which relates to the drainage design considered for the reference design.

3.3.26 *Section 10 – Implementation*

This section demonstrates the use of a phased approach to the implementation of the development proposed for the SSP3 allocation taking into account the dependencies on infrastructure, with a view to completion by 2028. The Scheme is located within Phase 1 of the SUN Brief's employment, temporary employment, and residential areas.

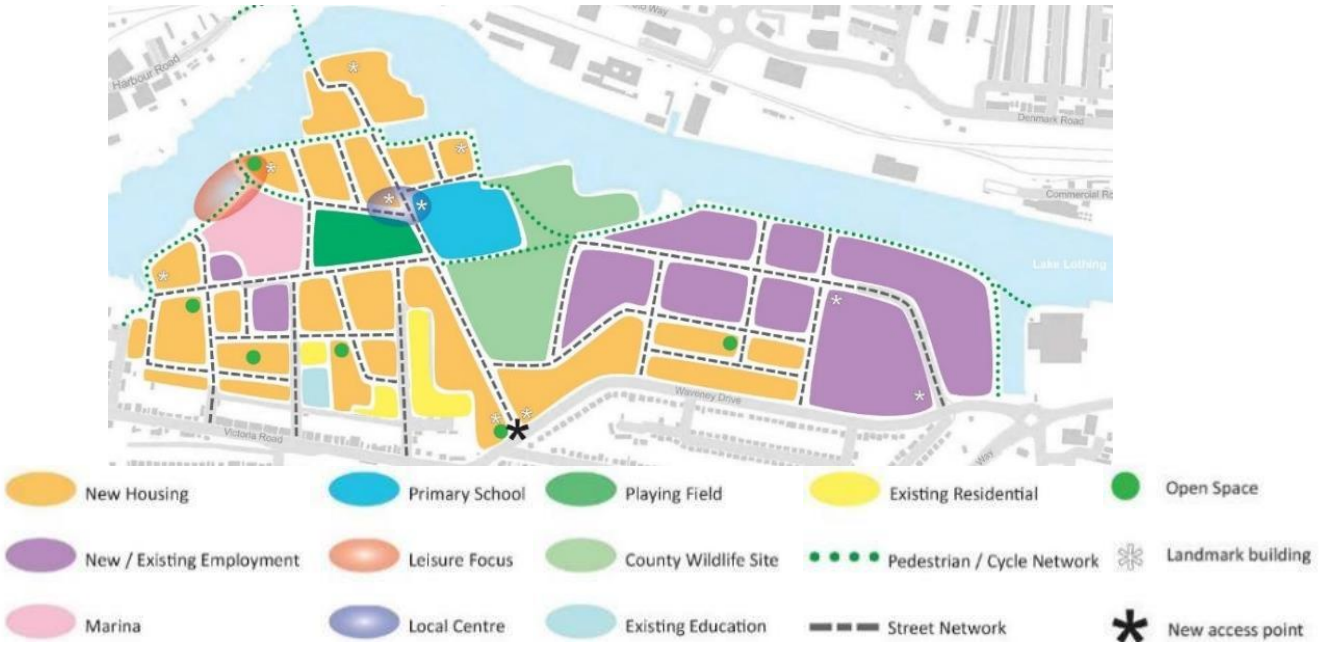


Figure 10: Outline masterplan for the development of SSP3 in the SUN Brief

3.4 Emerging policy

Waveney Final Draft Local Plan

3.4.1 WDC is currently preparing a new Local Plan for the district (excluding the Broads Authority area). The Waveney Local Plan is currently at Final Draft stage and due to be submitted for examination in summer 2018. This sets out the locations and level of growth for the Waveney area for 2014-2036, and the policies that will be used to determine the planning applications. This is explained further in Section 8.3 of the CftS.

3.4.2 The Scheme the relevant emerging policies of potential relevance to the Scheme design are:

- Design:

Paragraph 8.164 states: *'High quality design is a critical part of good planning and sustainable development and should contribute positively to making places better for people. Good design is concerned not only with how development looks but also how it feels and functions.'*

Policy WLP 8.29 – Design

'Development proposals will be expected to demonstrate high quality design which reflects local distinctiveness.'

- Design of Open Spaces:

Paragraph 8.174 explains: *'Where open space is provided this should be designed to a high standard and be well integrated into the surrounding area to encourage people to use it and enhance the public realm.'*

Policy WLP 8.30 – Design of Open Spaces

'Proposals involving the creation of open space should demonstrate that the design is inclusive of people of all ages and abilities. In doing so proposals involving the creation of open space should demonstrate that the design has considered the following:

- *Location*
- *Access*
- *Layout*
- *Use*
- *Appearance*

- Natural Environment

Policy WLP 8.34 – Biodiversity and Geodiversity

Development will be supported where it can be demonstrated that it maintains, restores or enhances the existing green infrastructure network and positively contributes towards biodiversity through the creation of new green infrastructure and improvement to linkages between habitats.

3.4.3 Subject to the Local Plan being adopted, this will replace the Lowestoft Lake Lothing & Outer Harbour Area Action Plan (explained in 3.5 of this report), Core Strategy (2009), and Development Management Policies (2011).

3.5 Guidance

Design Manual for Roads and Bridges

3.5.1 The reference design for the Scheme has been prepared in accordance with the relevant the Design Manual for Roads and Bridges ("DMRB") guidance and standards.

3.5.2 Where the guidance is used for local road Schemes, SCC as the local Highways Authority may wish to advise on the appropriateness in any particular situation.

3.5.3 Formal procedures by SCC as the local Highways Authority are in place for any departures from the guidance, to ensure that there is no compromise in safety or unacceptable impact on the environment.

3.5.4 Departures from the standards and guidance in the DMRB are only included where absolutely necessary and considered separately taking account of the constraints and balancing the associated risks involved. These are discussed further in 7.3.36-37 of this report and in Appendix 1 the 'Departure from Standards Report'.

Outline Approval in Principle process

3.5.5 Technical approval of the reference design has been sought from SCC as the Technical Approval Authority ("TAA") for highways and Network Rail due to the Scheme crossing the East Suffolk Line.

3.5.6 Outline Approval in Principle ("OAIP") process has been agreed by the TAA's and informed by the BD2/12 'Technical Approval of Highway Structures' 2012 guidance provided in the DMRB. In summary, it is a process of agreement with the relevant affected parties on the design principles from which the reference design is developed and used as a basis to take forward the detail design and the final Approval in Principle ("AIP").

3.5.7 The TAA has approved the OAIP documents which will inform further detailed design work, and details the level of checks required, depending on the complexity of the Scheme.

3.5.8 The OAIP documents include information about the loading requirements of the structures, methods used for analysis, and requirements for future maintenance. They also capture any departures from the standards that would be required, and other guidance used.

3.5.9 OAIPs produced for the reference design of the Scheme include:

Structures

Approach Viaducts (Appendix 2)

Central Bascule Span (Appendix 3)

Riverside Road access portal frame (Appendix 4)

Geotechnical

Outline Strengthened Earthworks Appraisal Form ("OSEAF") (Appendix 5)

3.5.10 The detailed design process will involve development of reference design into a completed design and achieving full Approval in Principle ("AIPs") status prior to construction.

Design Council CABE: 'A design led approach to infrastructure'

3.5.11 The development of reference design has utilised guidance produced by Design Council CABE ("DCC"), and incorporated design workshops with DCC's interdisciplinary Built Environment Expert panel ("BEEs") to review and influence the development of the reference design.

3.5.12 Paragraph 4.33 of the NNNPS recommends the involvement of relevant third party experts and reviews to ensure good design is at the core of the Scheme; *"The use of professional, independent advice on the design aspects of a proposal should be considered, to ensure good design principles are embedded into infrastructure proposals."*

3.5.13 The design workshops held and their influence on the development of the reference design is described further in Section 5 of this report.

3.5.14 DCC's guidance on good design is captured in their document '*A design-led approach to infrastructure*'[7]. The document sets out ten principles for designing successful infrastructure Schemes as set out in the NNNPS. Through referring to the ten principles during the design process, it is possible to ensure the Scheme considers innovative and high quality proposals.

3.5.15 Section 8.6 of this report contains a tabulated summary of how the Scheme responds to or considers these principles. These principles, in summary, are:

1 Setting the Scene

From the outset of an infrastructure project such as the Scheme, the importance of good design must be central to the development of the project. Whilst the functionality of the infrastructure is vital, the execution of the design will ensure its success, local acceptance, and impact on the surroundings.

2 Multi-disciplinary teamwork

To ensure that a project works in terms of its functionality, and as a good design, input from architects and landscape architects, as well as the relevant engineering disciplines is required. Input from affected parties, the community and the local authority early on in a project can provide valuable insight and efficiency in the development of the reference design.

3 The bigger picture

A holistic approach can enable a project to contribute to the wider picture, to regional and sub-regional planning or strategies.

4 Site masterplan

Naturally an NSIP has far-reaching impacts, good design must ensure it responds well to its context. By understanding all that a project connects with, this can be enhanced and made more efficient through an overarching masterplan for the site.

5 Landscape and visual impact assessment

Every project requires a different appreciation of how to handle scale, and the relationship between a project and its environment. The guidance explains: *"Visual impact assessment should be used as a tool to inform location, orientation, composition and height."*

6 Landscape Design

Landscape and public realm can be used to enhance a project and should be developed in parallel with the proposals. Consideration will be made to the use of appropriate materials and limit the predominance 'hard' surfaces, to facilitate social activity and biodiversity.

7 Design Approach

A clear concept can manifest through every detail of the project, and enable meaningful decision making in the development of a design. This approach can be

[7]https://www.designcouncil.org.uk/sites/default/files/asset/document/A_design_led_approach_to_infrastructure_Cabe.pdf

evident in the overall effect of a design, allowing it to read as one good design rather than a composition of disparate components.

8 Materials and detailing

The choice of materials used can tell a story about the project, the purpose it serves, and the relationship to the existing materials and structures around it. A good understanding of the detailing early on in a project can ensure these intentions are carried through to detailed design. *"High quality materials and careful detailing will limit the need for maintenance and allow schemes to weather and age well."*

9 Sustainability

It is important that sustainability is considered throughout the design of a project, in its detailing, construction, and operation. *"Ideally building materials should be locally sourced, reclaimed, recycled or have very low carbon impact*." The project should be designed with consideration to changes over the structures' lifetime, including climate change.

10 Visitor centre

Incorporating an interactive element to the infrastructure design can provide an understanding of the need for the Scheme, and how it operates, and a new destination.

4 Scheme Context

4.1 Strategic Context

4.1.1 The CftS (document reference 7.1) comprehensively describes the strategic context surrounding the Scheme, including land designations and areas of interest.

4.2 Current site conditions

4.2.1 Figures 11 and 12 provide photographs of current conditions in the area around the Scheme.

North of Lake Lothing

4.2.2 The area surrounding the Scheme features a mix of residential, port, industrial, commercial, and retail land uses. There is also a fenced play park adjacent to the site.

4.2.3 The streets and public realm in this location are separated visually and physically from Lake Lothing by inaccessible private land, containing the East Suffolk Line, and the operational port of Associated British Ports ("ABP").

4.2.4 The grain store located east of the Scheme is the only visually notable structure in the vicinity due to its height of approximately 50m, making it stand out from the built form elsewhere in the town.

Lake Lothing

4.2.5 Lake Lothing itself is a large saltwater lake forming a link between The Broads National Park to the west and the North Sea to the east, via Oulton Broad and the Lowestoft Inner Harbour.

4.2.6 Fringed with various uses, this water body has a navigation channel that can be used 24 hours a day by commercial and leisure vessels of varying sizes. The navigation channel has quays on both its northern and southern sides.

South of Lake Lothing

4.2.7 This area features various private businesses and buildings, including the Registry Office, and the Suffolk County Council and Waveney District Council offices. The land immediately at the water's edge, to the west of, and on, the site of the Scheme is unused.

4.2.8 The Scheme lies on what is currently Riverside Road. This road currently provides access to a number of the buildings and businesses adjacent to the Scheme, north of Waveney Drive.

4.2.9 On the southern corner of Canning Road and Riverside Road features habitats broadly fitting the criteria for Open Mosaic Habitat on Previously Developed Land ("OMH") and is a UK Biodiversity Action Plan habitat of importance to invertebrates.

4.2.10 South of Waveney Drive is primarily a residential area adjacent to the Scheme. Waveney Drive is a key vehicular route in this location, separating the commercial, council and private businesses land uses from the residential.

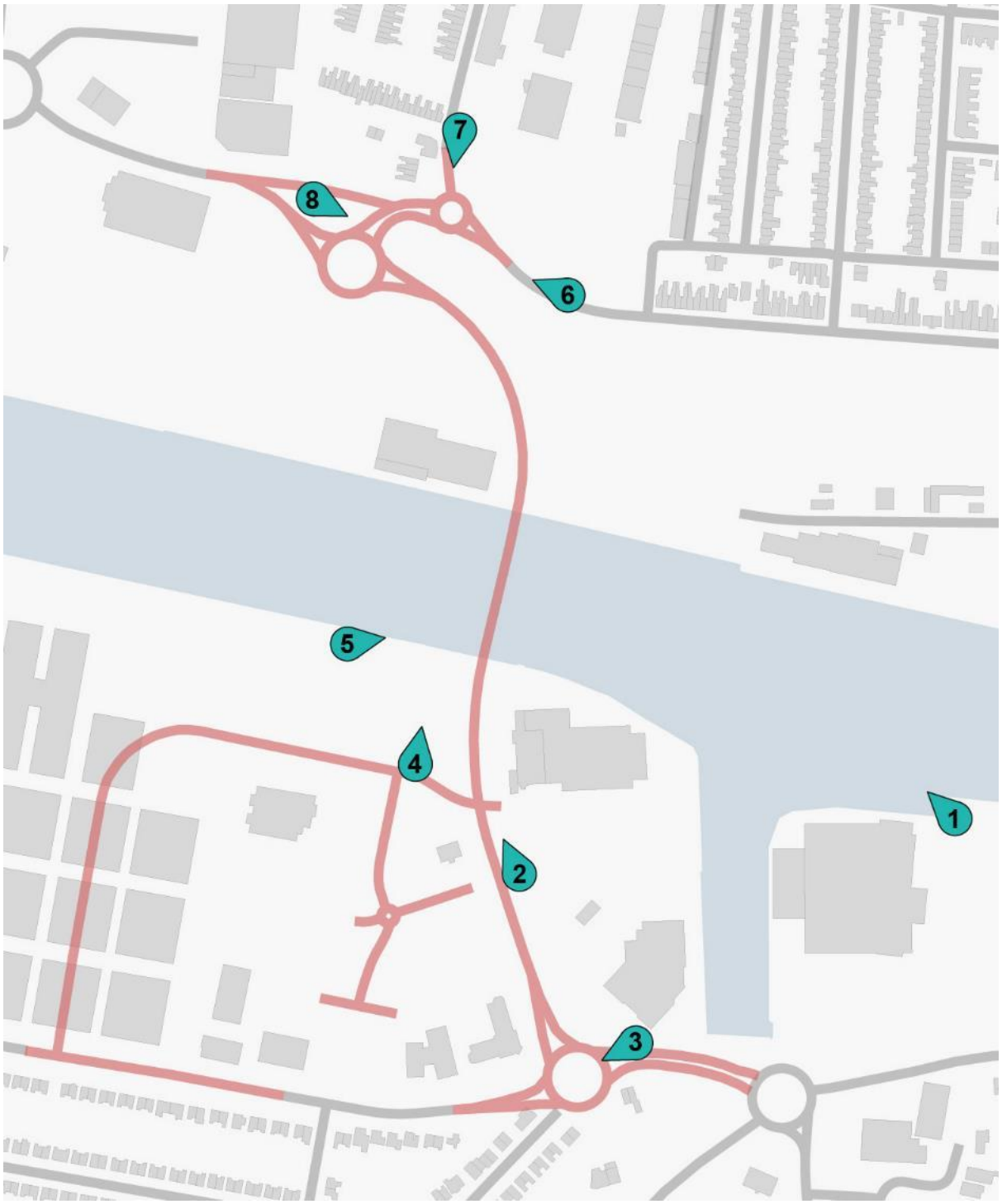


Figure 11: Diagram showing locations of site photos taken around the Scheme location

Figure 12: Site photos of existing conditions around the Scheme location

4.3 Environmental impacts

The environmental impact of the Scheme has been assessed by a team of competent specialists and is reported in the ES (document reference 6.1). Volume I of the ES reports on the following topics:

Chapter Number	Title
Chapter 1	Introduction
Chapter 2	Need for the Scheme
Chapter 3	Alternatives Considered
Chapter 4	The Existing Environment
Chapter 5	Description of the Scheme
Chapter 6	Scoping and Introduction to the Assessment
Chapter 7	Consultation
Chapter 8	Air Quality
Chapter 9	Cultural Heritage
Chapter 10	Townscape and Visual Impact Assessment
Chapter 11	Nature Conservation
Chapter 12	Geology, Soils and Contamination
Chapter 13	Noise and Vibration
Chapter 14	Materials
Chapter 15	Private Assets
Chapter 16	Socio Economics including Recreation
Chapter 17	Road Drainage and the Water Environment
Chapter 18	Flood Risk
Chapter 19	Traffic and Transport
Chapter 20	Cumulative Impacts
Chapter 21	Schedule of Environmental Commitments

Table 1: Contents of Volume I of the ES - the Written Statement

4.4 Land uses

4.4.1 The Scheme is a natural link between a number of land uses which are broadly grouped in the diagram below (Figure 13). This demonstrates the diversity of users that will benefit from the Scheme, with the potential to improve connectivity to local retail, green space, residential and employment areas.

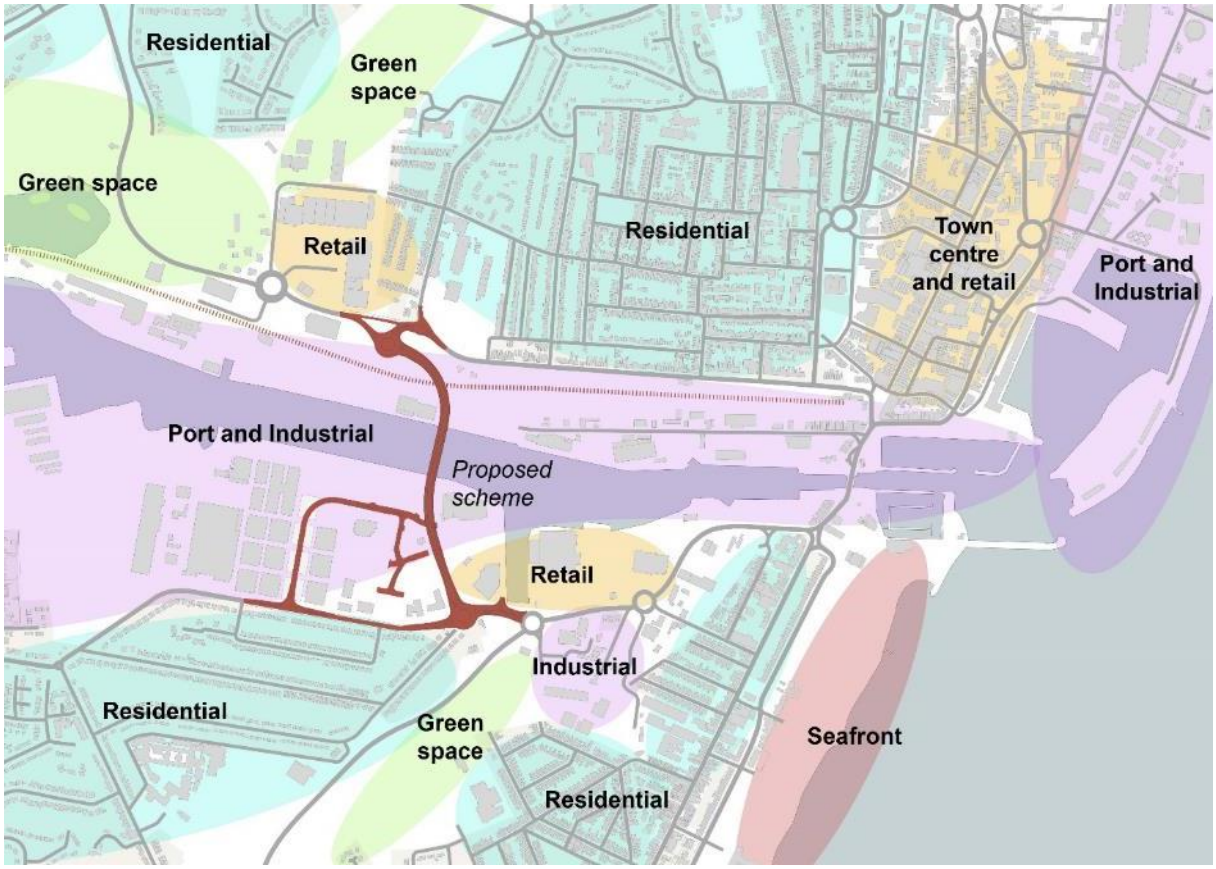


Figure 13: High level analysis of existing land uses surrounding Scheme location

4.5 Local development

4.5.1 A local development of particular relevance to the Scheme due to its proximity, is the 'Sustainable Urban Neighbourhood and Kirkley Waterfront Development'. This proposed large mixed use development forms SSP3 of the AAP.

4.5.2 This development comprises of housing, employment, retail, leisure, education, and open space is located on a 59.8ha of unoccupied and underutilised waterfront land.

4.5.3 The Scheme would form a key connection to this proposed development in Lowestoft and facilitate sustainable modes of transport for short journeys around the town.

4.5.4 The CftS discusses relevant local development around the location of the Scheme.

4.6 Movement and circulation analysis

4.6.1 Currently Lake Lothing forms a barrier for movement around and through Lowestoft,

with the existing two crossings (Mutford Bridge and A47 Bascule Bridge) being insufficient to accommodate current and future travel demand without undue congestion or delay.

4.6.2 The geographical location of the two existing crossings and the distance between them means that journeys for NMUs in particular can be inconveniently long and indirect. This makes walking and cycling less appealing to people, even when only making short trips.

4.6.3 Bus services operate along key corridors in the town, but can often be subject to delays caused by the opening of the existing A47 Bascule Bridge. Figure 14 demonstrates the location of the proposed Scheme relative to bus and cycle routes, and the existing social attractors.

4.6.4 There are a variety of land uses and 'social attractors', key destinations in the town that locals and visitors travel to often such as schools, shops, entertainment. The current network is not always efficient for short journeys across the town, and does not provide a direct route from north to south.

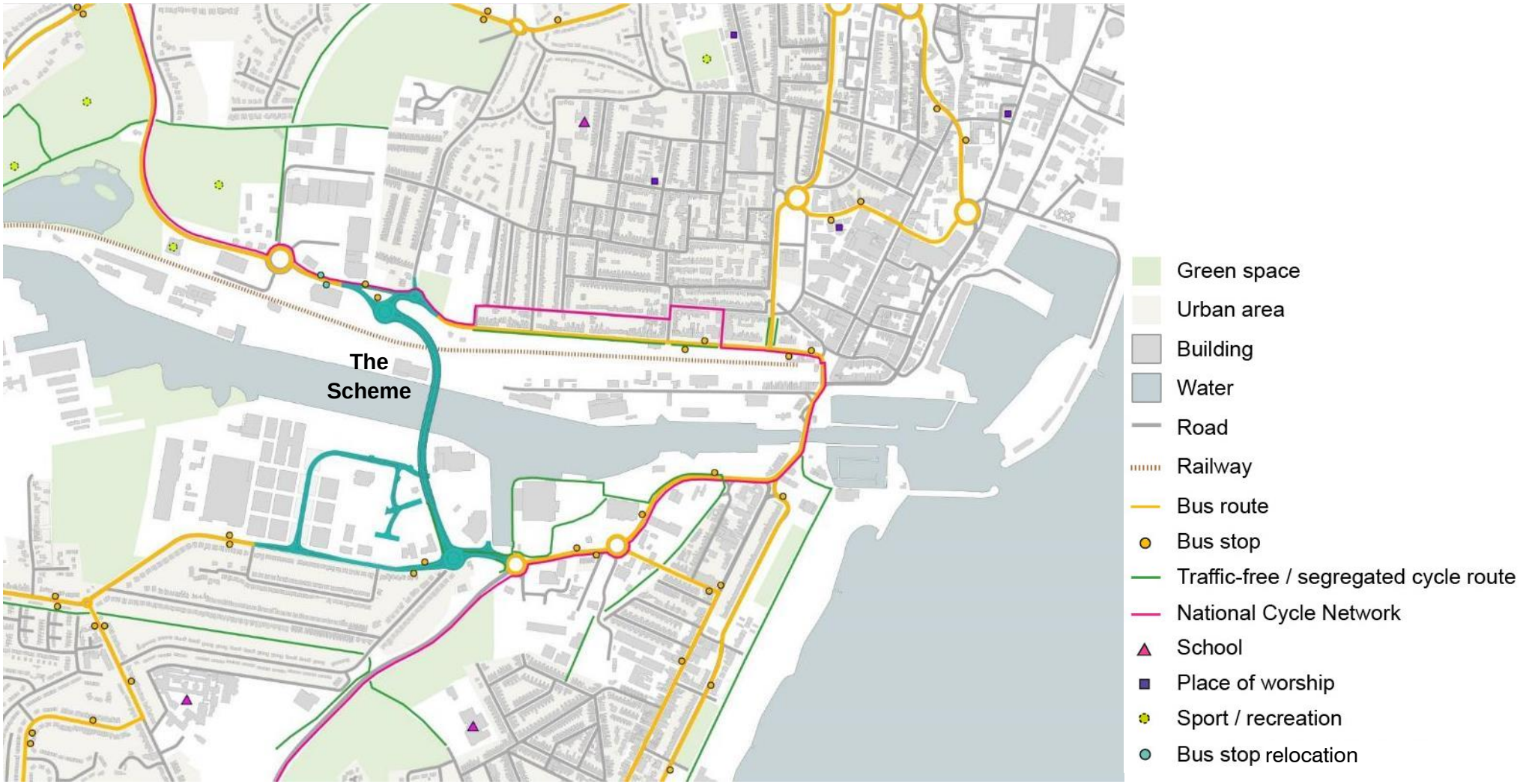


Figure 14: The Scheme in relation to current movement and circulation networks

5 Consultation and engagement

5.1 Introduction

5.1.1 Consultation and engagement with interested and affected parties is fundamental to the development of the reference design for the Scheme. The Applicant has gone beyond the minimum statutory requirement for consultation and engagement as required by the PA 2008 for a DCO application. This includes providing an extended consultation period, and maintaining ongoing dialogue with key stakeholders and affected parties such as the LPAs and Design Council CABE.

5.1.2 The statutory consultation period occurred from September 2017 to October 2017 and included the following activities and materials:

- A range of informative consultation materials including brochures, a website, information boards
- A series of public exhibitions held at various locations around the district at times and venues considered convenient for locals and businesses to attend
- A questionnaire to capture opinions and feedback on the proposed Scheme by topic and location, as well as overall support for the Scheme. This was available in hard copy or online
- Deposit locations where consultation material were available and questionnaires could be submitted
- Publicity to raise interest in the consultation through posted leaflets, posters and advertising

5.1.3 The consultation material included a Design Process Summary, to explain the approach taken to the emerging reference design and explain the design narrative which is appended to the Consultation Report.

5.1.4 The events and materials provided were designed to be as legible and accessible as possible to ensure anyone could have their say on the Scheme.

5.1.5 Feedback provided through the consultation has provided further insight to the specific needs of locals and businesses in the area who could be affected by the Scheme. Preferences and requirements in the design have been either been considered in the design, or captured for inclusion in the detailed design stage where relevant.

5.1.6 Throughout the preliminary design process for the Scheme, the Applicant has sought to engage with key stakeholders, affected parties, businesses and landowners in an open and transparent way.

5.1.7 In summary, 1474 responses were received during the consultation period, demonstrating a 96% support rate for the need for the Scheme as a whole. The responses also show a 84% support rate for the reference design for the Scheme. The Consultation Report also documents the development in the reference design that has occurred as a result of consultation feedback and engagement.

5.1.8 A comprehensive explanation of the consultation process undertaken, covering the Applicant's statutory and non-statutory consultation, and the data received can be found in the Consultation Report.

5.2 Local planning authority design workshops

5.2.1 An ongoing series of collaborative workshops have been undertaken with relevant officers from the WDC and SCC local planning authorities (the LPAs) to ensure they are well informed on the progression of the Scheme, and could provide feedback to input to the reference design throughout its development.

5.2.2 The Applicant intends to continue to provide such workshops with the LPAs to maintain engagement when appropriate, and gain feedback on the content of the DGM as it is developed during the course of the examination.

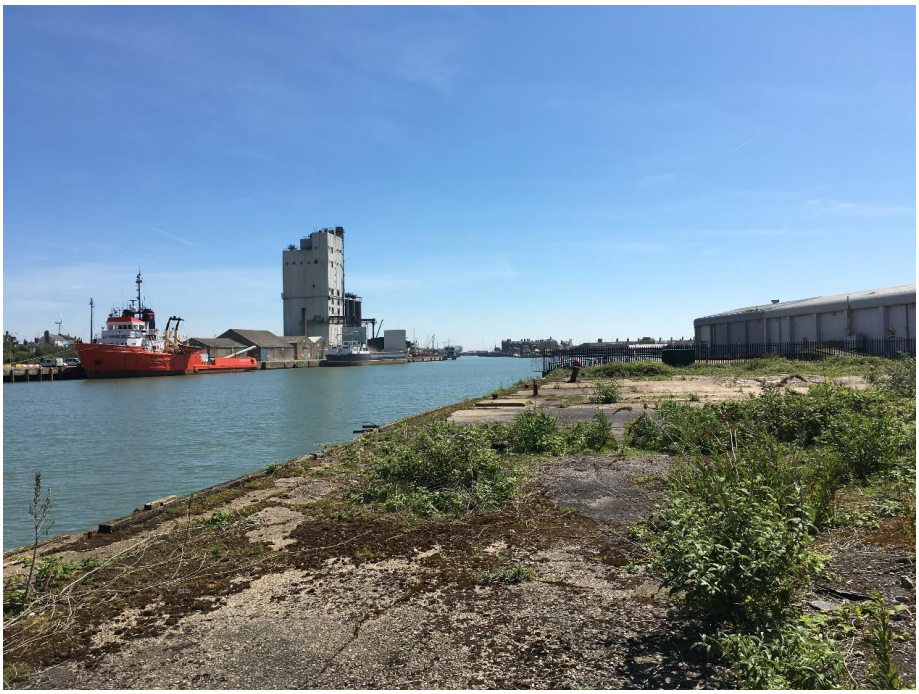


Figure 15: Photograph from site visit with local authorities to discuss aspirations for the area

5.3 DCC guidance and workshops

5.3.1 As recommended in Paragraph 4.33 of the NNNPS, the Applicant sought Design Council CABE's independent advice on the design aspects of the proposal and review of the emerging reference design of the Scheme *"to ensure good design principles are embedded."* in accordance with paragraph 4.33 of the NNNPS.

5.3.2 The reference design was developed with consideration to DCC's guidance document '*A design-led approach to infrastructure'*. This guidance provides advice on the development of the design of sustainable new infrastructure.

5.3.3 The Applicant engaged in two 'Design Workshops' with DCC, during the evolution of the reference design to provide feedback on the iterative design. DCC's feedback from the workshops held can be found in Appendix 6.

5.3.4 Through the workshops which the Applicant sought, DCC's Built Environment Experts ("BEEs") had the opportunity to visit the site, review the designs, and interact directly with the project design team and the LPAs.

DCC Workshop One: 22nd March 2017

5.3.5 The BEEs met with the Applicant and its design team at the site of the Scheme in Lowestoft and were given a presentation of the initial engineered design.

5.3.6 The BEEs provided valuable feedback on the emerging design, noting that it has thus far been driven by the constraints of the Scheme. They also outlined the further opportunities they saw for the structural components and for place-making which were developed in the reference design.

DCC Workshop Two: 29th June 2017

5.3.7 The Applicant's design team, including its architectural advisor Jonathan McDowell (appointed following DCC workshop one), provided a presentation to the BEEs on the design development and alternatives explored since Workshop One.

5.3.8 An emerging reference design – still a work in progress at the time – was presented, with clarification provided as to the outstanding work to be done ahead of the DCO application.

5.3.9 The discussions with the BEEs included the development of the crossing and opening mechanism design, as well as the north and south approach areas with their connections to the existing environment.

5.3.10 The LPAs were also present at part of this event, to provide their thoughts to the BEEs on how they felt the reference design had been developed, and how the Scheme as a whole would be received in Lowestoft.

DCC Feedback

5.3.11 The feedback from DCC showed a positive response to the progress made to the reference design following Workshop One. There was discussion of the benefit of a 'Design Guidance Manual' to maintain the approach to good design for the Scheme.

5.3.12 DCC explained:

"We are very supportive of the positive progress made to design development since the previous Design Workshop in March 2017. A clear design narrative is emerging, which alongside the input of the appointed architectural advisor is leading to some exciting ideas based on thorough analysis. The design concept of "marine tech" provides a utilitarian, beautiful and contemporary reference point that can help to focus the development of options and bring cohesion to the separate elements of the structure towards a single aesthetic purpose."

"The concept sketches for the bridge suggest a simple, minimalist and elegant structure with a continuous sense of "flow" from end to end."

5.3.13 The Applicant will engage with further internal review panels and independent experts as appropriate through the detailed design stage to ensure good design is embedded in the project. This is a standard local authority process when delivering major projects.

5.4 Architectural advisor

5.4.1 Alongside involvement with DCC, an Architectural Advisor was appointed to provide feedback and knowledge through the development of the reference design, acting as a 'critical friend' to the project design team.

5.4.2 This is recommended in 1.8 of the DMRB BA 41/98[8] "The Design and Appearance of Bridges":

"Their experience in integrated design can help improve the appearance of bridges. Therefore it can be of benefit for a bridge design team to have an architect as adviser."

5.4.3 Jonathan McDowell from *Matter Architecture Ltd* was appointed as Architectural Advisor to the Scheme. His previous professional appointments have included; RIBA competitions advisor, CABE enabler, and an ongoing member of other relevant design panels. He has experience on many prominent, completed bridge designs including *Scale Lane Swing Bridge* in Hull (an opening pedestrian bridge in a port town undertaking regeneration projects). He provided valuable input and experience to the refinement of the reference design as a whole.

5.4.4 Matter Architecture Ltd were also appointed to produce a conceptual design for the control tower, as part of the reference design (see Section 7.6.32-60 and Appendix 7 'Control Tower Report').

5.5 Land owners and affected parties

5.5.1 As part of the consultation and engagement, land referencing is undertaken to identify individuals and parties affected by the Scheme or with an interest in the land.

5.5.2 This process of engagement and its influence on the reference design is explained in the Consultation Report. The Applicant has sought throughout the development of the reference design to minimise the extent of land required for the Scheme.

5.6 Response to consultation feedback

5.6.1 The Consultation Report contains an analysis undertaken on responses received during the statutory consultation. Some responses contain queries or questions about the design and alternatives that could have been considered. Section 7 of this DR includes explanation of a selection of design related questions raised during the statutory consultation together with the Applicant's responses to them, in the following format:

Design related question

Explanation to respond to the question, and/or justify design decisions made on the reference design for the Scheme.

[8] http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol1/section3/ba4198.pdf

6 Scheme constraints and considerations

6.1 Overarching considerations

6.1.1 The overall design ambition for the Scheme is for an exemplary new piece of infrastructure that contributes to the emerging identity (see explanation of narrative in Section 2.4 of this report) for Lowestoft's future. Not only will the crossing provide a new connection between the north and south of the town and relieve congestion, but create a new 'place' for people to experience.

6.1.2 It is anticipated that a place-making approach, aligned with well-designed walking and cycling infrastructure will encourage residents and visitors to choose more sustainable modes of transport, for their short journeys in particular.

6.1.3 This aligns with paragraph 3.15 of the NNNPS which states: *"The Government is committed to providing people with the options to choose more sustainable modes"* making this *"an attractive and convenient option"*.

6.1.4 There are areas within the reference design that provide opportunities for new public spaces, planting, and the potential for habitat features to soften the connection between the Scheme and the existing streetscape.

6.1.5 This utilisation of spaces associated with the Scheme relate to paragraph 5.33 of the NNNPS which states: *"Development proposals potentially provide many opportunities for building in beneficial biodiversity…as part of good design"* it goes on to explain that applicants should *"maximise such opportunities in and around developments."*

6.1.6 The implementation of the Scheme to relieve congestion town-wide may present opportunities to improve the town centre and public realm where traffic volumes are reduced.

6.1.7 Whilst the reference design is considered to be at a preliminary design stage to demonstrate the feasibility, and understand the impacts, of the Scheme the level of detail presented in the DCO application demonstrates the following:

- The reference design is consistent with the Vision for the Scheme
- That the Scheme is technically feasible, appropriate, and of good quality
- The likely significant environmental effects of the Scheme (captured in the ES)
- That the design retains sufficient flexibility for innovation as the design develops
- The Scheme design is of a high quality that integrates appropriately in the surrounding context and any future development adjacent to it

6.1.8 Refer to Table 6 in Section 8.7 of this report, which summarises how the Scheme considerations and constraints have been addressed in the reference design.

6.2 Parameters for design

6.2.1 The environmental impact assessment for the Scheme has proceeded on the basis of the 'Rochdale Envelope' principle in order to secure the necessary flexibility for the

development of the detail design. The parameters of the Scheme are set by reference to the limits of deviation, the works plans and Schedule 1 to the draft DCO The 'Rochdale Envelope' approach to environmental impact assessment is detailed in the ES.

6.2.2 The reference design is illustrative of a solution that achieves the Vision within the parameters set by the Rochdale Envelope and the limits of deviation. The detailed design will be developed within these parameters.

6.2.3 Consequently there are components of the Scheme for which the design is relatively fixed, or defined by the LoD in the DCO. For other elements, such as finishes and details, there is greater scope for refinement during the detailed design.

6.2.4 There will also be components of the Scheme for which the design are fixed in principle, or may developed within a set of design parameters defined by the Design Guidance Manual ("DGM"). The requirements to the draft DCO secure a detailed design that must be in general accordance with the DGM.

6.2.5 To ensure that the design quality is maintained through the detailed design, the Vision for the Scheme will continue to be followed through the guidance contained in the DGM. A draft of the Design Guidance Manual can is included in the application (document reference 7.6). The Design Guidance Manual is being developed by the Applicant in consultation with Waveney District Council and Suffolk County Council. The Applicant's intention is to continue to develop the Design Guidance Manual to reflect those discussions such that a final version will be submitted prior to the close of the Examination.

6.3 Physical constraints and considerations

6.3.1 This section of the Design Report sets out the key physical constraints and other considerations that have been considered in the development of the reference design for the Scheme. Table 8 in section 8 of this Report summarises how the reference design for the Scheme has responded to these constrains.

Topography

6.3.2 The Scheme must tie into the existing conditions and levels surrounding it. The levels at Peto Way and Rotterdam Road at the northern approach, and Waveney Drive at the southern approach must be linked successfully and considerate of the existing drainage strategy on site.

Port and leisure vessel activity

6.3.3 The Scheme crosses an operational port, requiring compliance with the needs of the commercial and leisure vessels navigating through Lake Lothing. The construction methods also need to consider minimising disruptions to port operations and maintain access to Lake Lothing as far as is practicable.

6.3.4 The alignment of the Scheme lies west of the turning circle used by vessels and must allow this movement to continue.

6.3.5 To minimise the number of bridge openings, the air-draught (space between the underside of the bridge and the highest astronomical tide ("HAT")) should be as high as is consistent with engineering requirements for the Scheme. Allowing for appropriate connection points on the northern and southern sides of Lake Lothing to the existing highway network, this should be at a gradient of generally 5%, maximum 6% to cater for NMUs. This produces an available air-draught of 12m for the reference design.

6.3.6 For vessels larger than the proposed air-draught in height will require the opening span of the bridge to raise in order to make their passage through.

6.3.7 The Scheme maintains a navigable width of 32m present on Lake Lothing, which provides a generous space for vessels comparable with the channel provided elsewhere on the lake. This width exceeds that of the existing A47 Bascule Bridge, which provides less than 23m.

6.3.8 There is a need to minimise the structural components located on the operational port to ensure as little impact on affected parties and berthing space as is practicable. This includes the need to understand the headroom required to move and store items under, and around the crossing.

6.3.9 The reference design considers the dredging regime present in Lake Lothing and how the Scheme affects this through the location of structural members (such as piers, fenders, dolphins, and pontoons) in the lake.

6.3.10 Leisure craft must be considered in their use of the crossing to ensure this is safe and efficient, particularly small craft who may have technical difficulty whilst awaiting the opening of the crossing.

6.3.11 Lighting proposals must be considerate of the vessel users, to minimise glare or reflection on the water, which could interfere with navigation.

Railway: the East Suffolk Line

6.3.12 The Scheme must be future-proof, in the event that the East Suffolk Line were electrified, DMRB compliance may require 'very high containment' parapets on the bridge deck over the railway and approaches.

6.3.13 The parapet heights required on the crossing, and over the East Suffolk Line (being a railway line) are defined by TD 19/06 'Requirement for Road Restraint Systems' in the DMRB. As there is potential for the lines to be electrified in future consideration should be given to the guidance which states that a 1.8m high 'very high vehicle containment' barrier is required over this section of the crossing. Were the lines not likely to be electrified, the height required beside a footway/cycleway would be 1.5m over the railway line.

6.3.14 The East Suffolk Line running parallel with Lake Lothing require a minimum of 4.9m headroom clearance beneath the structure of the Scheme. This headroom will facilitate the potential electrification of the lines in the future. There is also a need to minimise the presence of structural components in this area..

6.3.15 The East Suffolk Line operated by Network Rail, must maintain uninterrupted train services during the construction of the Scheme. This may require a special method of

construction over the railway to maintain operations, see 7.4.34-7.4.35 which shows how this could be achieved.

Accessibility

6.3.16 There is a need to consider the safety of all users of the Scheme on land and in water, particularly their access and egress from the crossing.

6.3.17 To ensure the new crossing is safe and comfortable for all users, a gradient of no steeper than 5% or 1:20 (6% maximum) should be achieved in the reference design, in accordance with 'Design Criteria for footbridges' BD 29/17 in the DMRB. This requires enough land to accommodate the crossing from its connections with the existing road network at a comfortable slope, to the highest point of the bridge deck.

6.3.18 The Scheme requires the relocation of bus stops on the northern approach to ensure they can safely be positioned with the Scheme's connection to the existing highway alignment.

Access and maintenance requirements

6.3.19 Appropriate and durable materials must be included in the design to minimise long term liabilities in the context of the marine environment.

6.3.20 To ensure the bridge can be maintained and inspected periodically, access is needed to all areas of the structure and mechanism. In some places this may require vehicular access and parking, and the use of heavy machinery.

Connections to existing road network

6.3.21 To connect to the surrounding highway network, the Scheme requires a well-considered vertical and horizontal geometry of the highway alignment to provide comfortable routes. Continuity in the connections between the Scheme and the existing conditions are required for vehicles, cyclists, and pedestrians to navigate the new infrastructure successfully.

Ground conditions

6.3.22 Ground investigations ("GIs") have been undertaken to understand and appropriately design the foundations required beneath ground level and in the lake bed. These investigations also reveal the condition of the existing quay walls, and their suitability to new development and structural loads.

6.3.23 To ensure no structural interference with the existing quay walls, structures such as piers should be located at a suitable distance away. Further ground investigations may be required during detailed design.

Service tunnel

6.3.24 A pre-cast concrete service tunnel orientated north to south is located under the Lake Lothing close to the Scheme alignment. There is a necessity to ensure construction of the Scheme and associated protective fenders are located no closer than 4m from the UK Power Networks owned tunnel.

Private and business accesses

6.3.25 The location of the crossing on what is currently Riverside Road, means that some businesses and buildings which would usually use this road, will require a new access.

Utilities and underground assets

6.3.26 The presence of underground power, gas, phone/internet and other assets or services must be considered and relocated where necessary.

Order Limits

6.3.27 The extent of the Scheme or 'Order Limits' were updated throughout the development of the reference design, to incorporate any land required to construct, operate, or maintain the Scheme. This includes land required permanently, land required temporarily during construction, and land requiring rights to be obtained. The Scheme design is therefore constrained to the area within the Order Limits (see Figure 16).

Figure 16: Order Limits of the Scheme

6.4 Environmental constraints and considerations

Habitat areas

6.4.1 Ecological studies undertaken as part of the ES (document reference 6.1) reveal the species present on, and around the site of the Scheme which will require consideration of their habitats, nesting, and corridors for movement during construction and as part of the design itself.

6.4.2 In particular, a site on the southern side of the lake which is a UK Biodiversity Action Plan habitat and is of importance to invertebrates. The design must consider the proximity to this ecologically valuable area.

Contamination

6.4.3 Careful consideration must be given to the construction methods proposed for the Scheme to ensure any contaminated material discovered in the ground and locally in the lake bed are handled appropriately.

Flood risk

6.4.4 The Scheme must consider the issue of flood risk and appropriately deal with surface water management.

Visual impact

6.4.5 The Scheme must consider its appropriateness to its setting and potential effects on the perception of local townscape character; and visual amenity experienced by the people in the surrounding area.

6.4.6 The likely significant environmental effects of the Scheme are assessed in the ES.

6.5 Affected party considerations

Land ownership

6.5.1 As shown within the Order Limits, land will need to be possessed temporarily and permanently acquired to facilitate the construction and operation of the Scheme. The land requirements for the Scheme should be carefully considered to ensure that no more land than is reasonably necessary for the Scheme is required.

Affected parties

6.5.2 The crossing passes over the East Suffolk Line and the operational port operated by Network Rail and Associated British Ports respectively. This requires consideration of the operational needs of these affected parties.

6.5.3 The Scheme should seek to ensure that businesses and properties in the vicinity of the Scheme can still access their property.

Land designation

6.5.4 The land surrounding the southern approach of the Scheme is designated for employment use in the local development plan. The reference design should be considerate of this designation and not preclude aspirations to redevelop the SSP3 allocation and consider emerging policy for development.

6.6 Public acceptability

6.6.1 The Scheme should be appropriate to its context and make a positive contribution to Lowestoft, offering an attractive link and place for residents and visitors to utilise.

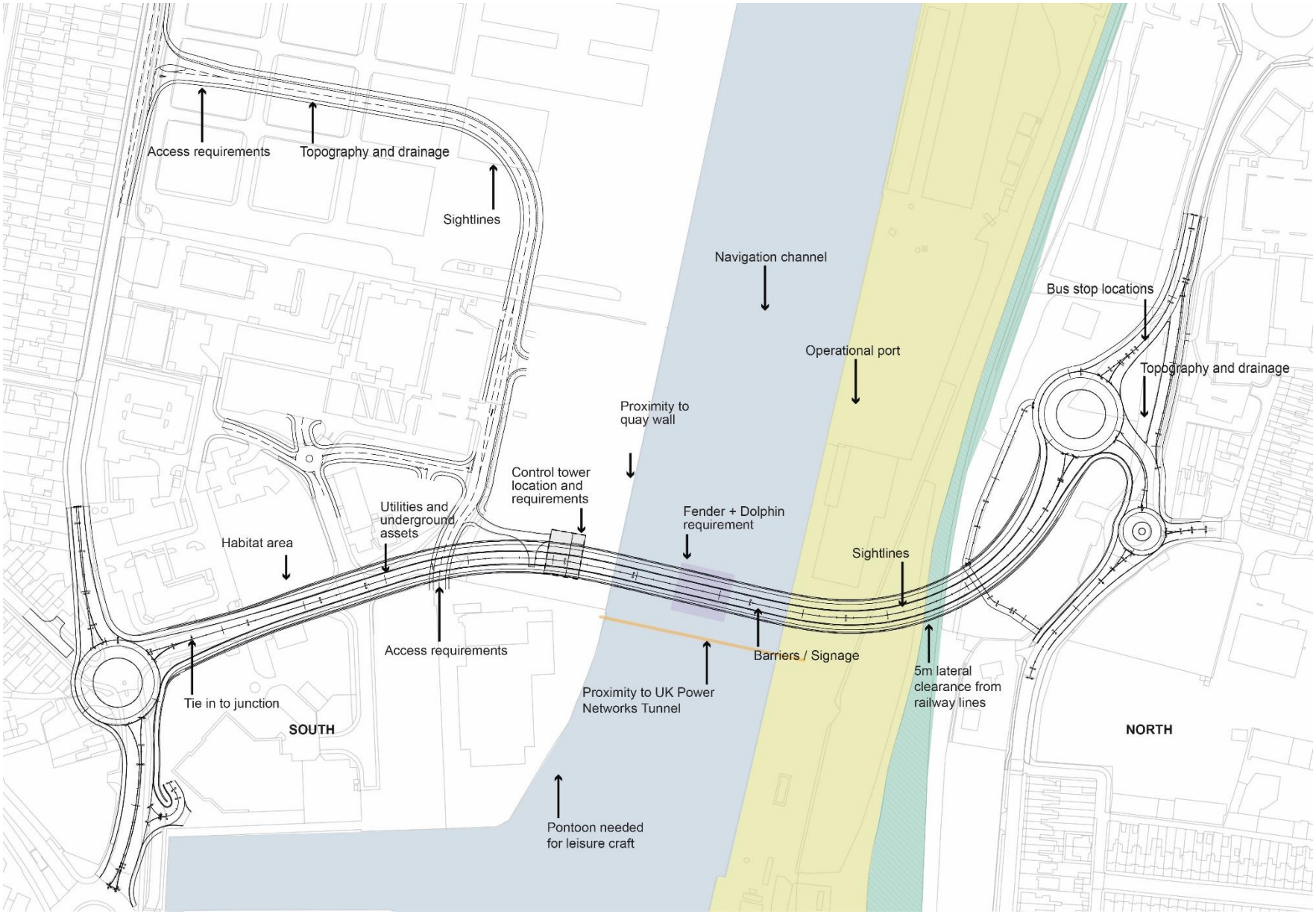
6.6.2 The Scheme should be reliable and efficient in its opening sequence to minimise traffic delays and inconvenience.

6.7 Financial constraints and considerations

6.7.1 The bridge cost is estimated at £91.7m, with the Department for Transport committing £73.39m. The balance must be met by the Applicant, as such cost control is important.

6.7.2 The Scheme is constrained by the available funding for this project, this requires an innovative and well considered solution. Funding for the Scheme is discussed in more detail in the Funding Statement (application document reference 4.2).

6.7.3 A number of constraints and considerations for the Scheme design have been illustrated in Figure 17.


Access requirements
Topography and drainage
Sightlines
Navigation channel
Bus stop locations
Operational port
Topography and drainage
Proximity to quay wall
Control tower location and requirements
Utilities and underground assets
Fender + Dolphin requirement
Habitat area
Sightlines
Access requirements
Barriers / Signage
Tie in to junction
Proximity to UK Power Networks Tunnel
5m lateral clearance from railway lines
SOUTH
NORTH
Pontoon needed for leisure craft

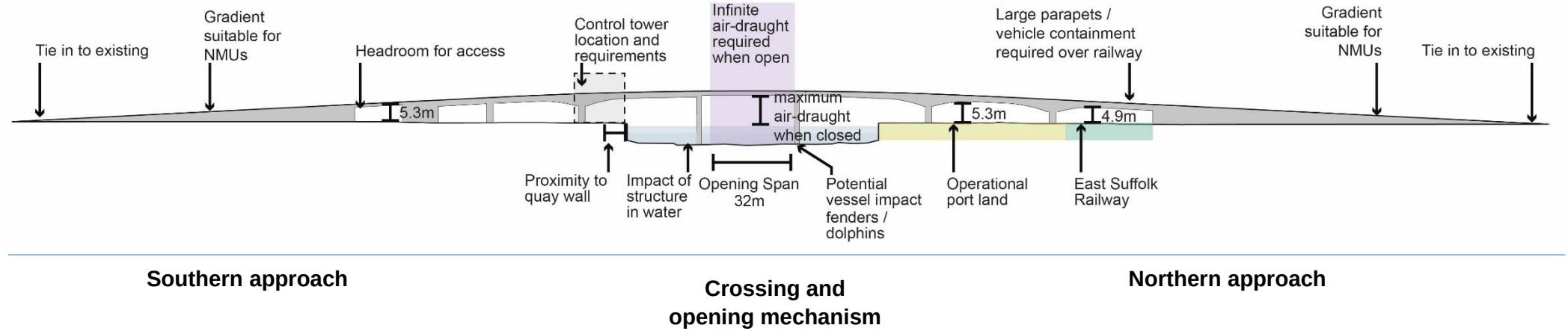


Figure 17: Diagram showing numerous constraints and considerations for the Scheme in plan and elevation

7 Scheme proposals: reference design evolution

7.1 Introduction

7.1.1 This section of the report looks to describe the main components of the reference design for the Scheme in further detail, including the alternatives explored.

7.1.2 Through separating the design into the various disciplines within the Applicant's project design team, it is possible to describe the iterative and collaborative process that has been undertaken to reach the current solution.

7.2 Exploring alternatives

7.2.1 The NNNPS requires an assessment of alternatives in the design of the Scheme, and explanation made to the decisions made on the design. Paragraph 4.35 explains: *"Applicants should be able to demonstrate in their application documents how the design process was conducted and how the proposed design evolved. Where a number of different designs were considered, applicants should set out the reasons why the favoured choice has been selected."*

7.2.2 The CftS (document reference 7.1) and the ES (document reference 6.1) describe the options appraisal undertaken to inform the central location of the Scheme and is therefore not explained in detail here. It also describes how previous consultation and engagement enabled a preferred Scheme location to emerge.

7.2.3 The reference design for the Scheme is described in Section 1.1 of this report, but in summary comprises:

- A single lane carriageway all-purpose road carried by approach viaducts
- New carriageway connecting to the road network by a new roundabout at both the north and south extents
- Seven span structure supported by piers and abutments, including one opening span
- A 35m opening span of the bridge, operated with a 'rolling bascule' mechanism from a nearby control tower building
- Public realm, planted areas and trees
- A new Access Road for the Riverside Road businesses and buildings

7.2.4 Where alternative solutions were considered in the development of the reference design, these are shown in a box format such as this for clarity:

Example / design component

- Alternative solution considered

Explanation of design decision made or reasons alternatives discounted.

7.2.5 The Consultation Report contains an analysis undertaken on responses received during the statutory consultation. Some responses contain queries or questions about the design and alternatives that could have been considered. This section of the DR includes explanation of a selection of design related questions raised during the statutory consultation together with the Applicant's responses to them, in the following format:

Design related question

Explanation to respond to the question, and/or justify design decisions made on the reference design for the Scheme.

7.3 Scheme-wide design

7.3.1 This section of the report describes parts of the reference design that apply to the whole Scheme.

7.3.2 The location of the Scheme was investigated and consulted on as part of the OBC, this is documented in the CftS (document reference 7.1) and the ES (document reference 6.1).

7.3.3 The central location of the Scheme documented in the OBC has since moved approximately 10m west due to the proximity to a Service Tunnel located in the lake bed.

7.3.4 Components of the reference design must be read as an indicative solution that aligns with the Vision of the Scheme, but will be refined through detailed design in accordance with the Design Guidance Manual.

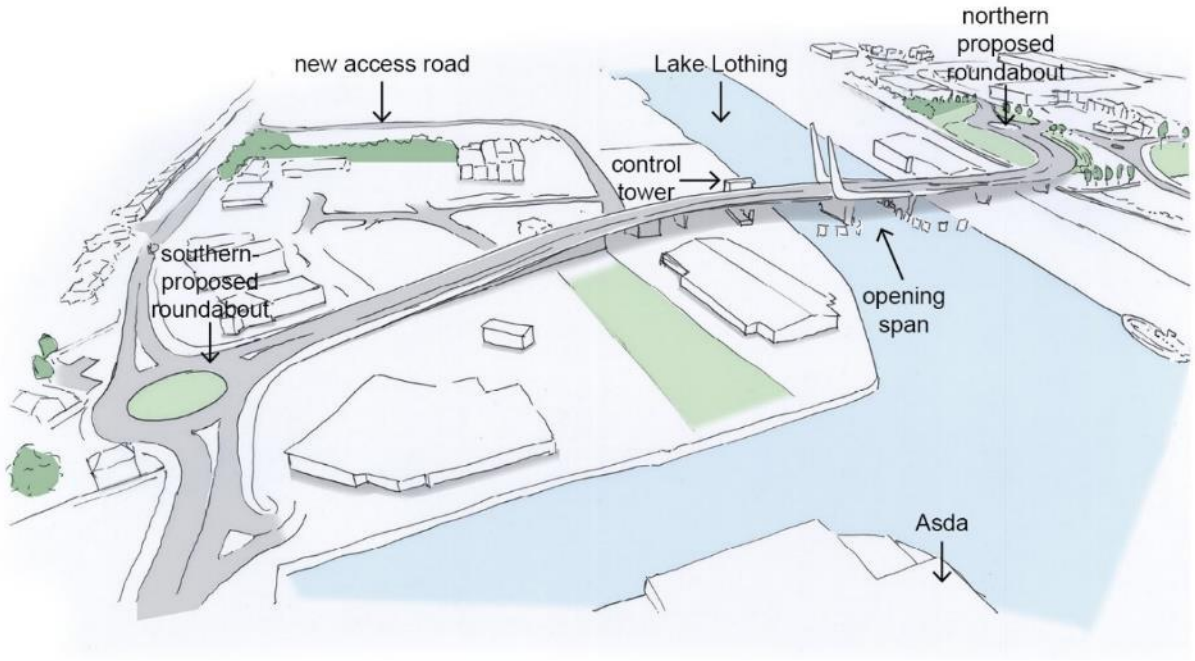


Figure 18: Sketch view of reference design for the scheme

Design-led approach to the Scheme

7.3.5 As discussed in Section 2 of this report, the ambition for the Scheme is for it to be infrastructure with 'good design' offering more to Lowestoft than its function alone.

7.3.6 A design-led approach ensures that a good quality solution for the Scheme is derived whilst performing its primary functions efficiently. This is in line with Paragraph 4.33 of the NNNPS requirement that *"the applicant should take into account, as far as possible, both functionality and aesthetics."*

7.3.7 A successful design is achieved here through the use of a design-led approach, and evaluation of the Scheme design against the Vision defined from the outset.

7.3.8 The 'marine tech' narrative was established with the LPAs (as explained in Section 2.4 of this report) as an influence on the forms and finishes of the reference design. This overarching theme provides an approach to ensuring all engineered components read as one consistent design.

Design narrative alternatives; a few examples:

Through consideration of Lowestoft as a place, its associations and heritage, it was possible to derive sources of inspiration for the design.

These narratives were then used to inform conceptual sketches of components of the Scheme which were shared with the LPAs for discussion to enable a consensus to be reached on the approach. The alternative narratives considered can be broadly grouped into the following themes:

- Organic forms; inspired by marine life and natural aquatic forms that could 'soften' the infrastructure. The 'S' shaped alignment of the highway alignment is comparable to a whale-like segmented skeletal form.
- Port related; inspiration can be drawn from the bold and functional forms found on in the harbour, including the cranes, containers, and vessels which use Lake Lothing.
- Heritage; drawing on the local heritage, past uses of the port and forms that would have frequented Lake Lothing and were iconic for the area, such as fishing, the Lowestoft Scores, wherries and pillboxes.

Through consideration of a number of alternative narratives for the Scheme design, the symbolism of 'marine tech' reflecting the 'future of Lowestoft' and its renewable energy sector is favoured as a positive focus for the town. This narrative also facilitates simple, yet elegant forms to be considered, which is appropriate for the Scheme in its surrounding context.

7.3.9 Paragraph 4.29 of the NNNPS states *"Visual appearance should be a key factor in considering the design of new infrastructure, as well as functionality, fitness for purpose, sustainability and cost."* The following sections of this report explain how this approach has been applied to the reference design. The forms derived for components of the design are informed by their function and the design narrative. For this reason, all components of the design aim to be as minimalistic as possible removing any

unecessary material where structurally possible. This approach also offers a sustainable approach to ensure materials are not used in excess.

7.3.10 The DGM secures the Vision for the design of the Scheme and define criteria that must be met during detailed design.

Land uses and destinations

7.3.11 The Scheme provides a link between various land uses and social attractors including the industrial port area, Lowestoft North Quay Retail Park, residential areas, and a play park. As part of analysis of the site and surrounding context, consideration was made to the role the Scheme plays in linking these areas.

7.3.12 The Scheme offers an opportunity to connect to the sites of future development and enhance the offering of the town.

7.3.13 The southern quay, west of the Scheme is of particular importance in the consideration of adaptable spaces and treatment used in the reference design which can accommodate any future development that may come forward. This includes the aspirations for employment and residential uses, and new routes proposed in the AAP.

7.3.14 An overview of the existing and potential land uses has been prepared as part of the design development and engagement with the LPAs to establish aspirations beyond the strategic objectives (see Figure 19). The Scheme takes into account existing and emerging local policy proposals for the area.

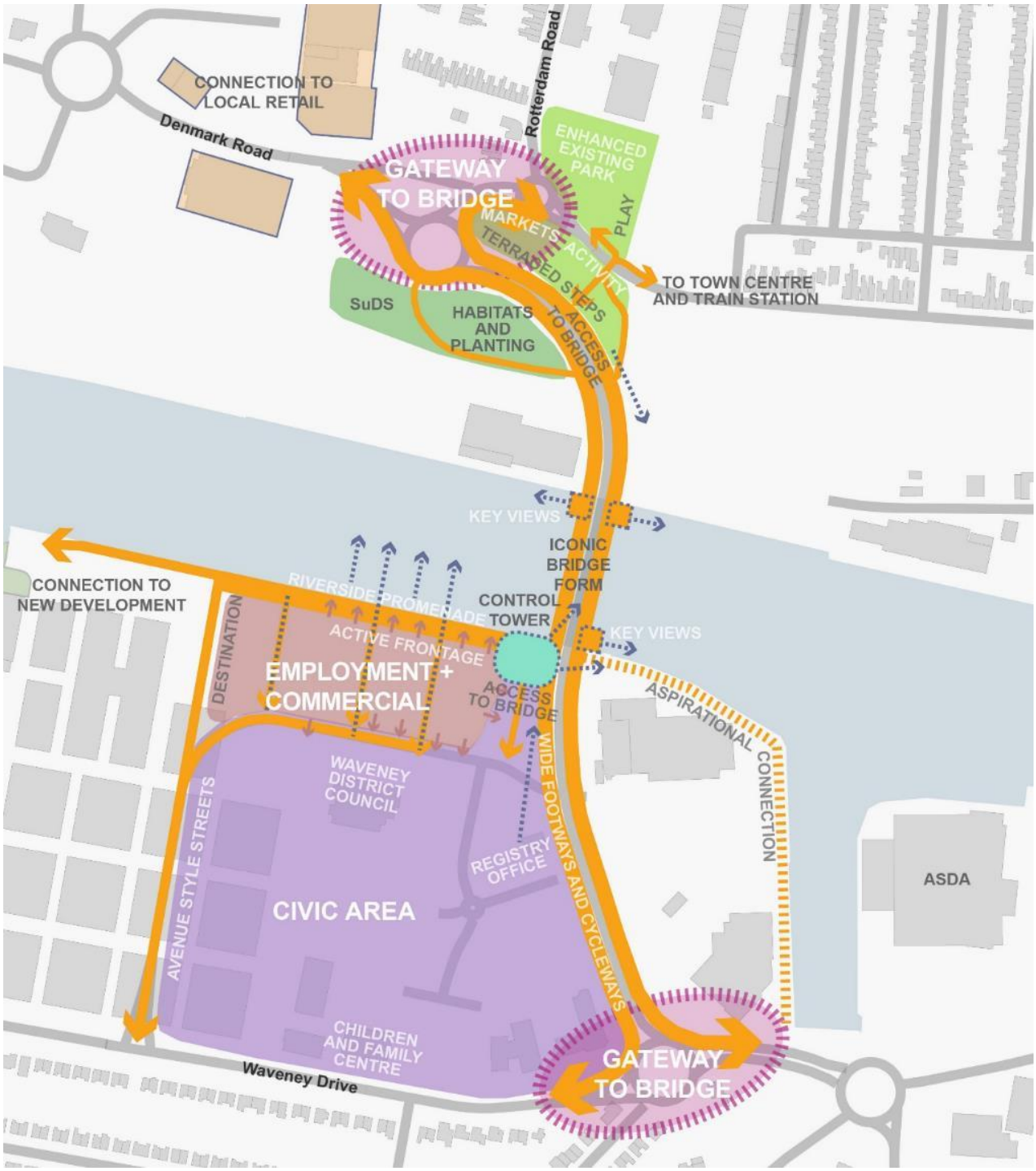


Figure 19: Overview of the existing and potential future land uses connecting to the Scheme

Sustainability through design

7.3.15 Sustainability is a multifaceted topic which threads through many aspects of the Scheme, in its design, construction, operation, and wider impacts on the community and surrounding context.

7.3.16 The consideration of sustainability is integral in the objectives and design principles set out for the scheme, particularly through the use of good design and the facilitation of sustainable modes of transport.

7.3.17 The relevant policies concerning sustainability are referred to in the CftS.

7.3.18 DCC Guidance defines sustainability as one of their ten principles explained in 3.5.15 of this report stating:

"Given the complexity of infrastructure projects, sustainability must be integral to the design from the very beginning.

The site strategy should include biodiversity, planting and sustainable urban drainage systems.

Ideally, building materials should be locally sourced, reclaimed, recycled or have very low carbon impact. Most infrastructure has a long lifespan and should therefore be designed to take account of potential changes to the frequency and severity of extreme weather due to climate change. Aspects of use are likely to change over the structure's lifetime, as will the technologies it contains. A good design will be flexible, able to accommodate changing requirements without major alterations, and adaptable, able to be altered or extended conveniently when necessary."

7.3.19 The Scheme seeks to minimise its impact on the surrounding environment as far as is practicable, and assessments which consider potential impacts and mitigation are documented in the ES.

7.3.20 Sustainability has been considered during the Scheme decision making process and in the development of the design;

- During development of the reference design, the opportunity has been taken to refine key elements to reduce any unnecessary material or volume in the structural components of the Scheme. This correlates with the design narrative which derives forms through their functional and structural requirements (see Figure 20).

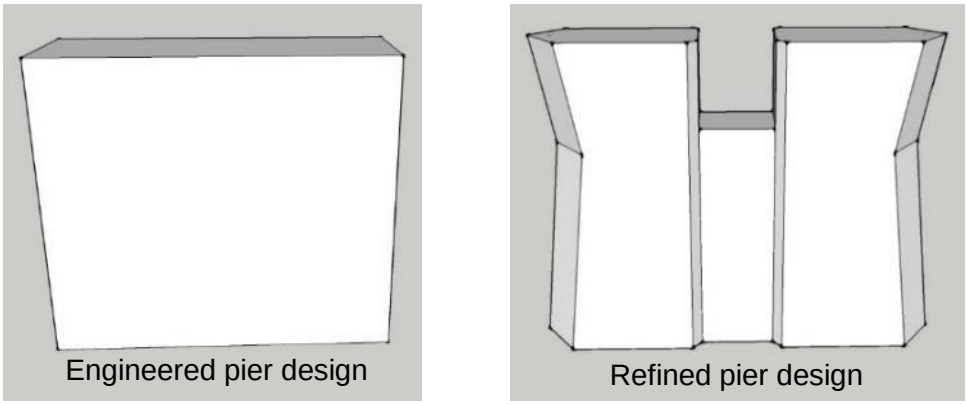


Figure 20: Example of how the design narrative can reduce the volume of material used

- The inclusion of SuDS, where practicable, to be developed through detailed design using relevant policy and design guidance provided. The AAP provides a comprehensive list of SuDS typologies which may be applicable to the Scheme.
- Water treatment measures to ensure that surface water run-off is managed appropriately.
- Ensuring resilience to flooding through considered design of both the structures required in Lake Lothing itself and those on the land side.
- The lighting strategy for the reference design features innovative LED technology which can be programmed to dim to conserve energy after midnight. The operation of this will be developed further through detailed design. This lighting is also designed to allow for wear and tear ensuring that even if some LEDs were to fail, the lighting levels remain appropriate. This will ensure longevity and reduce the frequency of maintenance and repairs.
- The Scheme provides safe and convenient pedestrian and cycle facilities connecting to the surrounding networks. This enables sustainable modes of transport to be a viable and more attractive choice for the community and visitors in the town, particularly for short town centre journeys. This has other benefits including the provision of healthier lifestyle choices and the reduction in severance currently caused by Lake Lothing.
- The design makes allowance for adaptability of structures and spaces for future development. The control tower design provides the opportunity to add public stair and lift access to link the bridge deck and southern quayside following the development of the adjacent site. This allows the new structure to maximise its potential and utilise the Scheme for future benefit.
- The northern approach offers an opportunity for bio-diversity enhancement through the use of varied planting, pond systems, and habitat interventions. These respond to the species present on site, and can provide habitat for species which is otherwise lacking in the area.
- Where possible, materials can be reused on site to minimise waste requiring removal. Trees requiring removal may be used where appropriate as seating elements in the public space, or as a border feature to the biodiversity planting. Hibernaculum, where reptiles and insects can seek refuge, may be constructed from simple materials often left over from the construction sites such as felled timber, tree roots and inert rubble.

Highway Design

7.3.21 The highway design for the reference design is produced in accordance with the guidance and standards set out in the DMRB.

7.3.22 During the development of the reference design, it was tested through a Stage 1 Road Safety Audit (“RSA”) to identify where further development was to be considered.

7.3.23 The Stage 1 Road Safety Audit was undertaken in accordance with the DMRB Design Standard HD19, the Scheme constraints and the general layout drawings made available to the audit team prior the date of the inspection. An examination of drawings and a site visit were undertaken to perform the audit, providing recommendations for further development. The RSA1 can be found in Appendix 8.

7.3.24 The number of traffic lanes required for the reference design is informed by TD27 of the DMRB, and have been tested and quantified using a Transport User Benefit Appraisal ("TUBA") model. The single lane carriageway included in the reference design is expected to manage the flow of traffic, with the inclusion of flared junction arms providing localised additional lanes.

Number of traffic lanes considered

- Three and four lanes were considered for the Scheme design
- Flaring of the junction arms with short lengths of additional lanes to provide space for queueing and turning vehicles at the northern and southern roundabouts.

The reference design demonstrates an appropriate and viable solution to handle the forecasted traffic volumes, and minimise unnecessary additional width on the structures and highway alignment.

7.3.25 The Scheme has been designed for a speed limit of 30mph. This is considered appropriate for the nature of this Scheme and in relation to the surrounding network.

7.3.26 Standard materials have been considered for the reference design of the highway, and will developed in detailed design.

7.3.27 The highway design is considered in terms of its 'vertical' and 'horizontal' geometry.

7.3.28 The 'vertical' geometry refers to the curved slopes rising upward from the existing ground level, designed to a standard comfortable gradient of 5% or 1:20 (maximum 6%) in accordance with the DMRB.

7.3.29 For the Scheme, the requirement for an air-draught as high as possible at the opening span of the bridge defines the crest of the highway alignment, from which it slopes down to the existing ground level on the north and south sides of the lake.

7.3.30 The 'horizontal' geometry refers to the straight and curved layout of the road, which can be seen in plan view. Curves are constrained by the turning movements of vehicles relative to their speed to ensure safety.

7.3.31 Cycling facilities have been provided as part of the Scheme, connecting to the existing network, and indicative future routes as shown in the AAP (see Figure 21).

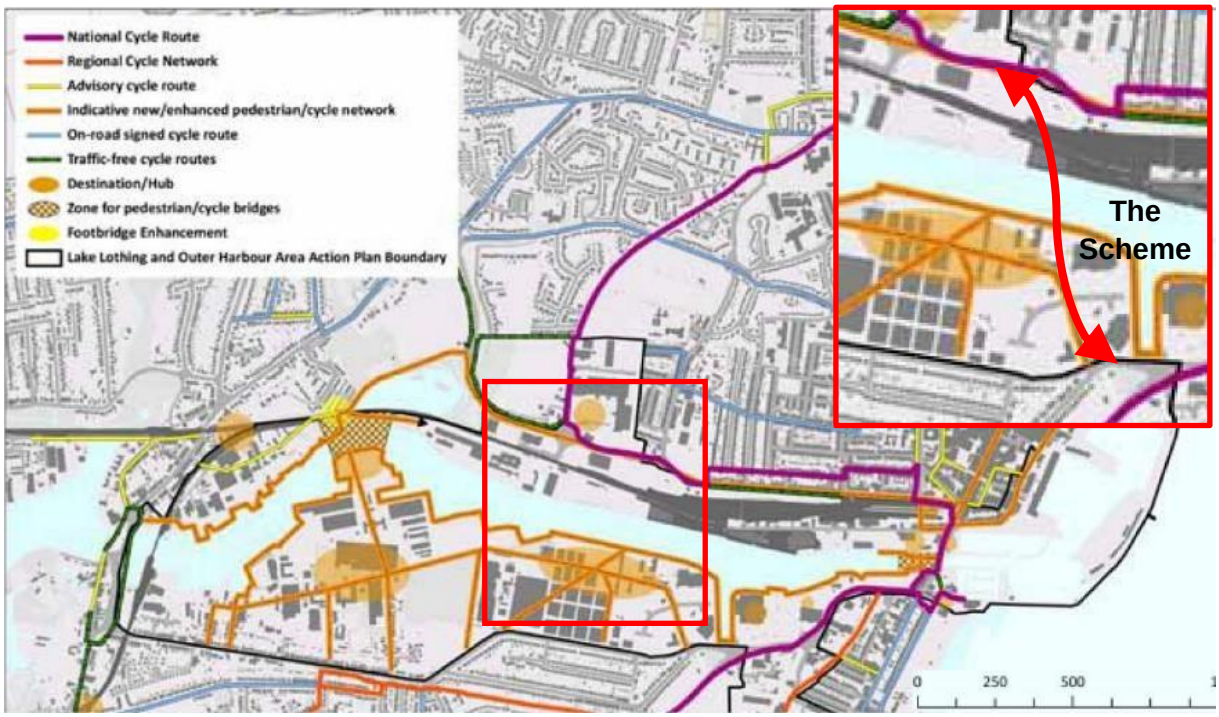


Figure 21: Indicative Future Pedestrian and Cycle Network Improvements – Section 3.5.15 of AAP

7.3.32 The inclusion of cycle facilities connecting to the wider network aligns with the Government's commitments as stated in Paragraph 3.15 of the NNNPS for *"providing people with options to choose sustainable modes and making door-to-door journeys by sustainable means an attractive and convenient option."* It goes on to explain that the Government is investing in "*developing a high-quality cycling and walking environment*."

7.3.33 The reference design features a shared cycle/footway facility on the eastern side of the crossing, and segregated footway/cycle facility on the west (see Figure 22). The exact design of these facilities, their connections to the existing network at the extent of the Scheme, and the type of segregation are to be developed through detailed design.

7.3.34 All NMU provision has been designed in line with the guidance provided by the DMRB for the reference design.

7.3.35 The DGM provides direction on development of the pedestrian and cycle facilities for the Scheme in detailed design.

7.3.36 The reference design takes into account the likelihood of adjacent future development, for which areas of the Scheme, particularly around the control tower, can be adapted following development to provide additional NMU access. See Section 7.6.39.

7.3.37 The Scheme by the nature of the project reduces community severance and improves accessibility by linking the North and South of Lowestoft.

Figure 22: Diagram showing proposed cycle facilities on the reference design

7.3.38 The NNNPS requires new infrastructure to incorporate proportionate security measures and as such security has been considered during the development of the reference design.

7.3.39 A high level assessment of the risk of such an event, set out in the Security Technical Note appended to the CftS, has assessed the probability of attack as being low and therefore it is not considered necessary to include Hostile Vehicle Mitigation ("HVM") features in the reference design at this stage. The design does not currently include any measures to mitigate against criminals or threats from hostile vehicles.

7.3.40 Furthermore, if mitigation measures are put in place, such as physical barriers, this may then present a risk to other road users, particularly motorcyclists and cyclists as this increases the risk of serious injury in the event of a collision. In addition, such features could have a negative impact on the street-scene and create street clutter.

7.3.41 As described in the Security Technical Note in the CftS, engagement with the Centre for the Protection of National Infrastructure ("CPNI") has been undertaken (as recommended in paragraph 4.76 of the NNNPS). This organisation concurs with the outcome of the assessment deeming the risk of a vehicle-borne threat to be low.

7.3.42 Departures or from the DMRB are only exercised where required in situations such as; if it can be justified that a requirement is inappropriate in a particular situation, where the application of standard would have unintended adverse consequences or where an aspect not covered by standards is identified.

7.3.43 The fact that a design includes departures from standards does not mean that the design is unsafe. It is not uncommon for highway schemes designed in the urban environment (in contrast to a 'green field' situation) to include departures from standards due to the constraints of existing features.

7.3.44 There is an opportunity, through the detailed design of the scheme, to reconsider the departures and investigate them in more detail to see if they can be removed within the physical constraints of the project.

7.3.45 Relaxations or departures from the DMRB in the reference design due to specific Scheme requirements are reported in Appendix 1 'Departures from Standards Report'.

Structural Design

7.3.46 The crossing features a multi-span structure, from the proposed roundabout on Peto Way in the north, across Lake Lothing to the proposed roundabout at Waveney Drive on the southern side.

7.3.47 The structure forming the crossing will have a total length of approximately 300m, with a width of up to 20m varying across the bridge deck where required to accommodate the highway alignment in the reference design.

7.3.48 The span lengths between piers and abutments, measured from the centreline of the bridge deck alignment in the reference design, are as follows:

Southern approach			Crossing and opening mechanism	Northern Approach		
Span 1	Span 2	Span 3	Span 4	Span 5	Span 6	Span 7
Abutment 1 to Pier 2	**Pier 2 to Pier 3**	**Pier 3 to Pier 4**	**Pier 4 to Pier 5**	**Pier 5 to Pier 6**	**Pier 6 to Pier 7**	**Pier 7 to Abutment 8**
19.2m	39.9m	52.4m	37.5m	52.9m	50.5m	48.0m

Table 2: Bridge span lengths forming the reference design for the Scheme with the precise measurements to be refined during the detailed design

Alternative spans considered

- No piers in the water/single span over the water:

  The length of the bridge span over water, and the need for an opening section meant that support structures are required to support the loads. Piers cannot be located on the quay walls due to the operational port on the northern side of Lake Lothing, and the poor condition of the structure on the southern side.

- Alternative pier locations:

  The piers are located to maintain access and meet the needs of the adjacent land owners and businesses. The spans are also constrained by their physical construction type: that the longer the span between piers, the weaker the centre of the span may be for absorbing live loads above.

7.3.49 The bridge deck structure in the reference design is predominantly an in situ post tensioned box, supported by reinforced concrete abutments and vertical cantilever piers. The majority of these connections are made using bearings, to accommodate the live loads acting on the bridge except Pier 4 (supporting the rolling bascule) which features an integral connection.

7.3.50 The bridge deck structure types for the reference design and purposes of assessment were considered through an optioneering exercise with two other alternatives. These options were compared in terms of:

- Impact on supporting substructure design
- Maintenance requirements
- Potential for impact on port operations, the railway, and other businesses during construction and operation
- Aesthetics and visual appearance
- Whole-life cost

The bridge deck alternatives included:

- Steel deck

  The steel option allows for the depth of the deck to be reduced, but would require periodic repainting to maintain it, which would increase the whole life cost of the Scheme.

- Precast concrete deck

  The precast option would not be suitable for the span over the railway due to headroom restriction that is required by the East Suffolk Line.

7.3.51 The most appropriate solution for the reference design was for the 'in situ post tensioned balanced cantilever' option. This provided a feasible structural solution for the Scheme which could be assessed for the ES and from which LoD could be derived. However, this does not preclude the use of an alternative bridge deck type being developed through detailed design, should a more appropriate and innovative solution be achieved.

7.3.52 This bridge deck type offers an appropriate structural solution to the constraints and considerations of the Scheme and aligns with the Vision for a sinuous, unified design.

7.3.53 Any bridge deck structure developed for the Scheme in detailed design will feature a unified appearance in line with the Vision and minimise undesirable material changes in appearance across the spans. This design consideration will be included in the DGM.

7.3.54 DCC provided feedback on this design decision, which was outstanding at the time of the first workshop held with them. They advised:

"We encourage the design team to explore using a box girder solution, which would not require a transition from steel to concrete and would allow for a more sculptural, slender form. There may be maintenance issues with steel bascules and we encourage the design team to fully explore these implications or to investigate other options."

7.3.55 The bridge structure is designed to have a working life of 120 years, in accordance with UK National Annex to BS EN 1990:2002. This is typical for a structure of this kind, and explained further in Appendix 2 'Outline Approval in Principle for Approach Viaducts'.

7.3.56 The piers supporting the deck structure in the reference design are single reinforced concrete vertical cantilever and are designed for impact loading. They are orientated perpendicular to the centreline of the carriageway.

7.3.57 Each pier at its connection with the bridge deck features two pot bearings, which is appropriate for this type of pier due to their height and rigidity. The pier design incorporates an efficient pile and foundation design to withstand the loading and forces.

7.3.58 The only exception to this arrangement is the southern in-water pier (Pier 4) which is an integral connection with the bridge deck. The integral connection is required here to withstand the loads of the rolling bascule.

7.3.59 The pier type and connections with the bridge deck included in the reference design allows continuity in appearance across all piers, however other types may be considered during detailed design if appropriate.

7.3.60 The piers have been placed to allow the bridge spans to extend as far as is structurally practicable, to ensure there are no more piers than required to support the structure. Their placement has also been influenced by the land uses around them to minimise impact where possible.

7.3.61 On the southern side of Lake Lothing, the pier location is set back from the quay wall to ensure no interference with the existing structure here which is of a poor condition.

7.3.62 Predominately 'normal containment level' N2/W1 will be used on the crossing, which is 1.4m high. The height is defined by the guidance provided in TD19/06 of the DMRB on height of parapets for cycleways immediately adjacent to the vehicle parapet.

7.3.63 The exception to this application of normal containment, is the section of the crossing situated over the railway. This area features H4a/W3 'very high containment' barriers at 1.8m in height in the reference design. This containment continues 45m either side (north and south) of the railway lines in accordance with TD19/06.

7.3.64 The transition between the 1.4m parapet and the 1.8m parapet with associated approaches, will be considered further in detailed design to refine the visual appearance where possible.

7.3.65 The vehicle containment barrier/parapet is located on the outer-most edges of the crossing and are designed in accordance with the DMRB Part 8 TD19/06 'Requirement for road restraint systems'.

7.3.66 The possibility of a vehicle containment barrier either side of the carriageway edge was explored to enable a lighter and more visually attractive parapet on the outer most edge of the bridge deck.

Alternative location of the vehicle containment barrier/parapet

- At the outer edge of the carriageway, between footway/cycleway and carriageway for the extent of the crossing. This would enable a parapet of 'lighter' appearance on the outer most edge of the bridge deck.

This was not feasible due to the obstruction of visibility from the carriageway that would be caused. This would also incur an additional width on the carriageway, and consequent cost.

- At the outer edge of the carriageway, between footway/cycleway and carriageway for the 'straight' section of the crossing only. This would enable a parapet of a 'lighter' appearance for the highest, most visible section of the crossing from afar.

This was considered a safety hazard due to the end treatments of the containment which could be considered a risk to oncoming traffic. This also creates an inconsistent effect visually which does not align with the Vision for the design to 'read' as one entity. This may be revisited through detailed design.

Geotechnical design

7.3.67 Ground Investigations ("GIs") were undertaken to provide information required to develop the foundation design and depth required for the proposed structures. Data from previous GI work undertaken within the Order Limits has also been reviewed.

7.3.68 The GIs also provide information about the condition of the existing quay walls, which influence the design around these existing structures.

7.3.69 The piers and abutment structures will be supported by reinforced concrete piled foundations. Through the information obtained from the GIs, the design for these foundations can be developed further in detailed design phase.

Alternative foundation types: on land

- Shallow foundations; rafts or footings
- Piled foundations; driven concrete, or driven steel

Consideration has been made to noise and vibration associated with the construction of each foundation type. The loads on the foundations are high, requiring a type that can withstand this. The presence of compressible soils, could result in settlement.

Large excavations would have been required for shallow foundations.

There is a potential for cross contamination of soils when using driven piles, which may impact the aquifer.

These potential environmental effects are assessed in the ES.

Alternative foundation types: in water

- Shallow foundations; caissons
- Piled foundations with pile cap at lake bed level; driven concrete, or driven steel
- Elevated pile caps; driven concrete, bored concrete, or driven steel

Consideration has been made to noise and vibration associated with the construction of each foundation type. The loads on the foundations are very high, requiring a type that can withstand this.

There is a potential for cross contamination of soils when using driven piles, which may impact the aquifer.

Consideration of the Service Tunnel lying east of the Scheme in the lake bed, must ensure clearance of the tunnel.

Concrete considered to have a higher durability in comparison with the steel piles.

These potential environmental effects are assessed in the ES.

7.3.70 All foundation designs are in accordance with relevant British Standards and Eurocodes.

Landscape and public realm design

7.3.71 Where applicable and appropriate, public realm and planted areas have been included in the reference design for the Scheme.

7.3.72 These areas of the reference design aim to soften the connection between the Scheme and the existing conditions and provide amenity space for people. The alignment of the highway design on the parcels of land adopted for the Scheme present opportunities for inclusion of these valuable elements of design without incurring any additional land take to do so.

7.3.73 As part of the reference design, the Scheme includes tree planting, additional access routes to the bridge for NMUs, and an adaptable public space. Areas are also identified for further development into SuDS and planting for ecological benefit to be maximised through detailed design.

7.3.74 Paragraph 3.3 of the NNNPS informs that where possible, opportunities *"to deliver environmental and social benefits as part of schemes".* It goes on to explain that outside the NSIP regime, Government policy is looking to address existing environmental problems on the SRN including *"reconnecting habitats and ecosystems…and respecting and enhancing landscape character."* Any added benefits such as this that the Scheme can provide through its design will be contributing to wider ambitions on the network.

7.3.75 The reference design therefore aligns with direction provided in Section 3.4 of 'Design in the AAP area' in the AAP: *"Provide well designed areas of soft and hard landscape, with appropriate planting including native species."*

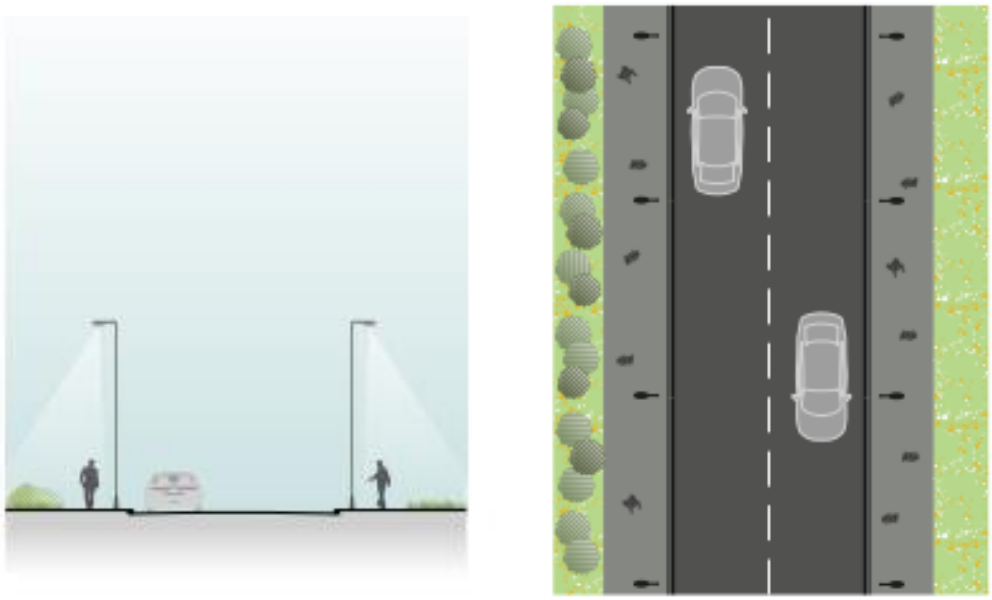


Figure 23: Example of street typology considered in the DGM

7.3.76 As part of the landscape and public realm design, consideration is given to the street typologies that feature in the reference design. This considers the proportion of space allocation between vehicles and NMUs and the perception of the users in these streets.

This will be considered further in the DGM (as shown in Figure 23).

7.3.77 The function, safety requirements, and constraints define the street typology layouts for much of the reference design. The inclusion of verges, tree planting, street furniture will be developed further where possible through detailed design to provide an appealing environment for all users.

7.3.78 As the new Access Road will feature lower volumes of traffic then that of the adjacent roads such as Waveney Drive, and the Scheme, there is an opportunity to consider a more pedestrian and cycle orientated perception for the street typology here.

7.3.79 The experience of NMUs has been considered Scheme-wide to ensure an attractive and comfortable experience will encourage more sustainable modes of travel utilising the crossing.

7.3.80 The NMU facilities provided by the Scheme are in line with the aspirations stipulated in the AAP (2.2.10: Transport, Movement, Linkages) "*Improving existing pedestrian and cycle routes and establishing new links is crucial to making walking and cycling an attractive alternative to the car. The AAP identifies key routes which will be promoted and enhanced over the plan period. Of particular strategic importance, will be to improve connections across Lake Lothing and integrating the study area with the wider urban fabric of Lowestoft.*"

Lighting design

7.3.81 Lighting design has a functional and aesthetic purpose on the Scheme. To ensure sufficient visibility and safety for all users, a lighting strategy has been developed to work with the existing lighting in Lowestoft (see Appendix 9).

7.3.82 The lighting strategy includes highway lighting to ensure adequate visibility for vehicles and pedestrians, architectural and feature lighting which is used on public realm areas and to highlight the structure, and navigational lighting to serve the vessels using Lake Lothing.

7.3.83 There is an opportunity for the lighting to enhance the identity of the Scheme in the skyline of Lowestoft and emphasise features during hours of darkness.

7.3.84 The proposed lighting strategy achieves all the requirements set out by relevant standards. The luminaires considered account for wear and tear, to ensure longevity and reliability of the implemented products.

7.3.85 Lighting columns have been placed in optimised positions in order to limit the number required and ensure uniformity of light (see Figure 24).

7.3.86 Simplistic style, reliable luminaires have been considered for the reference design, because of their aesthetic appearance and uniformity with those used elsewhere in the town. They provide good light distribution, with consideration to minimising the light spill onto the waterway. Additionally back shields can be added to prevent light coming spill from the rear of the luminaire, if required.

7.3.87 Consideration of the port operations and neighbouring properties will be required through detailed design to ensure that the lighting is sensitively positioned.

Figure 24: Example of how lighting design is assessed to ensure appropriate lux levels

Drainage design

7.3.88 The Drainage Strategy for the Scheme (see Appendix 18B of the ES (document reference 6.2)) is prepared in accordance with:

- The principles of SuDS water management solutions
- DMRB – Volume 4, Section 2
- SCC Specification for Estate Roads 2007 – Chapter 7

7.3.89 The following design parameters have been adopted for the reference design;

- Return Period 1 in 100 years and 6 hour storm for sizing of the pipes and storage facilities (63mm/hr);
- 1 in 1 year design period without surcharge; and
- 1 in 5 years without surcharge up to cover level – i.e. no flooding.

7.3.90 The NNNPS explains the advised use of mitigation for flood risk (Paragraph 5.110):

"To satisfactorily manage flood risk and the impact of the natural water cycle on people, property and ecosystems, good design and infrastructure may need to be secured using requirements or planning obligations. This may include the use of sustainable drainage systems but could also include vegetation to help to slow runoff, hold back peak flows and make landscapes more able to absorb the impact of severe weather events."

7.3.91 Drainage arrangements for the new carriageway are likely to consist of combined kerb drainage units and kerb and gulley arrangements (as shown in Figure 25). Conventional gullies may be used at the northern and southern proposed roundabouts. This will be developed further through detailed design.

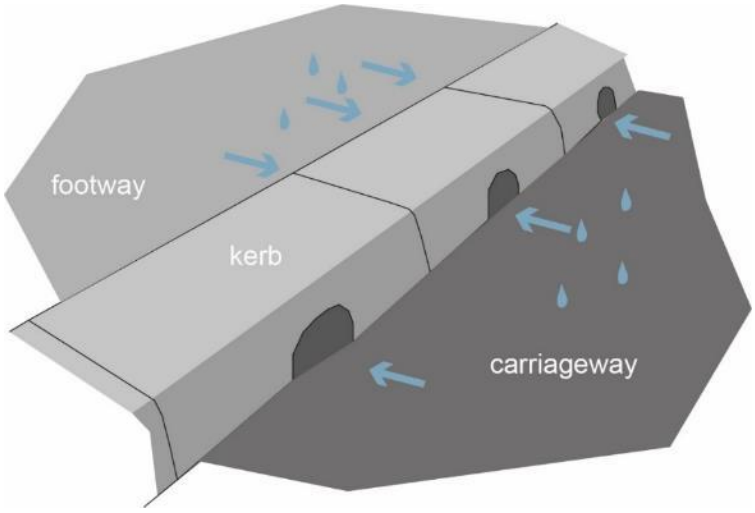


Figure 25: Diagram illustrating a combined kerb drainage system

7.3.92 Where possible, SuDS will be considered and included in the DGM to inform the detailed design of the Scheme.

7.3.93 The guidance provided by the AAP has also been taken into consideration for water management, as described in the Section 3.4 'Designing in the AAP Area' of the AAP: *"Ensure elements of Sustainable Drainage Systems (SuDS) such as swales, and permeable surfaces are well integrated into the design of new development as part of a strategic approach to flood risk management."*

7.3.94 The AAP also contains SuDS typologies for consideration during the development of new infrastructure, which will inform the content of the DGM.

Intelligent Transport Systems

7.3.95 The existing technology for Intelligent Transport Systems ("ITS") used in Lowestoft has been assessed, to determine what may be required to support network operations upon implementation of the Scheme. There are currently eight Variable Message Signs ("VMS") in use at key decision making points in the area intended to display route diversion information in the event of bridge openings or road incidents.

7.3.96 The current technology in operation is considered adequate to meet the needs of the town with the Scheme in place, and therefore no additional VMS is proposed as part of the Scheme. Further information about the assessment of ITS network operations and its relevance to the Scheme are reported in Appendix 10 'Network Operations Strategy'.

The Northern Approach, Crossing and opening mechanism, and Southern Approach

7.3.97 The following explanation of the reference design divides the Scheme into the following three geographical locations (as shown in Figure 26) for the purpose of this report:

- *Northern Approach*

The area of the Scheme situated on the northern side of Lake Lothing, including a proposed roundabout junction which connects the Scheme to Peto Way, Denmark Road, and the existing Rotterdam Road roundabout. Here a rising section of highway crosses over the East Suffolk Line, and ABP operational port land.

- *Crossing and opening mechanism*

The area of the Scheme situated over Lake Lothing, including an opening span to allow vessel movement through the crossing by means of a 'rolling bascule' mechanism.

- *Southern Approach*

The area of the Scheme situated on the southern side of Lake Lothing, including a roundabout junction which connects the Scheme to Waveney Drive. This area also includes a New Access Road for Riverside Road businesses and the closure to vehicular traffic of Durban Road at its junction with Waveney Drive.

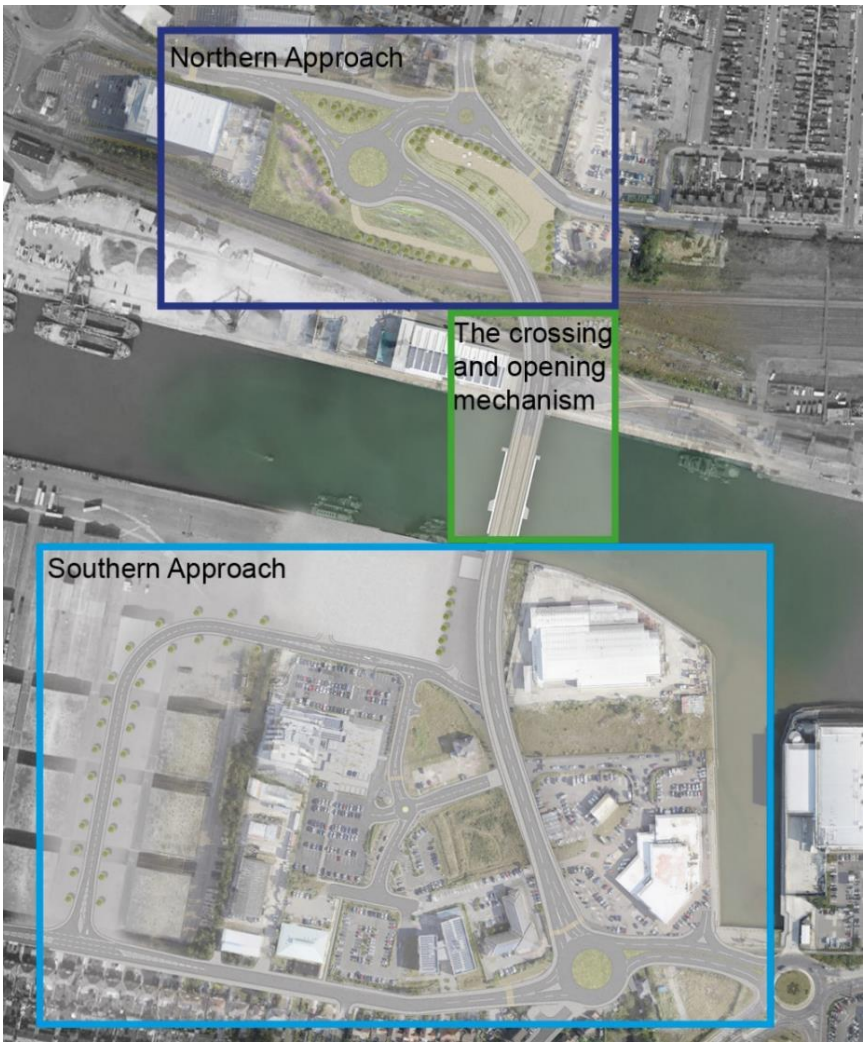


Figure 26: Three areas of the reference design described by the DR

7.4 Northern approach

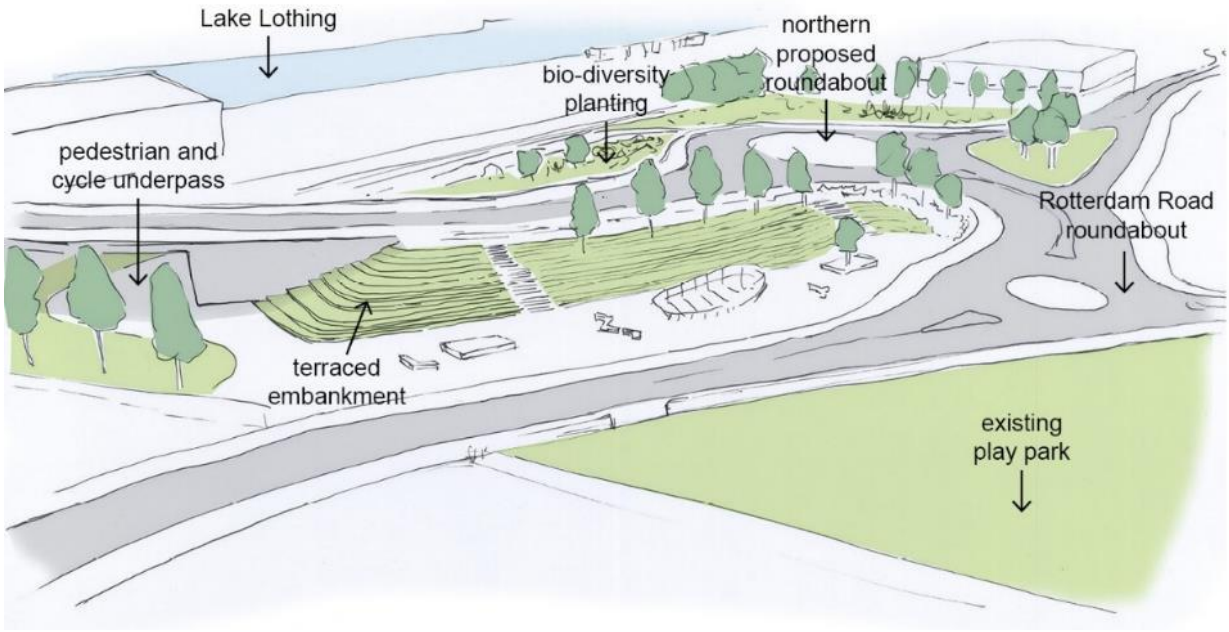


Figure 27: Sketch view of the northern approach area of the reference design

Highway design

7.4.1 The highway design encompasses the extent of the carriageway, footway, cycleway and their connections to the existing networks. In the northern approach area, this includes a new roundabout to connect the crossing to the existing roads, and additional pedestrian crossing facilities.

7.4.2 The geometry of the highway alignment is crucial to ensure all users including, vehicles, pedestrians, and cyclists can safely use the Scheme. The highway design takes into account traffic speeds, traffic volumes, vehicle types, gradients, visibility, and stopping distances of vehicles.

The vertical and horizontal highway alignments of the Scheme have been through a number iterations (as shown in Figure 28) to arrive at the optimum solution for safety, predicted vehicle volumes, and to minimise the land-take required.

Figure 28: Alternative highway alignments explored

7.4.3 The iterations of the highway design included alternative junction arrangements and varying number of lanes connecting them to the existing roads.

7.4.4 A new roundabout is proposed to connect the Scheme with Denmark Road, and ensure a constant flow of traffic can be maintained. Of the junction options tested through traffic modelling, a roundabout was proven the most suitable for providing traffic capacity.

Alternative junction types

- Signalised junction

  Discounted due to the additional land take that would be required to accommodate it. Consultation feedback also proved the negative perception of traffic signals currently implemented in Lowestoft and the additional delay they are believed to cause.

- Ghost island junction

  Only shown to work in traffic modelling with limited traffic flows during peak hours

7.4.5 Traffic modelling undertaken by the Applicant has demonstrated that the alternative junction options considered in this area would not alleviate congestion sufficiently.

7.4.6 The proposed roundabout at the northern approach in the reference design has a diameter designed to comply with the DMRB standards and accommodate turning movements, particularly of large vehicles that would be using the Scheme.

7.4.7 Additional lanes feature at each arm of the roundabout to enable traffic to maintain a consistent flow, whether they are entering the crossing or passing through east to west. During an opening sequence of the bridge, traffic can queue in the appropriate lane and enable some lanes to continue movement.

7.4.8 The existing carriageway alignment of Peto Way connecting to the Rotterdam Road roundabout is utilised to provide a bypass of the proposed roundabout for traffic moving eastbound from Peto Way to Denmark Road and Rotterdam Road.

7.4.9 Whilst the highway alignment is at a gradient from end to end, there is a curvature or camber across the highway to facilitate the drainage of surface water off the surface of the crossing.

7.4.10 To ensure unobstructed visibility for vehicles on the bridge, particularly on the curved sections (see Figure 29), modelling showed that no street furniture or features higher than approximately 300mm can be positioned near the carriageway.

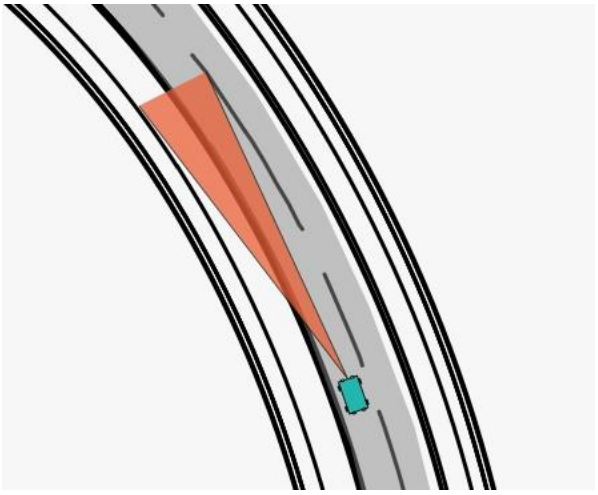


Figure 29: Diagram demonstrating visibility splay of a vehicle on the bridge

7.4.11 The width of the highway increases slightly where the crossing curves west and descends to the Peto Way proposed roundabout. This enables two Heavy Goods Vehicles ("HGVs") to pass simultaneously, and also accommodates the visibility splays for vehicles. The carriageway lanes are generally 3.65m wide, widening to 3.95m where required in the reference design. Precise carriageway widths will be determined during detailed design.

7.4.12 Footways of an appropriate width are maintained on all arms and approaches to the crossing, including the addition of a footway which is not currently present on the southern side of Peto Way beside Wickes.

7.4.13 The existing bus stops on Peto Way are relocated west of their current location to ensure a safe distance from the proposed roundabout junction. The precise locations will be determined during detailed design. The additional pedestrian crossing in this location meets an evident desire line, particularly for bus users, that is not currently served.

7.4.14 Proposed crossing points in the northern approach area are located:

- At the southern end of Rotterdam Road
- Near the existing play park entrance on Denmark Road
- Outside Wickes on Peto Way, near the relocated bus stop

7.4.15 Crossings are located to meet desire lines of pedestrians and cyclists, whilst allowing a safe distance from the junction to enable traffic suitable visibility and sufficient space to stop when required.

7.4.16 The type of crossing to be used in this location will be developed through detailed design, through further analysis and with guidance provided through the DGM.

7.4.17 Consultation feedback demonstrated a strong view on the frequency of traffic signals currently used in Lowestoft, and a preference for an alternative as part of this Scheme.

7.4.18 Cycle infrastructure is introduced as the bridge is approached, with the proposed crossing points acting as a gateway or transition to the shared or segregated cycle

facilities featured in the reference design.

7.4.19 The eastern side of the crossing features a shared footway and cycleway facility, considered favourable for less confident or slower speed cyclists.

7.4.20 The western side of the bridge features a segregated cycleway, a delineated two way lane to separate cyclists and pedestrians. Consultation feedback showed this type of cycle lane is preferred by some to the shared option. The reference design accommodates cyclists of all ages and confidence levels, to provide a choice on the type of facility they prefer to use.

7.4.21 Cycle segregation has not been developed as part of the reference design, and will be considered in detailed design through further analysis, and using the DGM.

7.4.22 Through engagement with local cycle groups on the emerging proposals for the reference design, and specifically for the cycle infrastructure, experiences and preferences of cyclists were considered during the design development.

7.4.23 Through engagement with local cycle users no clear consensus emerged expressing a preference either for segregated cycle facilities or for shared cycle facilities (where both pedestrians and cyclists share the same facility). Generally, segregated cycle facilities were considered favoured by more confident cyclists and inclusive shared cycle facilities were favoured by less confident cyclists.

7.4.24 Inclusive design for cyclists of all age groups and confidence levels, with connections to the wider cycle network where possible is important for the Scheme, and will be considered in the DGM.

7.4.25 The use of a footway and wide segregated cycleway on the western side of the crossing in the reference design also improves the visibility for northbound traffic descending towards the proposed roundabout. There is an opportunity for this arrangement to be reviewed through detailed design as the highway design is refined.

Structural Design

7.4.26 The structural design at the northern approach area includes the bridge deck on which the highway rises above existing ground level, and the connecting support structure beneath. It also encompasses the vehicle restraint system/parapet structures required.

7.4.27 In the reference design, the bridge deck structure in this location is supported by an abutment and two subsequent piers (Piers 6 and 7).

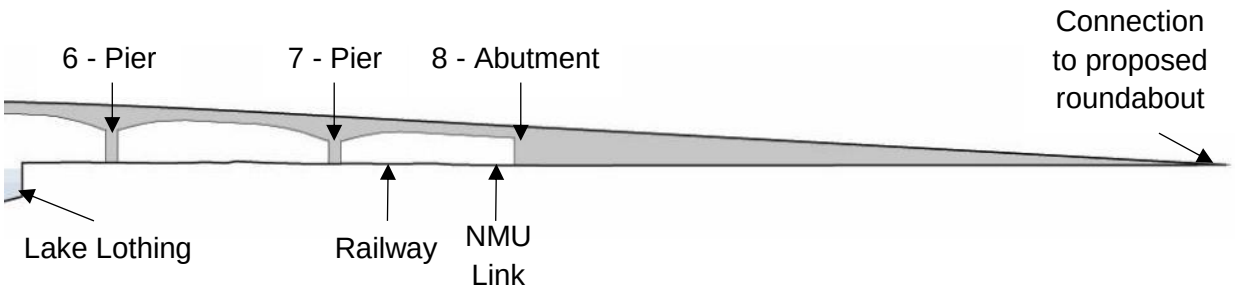


Figure 30: Elevation view of the proposed structures at the northern approach

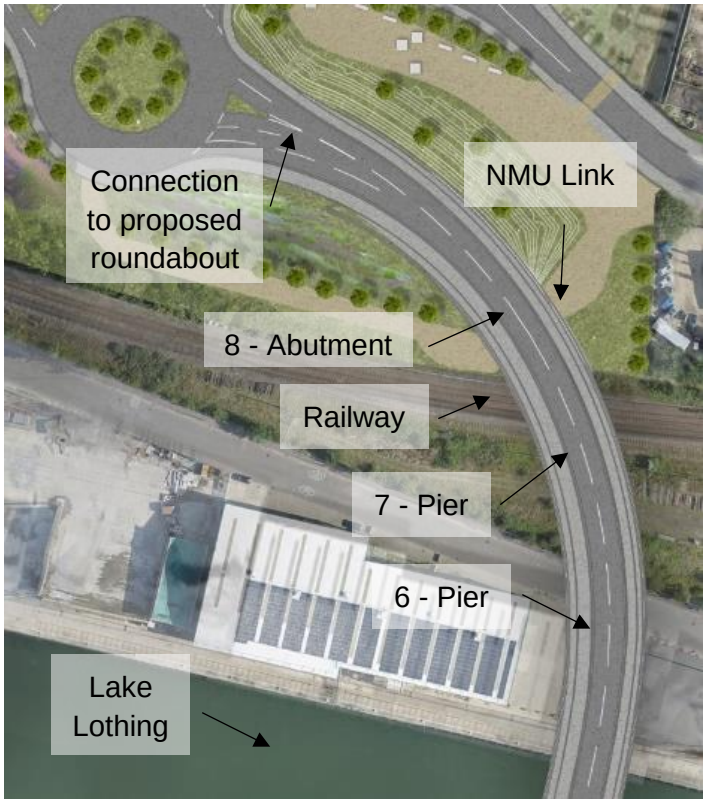


Figure 31: Plan view of structures at the northern approach

7.4.28 The thickness of the concrete bridge deck structure varies between 2.4m at the mid-span between piers, and 5m deep above the supporting piers (see Figures 32 and 33). The transition between the varying deck thicknesses provides the curved profile beneath the bridge.

7.4.29 The Scheme's alignment over the operational port and the East Suffolk Line railway constrains the design options for the structures spanning these areas.

7.4.30 Through engagement with affected parties, headroom and access requirements can be accommodated where practicable, to enable operations to be maintained. This informs the dimensional constraints which the reference design accommodates so far as is practicable.

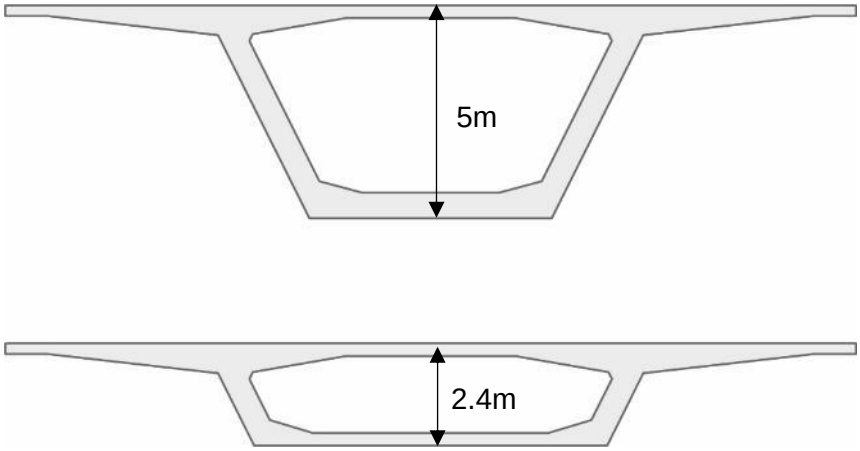


Figure 32: Indicative sections through the bridge deck structure

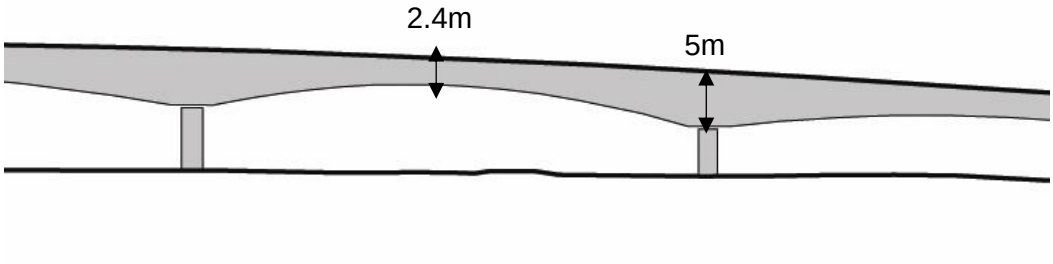


Figure 33: Indicative elevation of varying bridge deck thicknesses across spans

7.4.31 Through the development of the reference design, a solution had to be reached which aimed to minimise the structure and number of supporting piers required on land, and did not exceed the limitations of the support structure itself. Whilst meeting the needs of the affected parties and adjacent land owners is an important consideration, the desire for a good quality, unified design is maintained.

7.4.32 To ensure uninterrupted railway operations during construction of the Scheme, the section of bridge spanning over the East Suffolk Line railway may need to be constructed using a different method to the other spans.

7.4.33 An example of an appropriate method would be to construct the span parallel to the railway, and rotate it into place to connect to the abutment and pier it is supported by (see Figure 34).

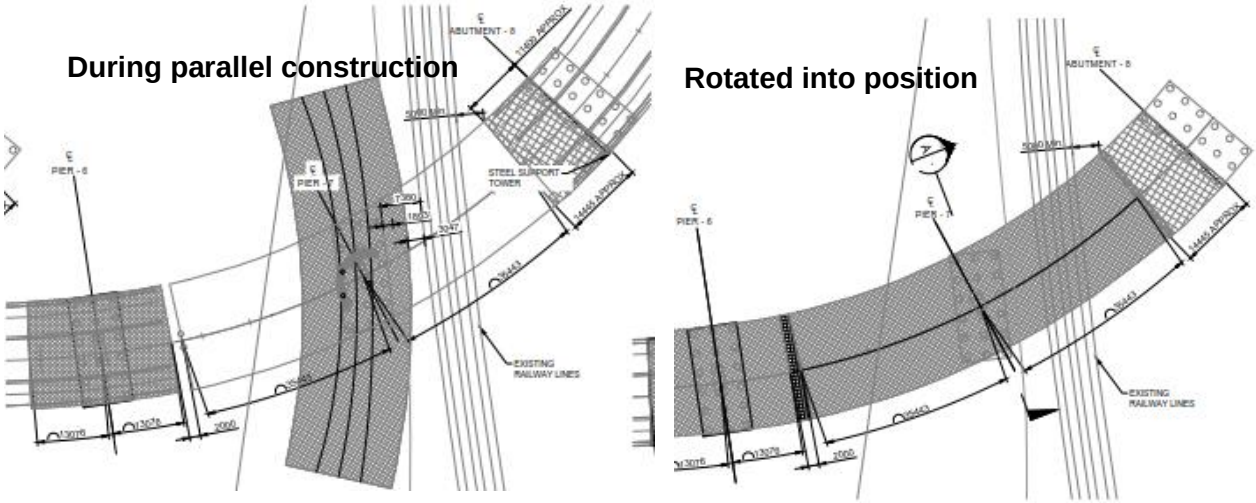


Figure 34: Diagram demonstrating parallel construction of bridge span over the railway

7.4.34 Vehicle containment and parapet designs are dictated by the safety requirements set out in the DMRB, and in discussions with Network Rail to ensure they are satisfied with the protection provided over their assets.

7.4.35 The parapet used over the crossing is expected to predominantly be a 1.4m high N2 containment barrier as shown in the reference design. This transitions to a 1.8m H4A parapet 45m either side of and over the railway lines for safety purposes.

7.4.36 Engagement with Network Rail revealed that while their current operations would require a 1.5m parapet (with 45m approaches either side) on the Scheme, in the event that their operations change and the lines being electrified, the parapet would need to increase to 1.8m high to be in accordance with the DMRB guidance.

7.4.37 While there is opportunity through detailed design to explore any adaptable products that could accommodate such a change in height in the future, the reference design includes a 1.8m parapet over the railway as a precaution which was the preferred option to futureproof safety and cost efficiency.

7.4.38 The reference design includes provision for a substation structure to be located on the eastern side of the abutment structure at the northern approach. This is likely to be required to provide power to the lighting and barrier features on the northern side of the opening span. The reference design provides a solution to how this can be integrated with the public realm location, rather than a stand-alone structure. This will be described further in the DGM.

7.4.39 The abutment in this location also features a viewing gallery for maintenance purposes on the western side.

Geotechnical Design

7.4.40 The geotechnical design at the northern approach encompasses the foundations and piling beneath ground level, and the earth embankment either side of the highway north of the abutment.

7.4.41 In this location, an earth embankment design forms the transition from the bridge deck structure down to ground level connection.

7.4.42 The material used to construct the embankments will need to be imported to site as there is not sufficient residual earth produced through the construction of the Scheme.

7.4.43 The embankment was designed at approximately a 1:2½ gradient slope to soften the edges of the design and minimise the additional structure required beneath the bridge.

7.4.44 The sloped embankment provides a soft transition from the bridge deck height to the ground. The areas either side of the Scheme can facilitate the embankment here, whereas on the southern approach this method is not possible due to space constraints.

Alternative geotechnical structures

- Gravity retaining walls
- Piled retaining walls
- Reinforced earth walls

The decision to use an earth embankment at the northern approach was considered appropriate when compared with the above alternatives which were dismissed because of the spatial constraints of the site and Order Limits, size of associated structure and the cost, visual impact, and the missed opportunity to provide additional function or amenity space for the community.

Landscape and public realm design

7.4.45 The landscape and public realm design includes areas surrounding the highway alignment and verges that can be utilised for planting and public space.

7.4.46 The northern approach area of the Scheme is situated at the connection between a variety of land uses, and social attractors. It connects with an existing play park, retail, residential, and is the main thoroughfare towards the town centre and railway station. This makes the Scheme a key link and decision making point for NMUs, but can also provide a destination point and public realm for people to enjoy.

7.4.47 To utilise this space, the reference design includes spatial allocation for an adaptable open public space to the east of the proposed roundabout, and planting for biodiversity to the west.

7.4.48 As explained in Paragraph 2.2.9 of the AAP: "*Lowestoft has an identified shortage of open space. The AAP therefore aims to protect, restore and increase access to open spaces. Within the study area, open spaces should promote biodiversity while providing a focus for leisure and recreational activities as part of a wider network of ecologically rich green infrastructure.*"

7.4.49 These areas are connected by a wide pedestrian and cycle path which passes under the crossing, linking the proposed crossing point on Denmark Road to the proposed roundabout.

7.4.50 This connection allows an alternative route to the bridge without negotiating the roundabout which may be attractive for less confident cyclists.

7.4.51 The landscape and public realm design utilises spaces as part of the Scheme to provide amenity green areas, and soften the connection between the proposed crossing and the surrounding context.

7.4.52 The adaptable public space east of the proposed roundabout is an area level with Denmark Road. This public space acts as an extension of the open space provided by the existing park on the corner of Rotterdam Road and Denmark Road, with a new pedestrian crossing allowing safer access between these areas.

7.4.53 Through a combination of textured planting framing the space, with paving and street furniture areas to be developed through detailed design, it is intended that this open space provides an adaptable area for community activities and events.

7.4.54 Street furniture, whilst not included in the reference design, could include seating platforms, benches, lighting, bins, cycle stands, and street trees around the perimeter to provide a sense of visual screening from the road. The public realm could be framed and separated from the highway using feature cube forms suitable for use as seating, and to act as a deterrent for vehicles.

7.4.55 Street furniture and other detailing developed through detailed design can add to the coherence and continuity of the Scheme from north to south, contributing to the identity of the place. The DGM will provide guidance and aspirations for the street furniture and other such items for consideration in detailed design.

7.4.56 Depending on the aspirations of the local community, it is possible for future commissions and community projects to be located here. This could for example, include art exhibitions, events, and outdoor gym equipment to enhance the space as a destination and promote community activities and a healthy lifestyle.

7.4.57 This area of the reference design also features the functional reinforced earth embankment, which has been adapted to incorporate large terraced steps for informal seating. There are also staircase accesses built into the terraces, providing an alternative and direct pedestrian access from Denmark Road to the bridge approach.

7.4.58 A ramped wheelchair or pushchair route was not considered to be appropriate in this location, due to the length of the ramp and number of landings needed to accommodate a comfortable gradient up to the bridge in this location. It would not have provided a more convenient or enjoyable route than is already provided beside the carriageway and was therefore discounted.

7.4.59 The terraced steps will be developed through detailed design and designed ergonomically to provide both access and informal seating for people to enjoy (see Figure 35).

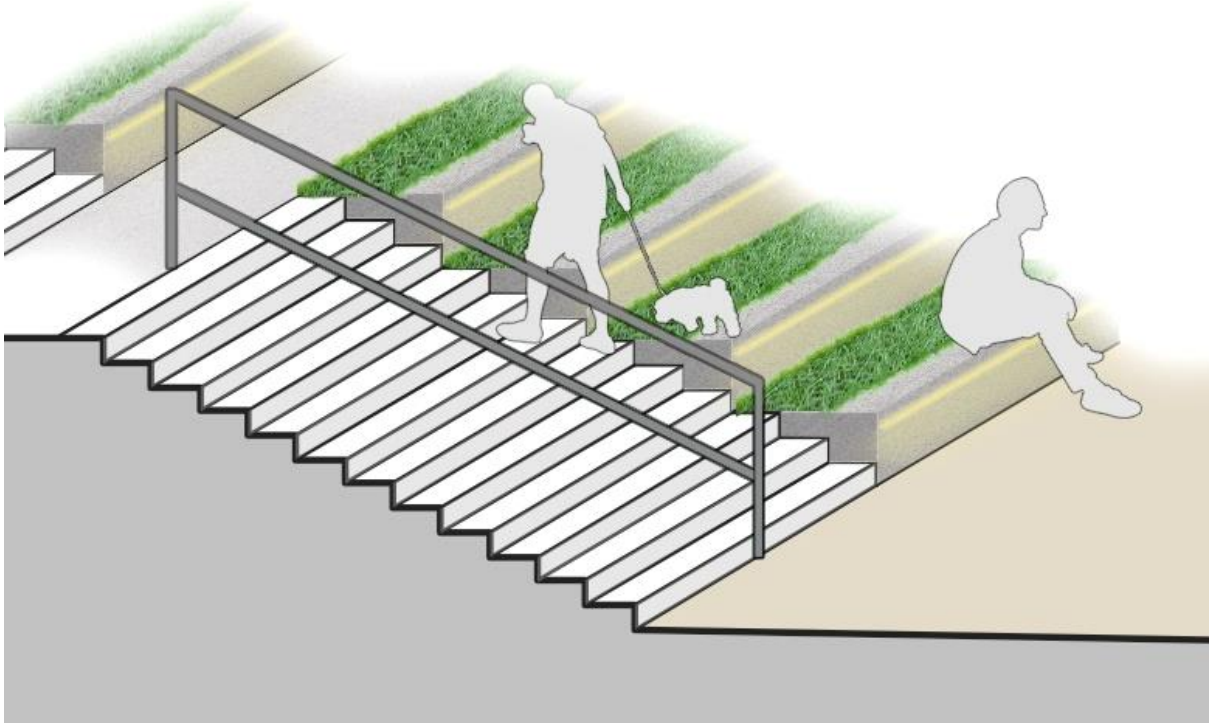


Figure 35: Typical section through the terraced steps to show how they could look

7.4.60 As mentioned in 7.4.38, a substation and associated electronic apparatus may be required to provide the power supply for the northern side of the bridge. In the reference design, this structure is integrated with the proposed terraced landscape for the reference design to ensure design quality is maintained, and the public space can be utilised. This also considers ease of inspection and maintenance which may use the NMU route for vehicular access when required.

7.4.61 There is a possibility that the lighting and barriers located on the northern approach may be operated from existing power supplies in the vicinity. The reference design includes the substations provisionally in the event that they are required, and can be suitably integrated into the design.

7.4.62 The northern approach of the Scheme lies within SSP9 of the AAP. The enhancement of the spaces surrounding the crossing within the Order Limits, aligns with wider aspirations for Lowestoft and addresses the issue of insufficient open space.

7.4.63 Paragraph 2.2.2 of the AAP states: *"Securing innovative urban design is essential in enhancing the character, heritage and biodiversity of the Lake Lothing and Outer Harbour area."*

7.4.64 Whilst the AAP suggests land for uses in the SSP9 area (see Figure 36), irrespective of the third crossing, the Scheme will support these uses through the provision enhanced transport links, potential environmental enhancements, and active space in the form of public realm.

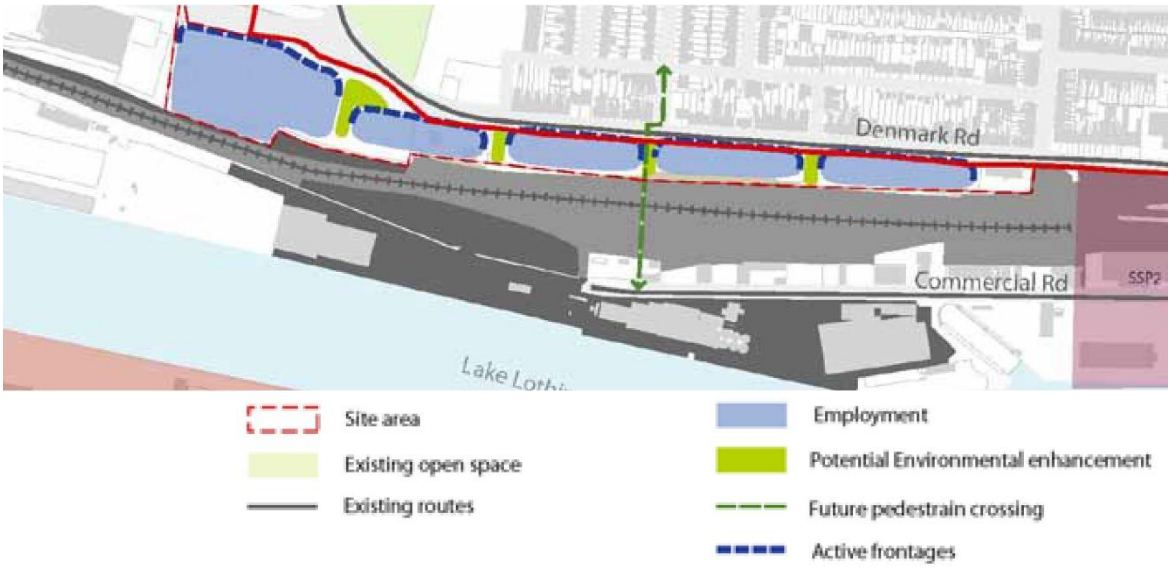


Figure 36: Extract from the AAP for SSP9

7.4.65 In contrast to the public space, on the western side of the proposed roundabout, the reference design proposes predominantly planting for this areas, with a mixture of colours, textures and heights. These will be designed to look attractive and provide habitat for species in detailed design.

7.4.66 This area of the reference design aligns with the guidance included in Section 3.4 'Designing in the AAP area' of the AAP: "*Promote biodiversity through the incorporation of habitats such as nesting spaces into the design of buildings and open spaces.*"

7.4.67 This area contains planted drainage ponds, designed to collect surface water run-off from the surrounding areas and release it into the mains system gradually.

7.4.68 The planting plan developed in the detailed design will need to consider a low maintenance solution, to encourage species to inhabit this area, whilst deterring pedestrians from perceiving this as a place to walk. The DGM will provide guidance on this, considering the needs of local biodiversity where required.

7.4.69 There is an opportunity to provide habitat and nesting areas for various species in this location. The use of structurally varied vegetation will help to provide a mosaic of habitats suitable for use by reptiles in particular, and other species.

7.4.70 With simple interventions such as the provision of hibernaculum together with appropriate conditions, reptiles, birds, insects can all inhabit this space. Hibernaculum can be constructed from simple materials often left over from the construction sites such as felled timber, brash, tree roots and inert rubble in appropriate locations. This will be included in the DGM.

7.4.71 Through development in detailed design, the landscape design will also provide areas of exposed substrate for the benefit of reptiles. Given the limited loss of land used by reptiles this constitutes an enhancement to the existing habitats.

7.4.72 The Scheme will include hard and soft landscaping where it is necessary to mitigate any identified environmental effects and to enhance the setting of the Scheme, so that

is fully integrated into the wider townscape.

7.4.73 Proposals are likely to include amenity tree and shrub planting, having regard to biodiversity interest, which will reflect the wider townscape and provide areas of interest to the adjacent hard landscape.

7.4.74 Working with schools in the future, there could be an information board in this location to inform children and educate them on local biodiversity. This will evoke an interest and understanding in importance of conserving local flora and fauna for all ages.

7.4.75 Any necessary tree removal on the Scheme can be reused, if appropriate, in this location to provide informal seating and ensure this natural material remains on site.

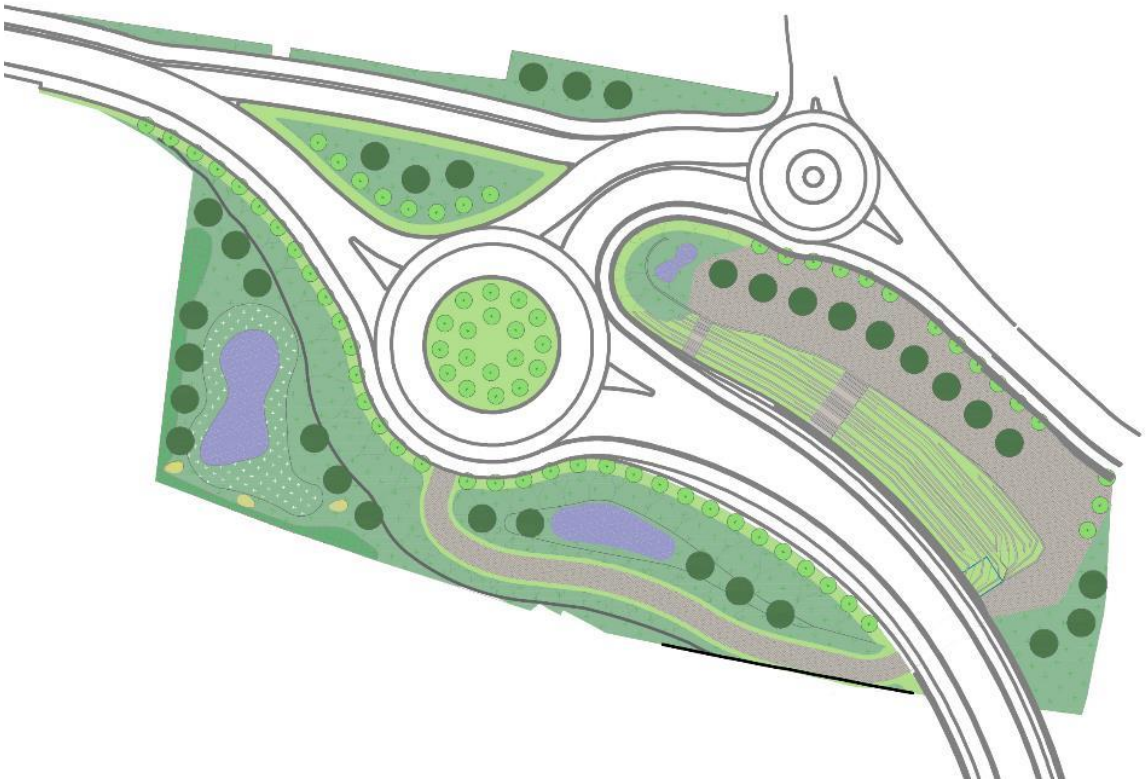


Figure 37: Extract from Landscaping Plan (document reference 2.8)

7.4.76 An opening between the abutment and the Order limits adjacent to the East Suffolk Line, provides a route which connects the proposed public space and green space for pedestrians and cyclists.

7.4.77 This pedestrian cycle path passes through this predominantly planted space to allow east to west movement beneath the bridge and alternative access up to the bridge deck on the western side (see Figure 37).

7.4.78 The path provides a route beneath the bridge from the proposed roundabout to the public space on Denmark Road. This will be constructed to withstand vehicle loads for maintenance access and inspection.

7.4.79 Maintenance access will be required for the abutment gallery, substation, and general landscaping care in this location.

Drainage Design

7.4.80 The Drainage Strategy for the Scheme is included in Appendix 18B of the ES (document reference 6.2). In general the footway and cycleway will drain to the carriageway by the fall gradient applied to these surfaces.

7.4.81 Surface water run-off from either side of the carriageway in this area will be collected by a combined kerb drainage system. This allows for the collection of water through regular openings into the hollow kerbs which then convey the water to the drainage system.

7.4.82 Water collected by the combined drainage kerb system will discharge into the local network, suitably sized ponds, or storage tank facilities. These will store the surface water run-off before it is discharged into the existing drainage system on Denmark Road / Peto Way.

7.4.83 A flow control device will be incorporated into the design to restrict the discharge to a rate acceptable to the relevant drainage authority.

7.4.84 The ponds located at the northern approach will be designed to maintain a minimum water level which will provide habitat benefits. These areas will feature suitable planting to aid in slowing the discharge of water, and creating suitable conditions for local biodiversity.

7.4.85 The drainage of the public realm area at the northern end of the crossing will be designed to meet the principles of SuDS in line with guidance shown in the AAP where appropriate.

7.4.86 It is proposed that the areas of terraced steps forming the embankment face will have permeable areas, and will be graded to minimise the risk of water ponding.

7.4.87 It is anticipated that the paved area will include features that incorporate interception to minimise run-off. This could be achieved through the use of permeable paving, particularly in the public space area. In order to limit infiltration this could be a lined system, however this would serve to reduce run-off rates and to store water. This system could then discharge via a flow control mechanism into the existing drainage system, possibly via further ponds.

7.4.88 Alternatively slot drains could be used, which would feed into the pond to provide storage prior to controlled discharge into the existing drainage system. Elsewhere permeable surfaces such as grassed areas should generate limited run-off, therefore not requiring additional drainage provision. The details of the drainage design for the public realm will be developed through detailed design.

Lighting design

7.4.89 Highway lighting is designed to provide the necessary light levels for visibility and safety. The proposals are intended to complement the local authority's existing strategy in the surrounding context and ensure longevity and efficiency through the potential for use of LED technology.

7.4.90 Feature lighting has an opportunity to be used in this area to ensure the public realm remains a safe and functional space (see Figure 38). Integrated lighting can highlight street furniture and features of the space.

Figure 38: Indicative image of lighting across the pedestrian and cycle path in the northern approach

7.5 The crossing and opening mechanism

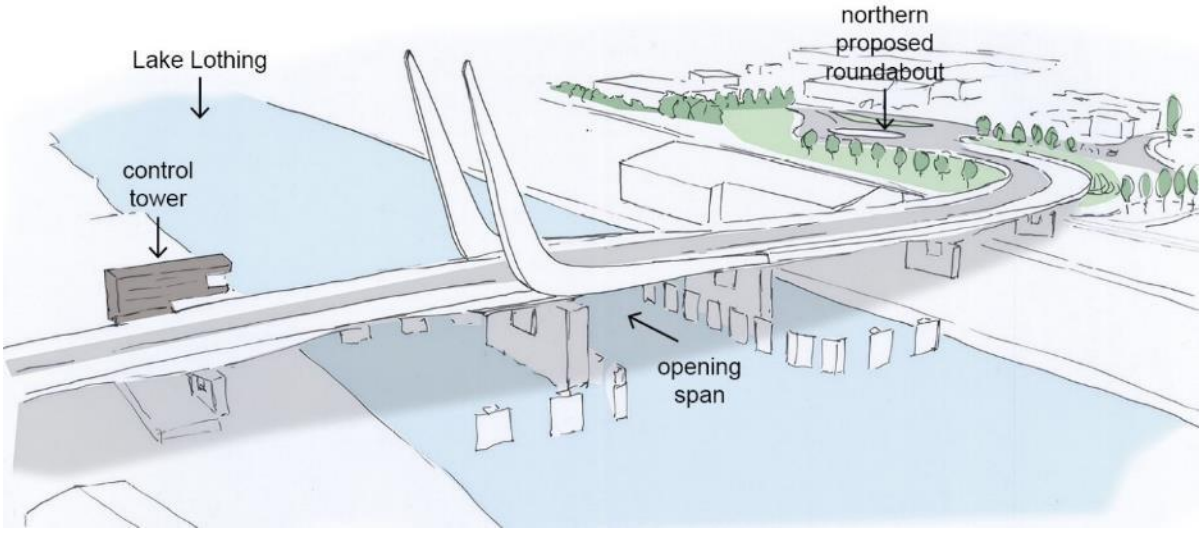


Figure 39: Sketch view of the crossing and opening mechanism area of the Scheme

7.5.1 This area of the Scheme encompasses the crest of the crossing, including the bridge deck structure over Lake Lothing, the opening span, and associated mechanism.

7.5.2 The navigation requirements included in the Scheme design were determined through engagement with ABP as a statutory consultee and the Harbour Authority.

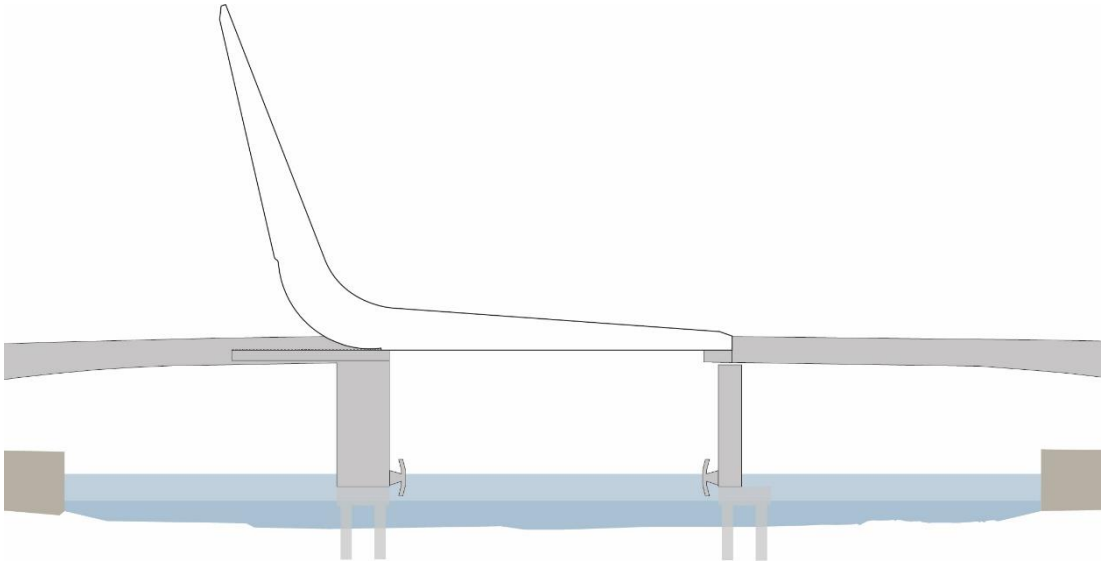


Figure 40: Elevation view of the rolling lift bascule bridge in lowered position

7.5.3 To ensure ongoing operations of the port and access for commercial and leisure vessels, the following design requirements are embedded within the reference design:

- Maximum air-draught when bridge is lowered, the reference design provides 12m above highest astronomical tide ("HAT")
- Sufficient width of navigation channel, the reference design provides 32m between protective fenders
- Unlimited air-draught in the navigation channel when the bridge is raised

7.5.4 A 12m air-draught is the maximum height that can be achieved by the reference design without requiring additional land take at the north and south approaches needed to achieve the appropriate highway, cycleway, and footway gradients sloping back to existing ground levels.

Highway design

7.5.5 The available air-draught of 12m between the HAT and the underside of the bridge structure (the soffit) informs the highest part of the highway alignment of the proposed crossing.

7.5.6 The highway alignment is designed to ensure it crosses perpendicular to Lake Lothing to ensure ease of vessel navigation and to minimise the land take required.

7.5.7 The width of the bridge deck accommodates footways and cycle facilities either side of a single lane dual carriageway of a standard width (see Figure 41).

7.5.8 The footway and cycleway widths in the reference design conform to the highway authority's guidance, which was provided through ongoing engagement.

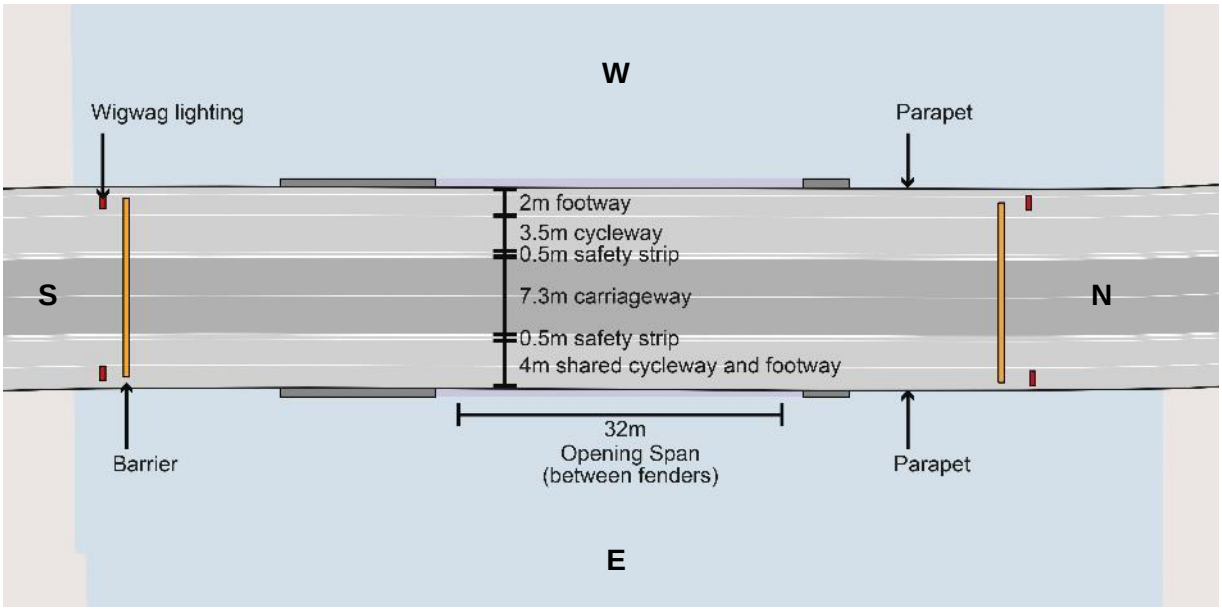


Figure 41: Plan view of indicative spatial allocation on bridge deck for the reference design

7.5.9 Within the footway and cycleway areas a width is allocated for required 'furniture' on the bridge such as lighting, signage, wigwag warning lights, and barriers. This additional width is to ensure the footway and cycleways are not wholly obstructed at any point by these essential features.

7.5.10 An offset from the carriageway edge is also defined as a 'safety strip' where no furniture may be positioned to ensure safety from wide or overhanging vehicles. This is a standard approach to use on this type of infrastructure.

7.5.11 The highway will likely feature standard kerbs and materials for cost efficiency and durability, but will be considered further through detailed design.

7.5.12 Wigwag warning lights and barriers similar to those seen on level railway crossings are required at either side of the opening span of the bridge deck. Such features are present of the existing A47 Bascule Bridge (see Figure 42). These features will alert traffic and NMUs on the bridge to the imminent opening of the bridge, ensuring the opening span is safely cleared and secured before it occurs.

7.5.13 There is an opportunity through detailed design to develop an innovative and sculptural feature to accommodate the necessary wigwags and barriers, which can offer a more visually appealing solution in keeping with the Vision. Such innovation will also minimise clutter on the pedestrian and cycle space where this furniture is located. This feature may be explored through detailed design, using the DGM.

7.5.14 In the reference design, the bridge deck has a 2.5% traverse fall each side of the centreline of the carriageway, plus a longitudinal fall of 1:80 to facilitate drainage of surface water. Further provision for surface water run-off could be provided by gullies and channels leading to the highway drainage system.

Figure 42: Photograph of wigwag warning lights and barriers on the A47 Bascule Bridge

Structural Design

7.5.15 This area of the reference design features two in-water piers (piers 4 and 5) to support the opening span of the bridge and its associated mechanism in the centre of Lake Lothing. Cantilevered spans of the bridge deck beyond the opening span connect to piers on land at the northern and southern approaches.

7.5.16 The bridge deck in this area features an opening span to allow the movement of tall vessels through the crossing. This span of the deck is made of steel to ensure it is as light as possible, and therefore more efficient to move.

7.5.17 There is a 35m space between the two in-water piers, with protective fenders fixed to the piers, which provide a 32m navigable width for vessels to pass through the crossing and along Lake Lothing. This is the existing width of the navigation channel within Lake Lothing.

7.5.18 The width provided between the two in-water piers was determined by the requirements of the port, and in response to vessel simulation undertaken. This is considerably wider than the existing A47 Bascule Bridge opening width of less than 23m. This could enable a simultaneous two way movement of smaller vessels and leisure craft during an opening sequence if desired and authorised by the harbour master.

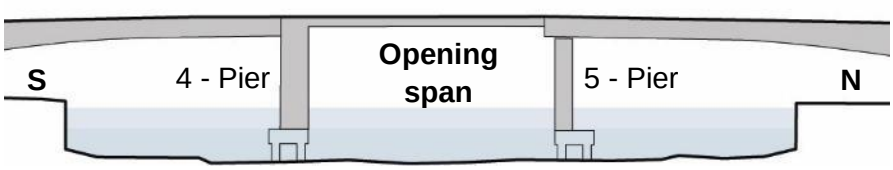


Figure 43: Diagram showing the in-water Piers 4 and 5 and the opening span

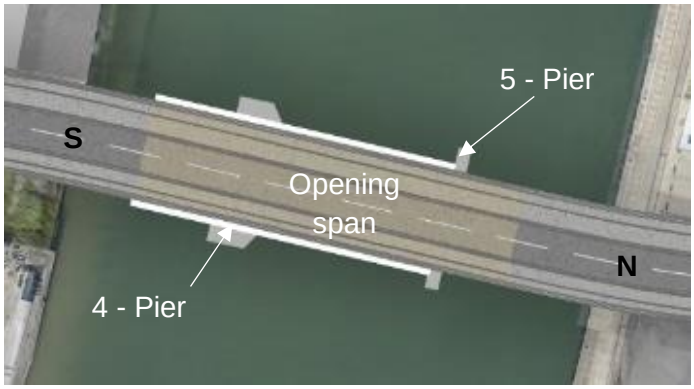


Figure 44: Plan view of piers supporting the opening span

7.5.19 The reference design for the in water piers has been developed to accommodate the mechanism and opening span of the bridge deck which it supports.

7.5.20 Consideration has been given to how the piers could be further developed through detailed design and will be included in the DGM.

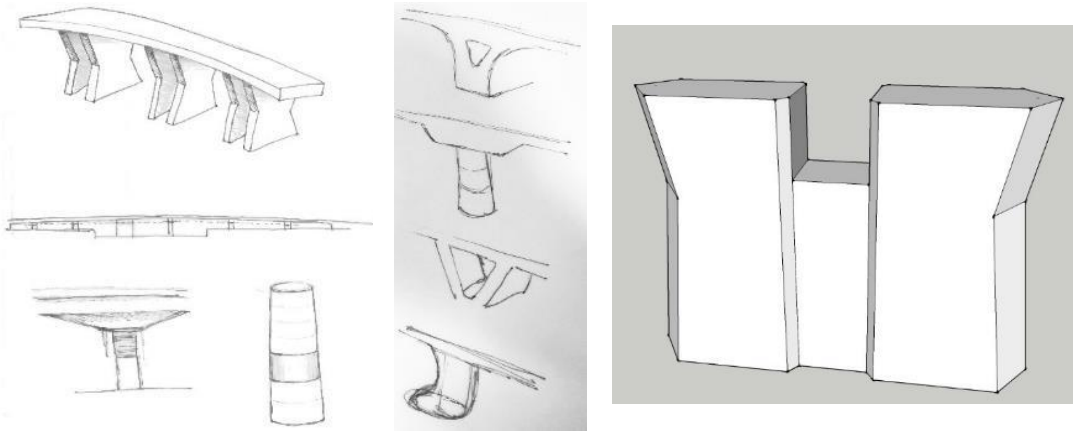


Figure 45: Examples of sketches and modelling of indicative pier designs

7.5.21 Whilst there are limitations to the 'sculpting' and refinement of the piers due to their structural performance requirements, many options were explored to test their unity with the Vision and appropriateness to the Scheme design as a whole (see Figure 45).

7.5.22 The pier design must be considered in its application from one end of the Scheme to the other on land and in-water piers (see Figure 46). The height of the piers vary across the reference design, to accommodate the sloping bridge deck above, and its relative connection to its foundations.

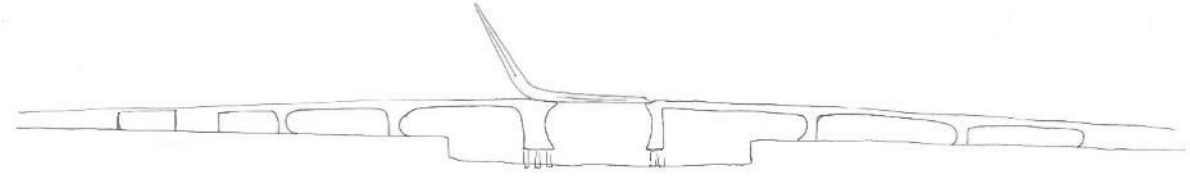


Figure 46: Sketch showing how a pier design concept may be applied to the whole structure

7.5.23 The design must accommodate maintenance access for inspection and repairs to bearings, and the hydraulics which facilitate the opening of the central span.

7.5.24 Due to the larger piers required in-water to support the loads transmitted by the opening mechanism, the design developed must take into account the scale and visual appearance of these piers relative to the piers on land.

7.5.25 In line with the Vision for the Scheme, the pier design aims to reduce any unnecessary material or structure that is not required functionally, to produce an honest and simplistic design.

7.5.26 Through the development of the opening mechanism for the reference design, the in-water piers were reduced in volume.

7.5.27 This reduction of in-water construction and associated piling can provide a cost saving in construction of the Scheme, less impact on the lake bed, and a more sustainable solution by using significantly less material.

7.5.28 A requirement of Pier 4 supporting the rolling bascule, was to have an open central section to accommodate the path of the hydraulic cylinders, which offered a functional 'Y' shaped form that could be considered for all piers.

7.5.29 The mechanism which raises the opening span, is operated from a nearby control tower. The reference design includes a control tower building to house the control room on the south west side of the crossing offset from the quay wall (this is discussed further in 7.6.31 to 7.6.59 of this report).

Mechanical Design

7.5.30 In the early stages of design, the Applicant explored using the same mechanism as is present on the existing A47 Bascule Bridge to the east. This 'trunnion bascule bridge' requires two large chambers beneath the bridge deck, to house the counterweight or 'kentledge' as the bridge raises.

7.5.31 Single (one) leaf or twin (two) leaf refers to the number of lifting deck sections forming the opening span. The A47 Bascule Bridge for example, is a twin leaf opening bridge. Breydon Bridge in Great Yarmouth is an example of a single leaf opening bridge.

7.5.32 The mechanism design has developed significantly during the development of the reference design, to ensure that the best solution can be achieved for the Scheme. As this design evolved, the alternatives to this mechanism were explored and compared to enable the most appropriate solution to be developed.

7.5.33 Following the first DCC Workshop (explained in Section 5.3 of this report) where the initial design was presented, the large bascule chambers were reviewed for their efficiency and suitability for use in the Scheme design. Variations of this mechanism design were explored to provide a reduction of this in-water construction, and therefore an improvement on the initial environmental impacts and construction cost. This also presented the opportunity for an architecturally striking design.

7.5.34 Other types of moveable bridge, were not considered appropriate for consideration here due to the scale, reliability required, and loading requirements of the Scheme.

Alternative mechanisms considered:

- Trunnion Bascule Bridge (single leaf, twin leaf symmetrical and asymmetrical)
- Swing Bridge (single leaf, twin leaf symmetrical and asymmetrical)
- Rolling Bascule Bridge (single leaf, twin leaf symmetrical and asymmetrical)

Table 3 contains a comparison of these options which was used to inform the development of the reference design.

7.5.35 The various mechanism options were compared against key criteria and their ability to achieve the Vision of the Scheme. The initial design for a twin leaf trunnion bascule bridge, formed the baseline from which the alternatives could be compared, the criteria included:

- Whole-life cost; compared with initial design
- Safety; to construct, and to operate after implementation
- Operating time; time required for a full opening sequence
- Navigation; impact on vessels in the vicinity and using the crossing
- Maintenance; complexity of access and maintenance on the mechanism
- Visual impact; height required, positive/negative impact visually
- Substructure requirement; volume of structure required to support mechanism
- Land use; impact on quay walls and any future local development
- Constructability; feasibility to construct on site
- Aesthetics; attractiveness of the appearance, ability to add to identity of town
- Environmental impact; such as impact on the lake bed through volume of construction
- Precedents; existing examples of this mechanism used elsewhere in the UK and worldwide

Within these mechanism types, the variations within them were also considered, such as single leaf, symmetrical twin leaf, or asymmetrical twin leaf.

7.5.36 Table 3 compares the initial double leaf trunnion design with alternative mechanisms using the criteria above and states a brief explanation which has been coloured in the following way:

Red – unacceptable or poor performance against criteria and initial design

Orange – generally acceptable performance against criteria and initial design

Green – positive performance, opportunity to improve on initial design

	Trunnion Bascule	Rolling Bascule	Swing Bridge
Variations	Single or double leaf	Single or double leaf	Single or double leaf
Cost	Baseline	Potential to reduce	Potentially neutral
Safety	Internal mechanism, safe for public	External mechanism, higher risk of public interference	Internal mechanism, safe for public
Operating time	Reasonable	Potential for faster raising time	Slower movement to open
Navigation	Acceptable	Acceptable	Unacceptable, potential interference with shipping navigation when opening
Maintenance	Complex due to internal mechanism	Simplified by external mechanism	Potentially complex mechanism
Visual impact	Low	Design dependant, could be visible from afar	Low
Substructure	Large in water chambers required	Smaller piers required	Contact with quay wall to facilitate large slewing ring chamber and allow sufficient navigation channel not acceptable
Surrounding land/water uses	Size of chamber prevents vessels using space between quay wall and chamber	No impact on surrounding uses	When open, bridge deck sterilises area of quay wall adjacent, obstructing mooring/berthing
Constructability	Feasible	Feasible	Not feasible
Aesthetics	Unattractive large chambers required	Visual potential	Simple structure, visual interest when opening
Environmental	Moderate impact due to high volume of construction in water	Low impact, potential wind considerations	Design dependant, potentially acceptable
Precedents	Many examples	Few examples	A number of examples

Table 3: Summary of the alternative mechanism comparison

7.5.37 The Applicant has compared alternative mechanisms to the existing A47 Bascule Bridge to improve on its performance, cost, and visual appearance. The rolling bascule is considered to be the most appropriate mechanism for the Scheme.

7.5.38 Whilst not overly common in the United Kingdom, the rolling bascule mechanism evidently offered many enhancements to the design for the Scheme in comparison with the initial design.

7.5.39 DCC consider the rarity of this bridge type a positive attribute of the design:

"The preferred option for a single leaf rolling lift is set to create a structure which is presently unique in the United Kingdom. The mechanism and the experience of its opening and closing will constitute a piece of moving sculpture which can go beyond its functional requirements to be celebrated by users and onlookers."

7.5.40 The option of single or twin leaf mechanisms were reviewed by the Applicant's design team of technical experts as part of the reference design development. Single leaf offered a simplistic mechanism design in terms of construction and maintenance, and is feasible for the length of opening span present in the reference design. A twin leaf rolling bascule would present a weak moment in the centre of the opening span where there would be no structural support to withstand loads. The single leaf rests on a pier at each end of the opening span, providing an efficient and structurally viable solution.

7.5.41 The rolling lift mechanism works in a similar manner to that of a trunnion bascule, except the counterweight is positioned vertically, rather than horizontally. The mechanism also performs a 'rolling' motion rather than pivoting around a fixed point to raise a bridge span (see Figure 47).

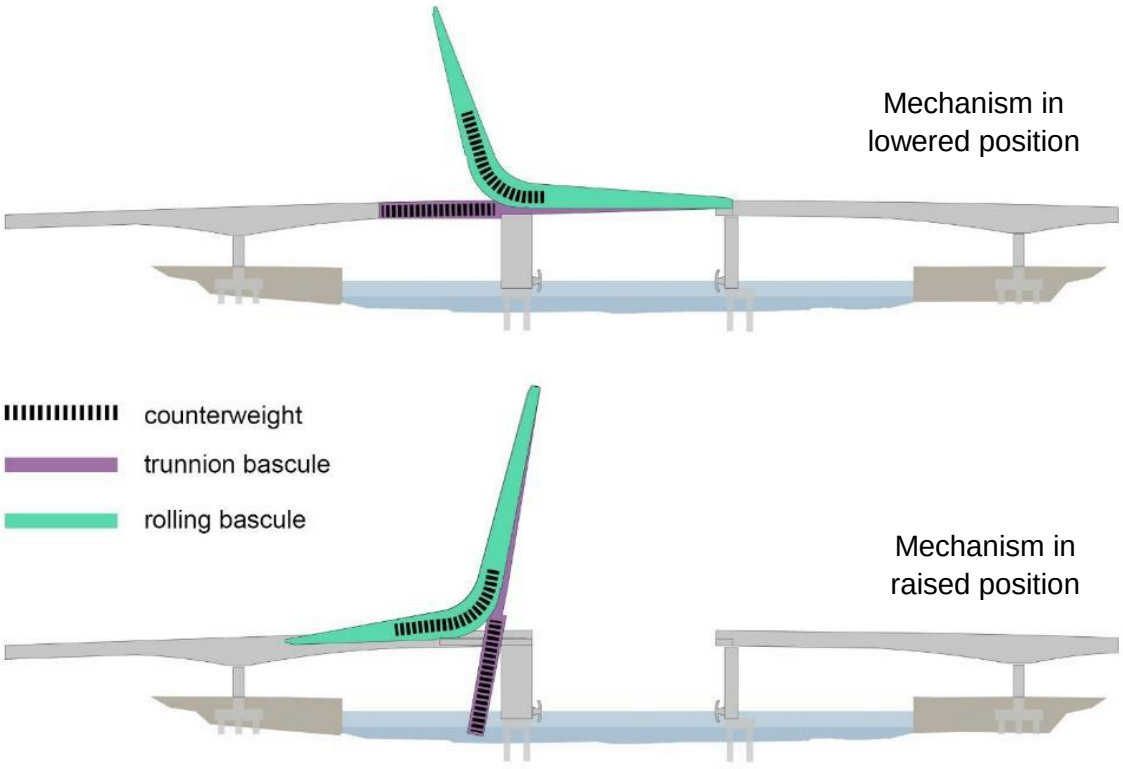


Figure 47: Diagram overlaying the variation in placement of counterweight between a trunnion and rolling bascule mechanism

7.5.42 The opening span is the only section of the of the bridge deck structure made of steel in the reference design. This is to ensure the opening span is as light in weight as possible, to minimise the size of the mechanism and counterweight required to move it.

7.5.43 The use of steel, whilst lighter than its concrete alternative, may incur a higher whole-life cost and require more frequent maintenance. It is for this reason, and the intention to ensure continuity across the structure, which prevents the use of steel elsewhere on the bridge deck for the reference design. The option of a steel deck on the fixed spans of the bridge could be considered further during detailed design.

7.5.44 The rolling bascule mechanism for opening the central span of the bridge features two solid concrete counterweights carried inside vertical steel superstructures above the bridge deck.

7.5.45 These superstructures are designed as a box girder which supports the opening span of the bridge deck through its connection at the outermost edges of the deck. This horizontal structure and bridge deck section is connected to the vertical counterweight by a curved radius on a rolling track.

Figure 48: Example of a rolling track located between footway and carriageway unlike the reference design for the Scheme where it is placed on the outer edges of the bridge deck

7.5.46 The superstructure forming the connection between the horizontal deck section, the rolling section, and the vertical counterweight naturally form an ‘L’ shape through its function. It is a predominantly hollow steel structure, except where the concrete counterweight is required.

7.5.47 To assist the lifting of the opening span, the reference design features two hydraulic cylinders are located centrally beneath the opening span of bridge deck to lift and lower

the span (see Figure 49).

7.5.48 Placing the hydraulic cylinders at the outer edges of the opening span would create torsion on the deck in the unlikely event that one of the cylinders fails. Centrally located cylinders means that were one of them to fail, the other could temporarily continue to operate as required to lift and lower the opening span.

7.5.49 The hydraulic cylinders are attached to the 'heel' of the opening span, a small protruding section of deck, an incision in the fixed span accommodates the movement path of the hydraulic cylinders when the bridge is raising.

7.5.50 The requirement to provide an 'unlimited air-draught' when raised, can be achieved in less time than a trunnion bascule bridge due to the motion it takes, rolling backward away from the navigation channel as it lifts.

7.5.51 The superstructures containing the counterweight for the rolling bascule mechanism are located on the outermost edges of the bridge deck. These features are symmetrical to ensure an even distribution of loads across the supporting structure beneath.

7.5.52 The positioning of the superstructures (hereafter referred to as 'counterweight arms') on the outermost edges of the structure also ensure they are most visible from afar, and their appearance not obstructed by associated barriers or furniture.

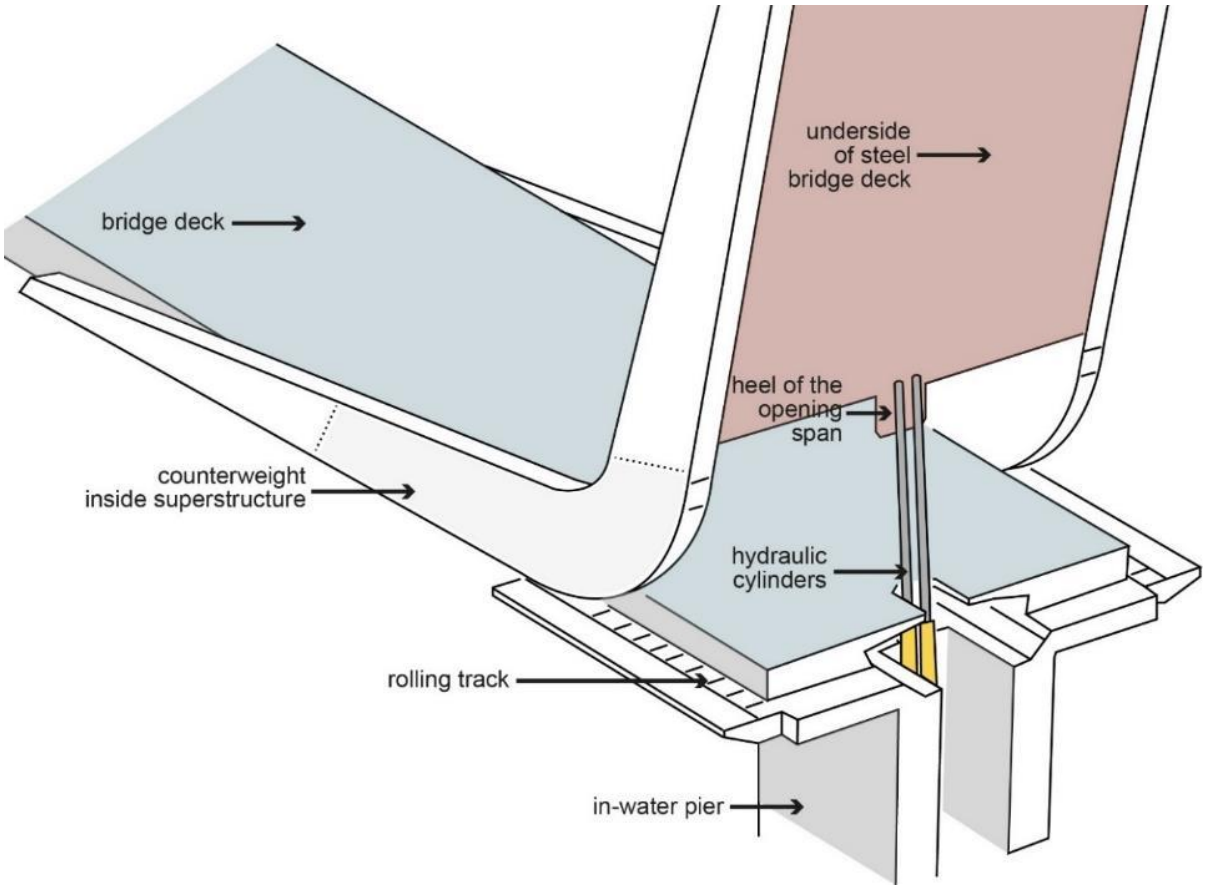


Figure 49: Diagram of a rolling bascule mechanism in raised position

Alternative counterweight locations

- Overhead weight across carriageway width, perpendicular to bridge alignment

  This was considered a safety hazard due to the position of the weight across the carriageway when raised. The weight required would also be so large, that it would not provide an attractive design.

- Two counterweight arms located on bridge deck between footway/cycleway space and carriageway

  This alternative was considered, but was discounted due to the additional width required to accommodate it on the bridge deck. This moving component may also pose a safety hazard to pedestrians, requiring unattractive barriers around it.

7.5.53 To ensure the reference design is as safe and efficient as possible, the position of the counterweight arms in relation to the bridge deck was developed through various iterations. The reference design features counterweight arms on a rolling track set approximately 1.2m below bridge deck level.

7.5.54 As the rolling track supporting the opening span is approximately 16m in length on either side of the bridge deck, this can be supported by a localised thickening in the deck and Pier 4, rather than incurring additional width on the bridge deck itself.

7.5.55 The reference design accommodates a 12m air-draught, whilst supporting the bridge deck structure. The track separation from the bridge deck level is also advantageous for pedestrians for safety reasons, and to reduce the visual obstruction caused by the counterweight arms when lowered.

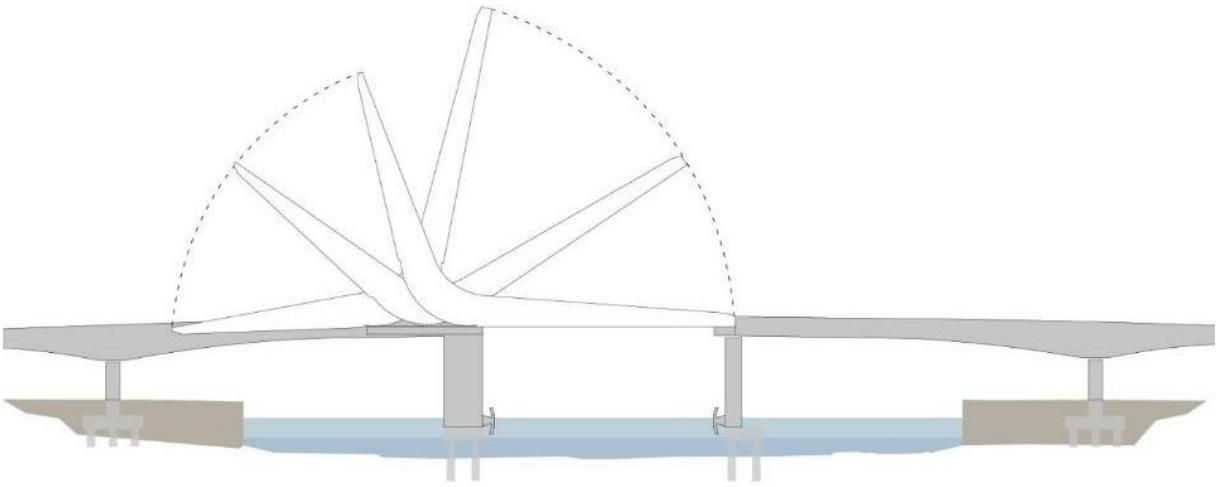


Figure 50: Diagram demonstrating the rolling bascule mechanism featured in the reference design when lowered, in motion, and raised

7.5.56 The radius on which the rolling section operates, and the length of the counterweight arms were explored extensively through a number of iterations to find the optimum design for efficiency of operation (see Figure 51), achieving unlimited air-draught when raised across 32m, and visual appearance.

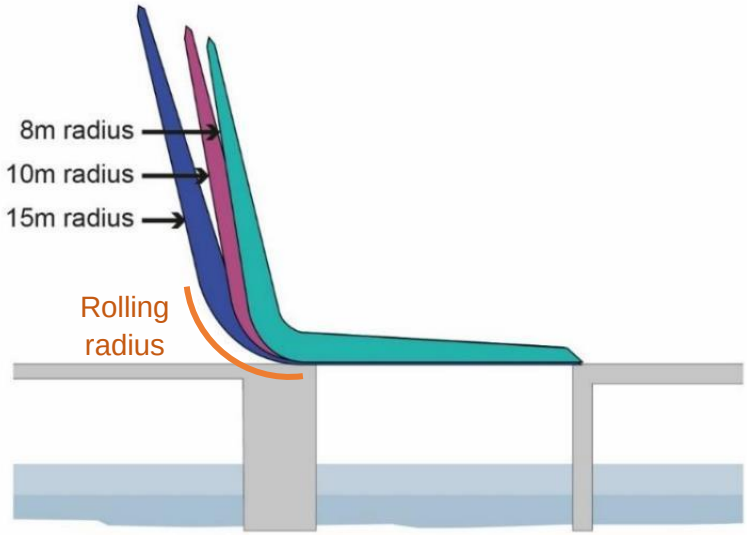


Figure 51: Examples of variations in rolling radius of counterweight arms

7.5.57 A key consideration in the design development of the counterweight arms was the scale, in proportion to surrounding buildings, the Scheme itself, and a person experiencing the crossing, walking beside the counterweight arms.

7.5.58 The height of design options (when raised and lowered) were tested and compared in relation to:

- the initial feasibility design (trunnion bascule bridge) height,
- the height of surrounding buildings and structures; with the most notable being the grain store tower east of the Scheme location
- ability to perform structurally
- efficiency in operation and cost effective
- human scale and experience
- appearance from afar, as part of Lowestoft's skyline; considered from various locations on the Scheme, around Lowestoft, and from the existing A47 Bascule Bridge
- appearance as a striking design feature or potential landmark for Lowestoft

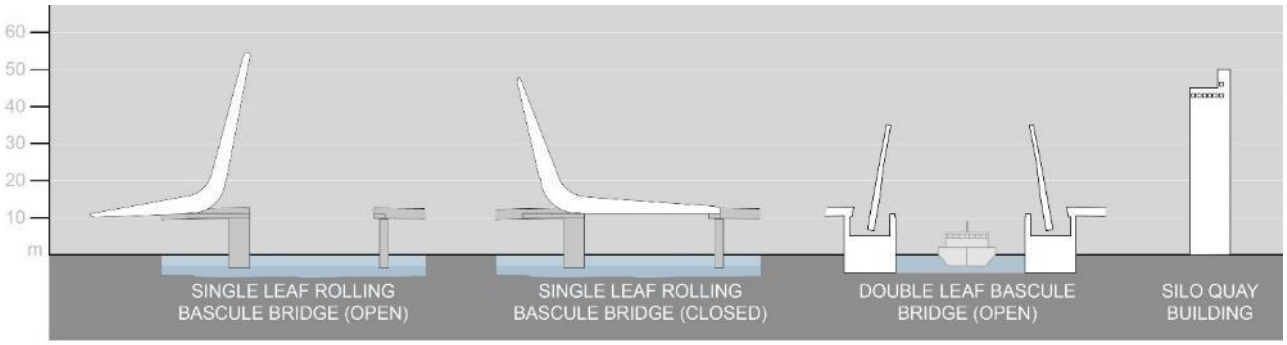


Figure 52: Diagrammatic comparison of heights

7.5.59 The reference design for the counterweight arms looks to show the vertical section broadly proportionate in size with the horizontal section, but no larger than the grain store building (labelled in Figure 51 as Silo Quay Building) when the bridge in its lowered position.

7.5.60 The 'marine tech' narrative provided inspiration for many interpretations of the counterweight arms and how they could look. Whilst considering the Vision which informs a simplistic and honest form, options were sketched and presented to the LPAs for their consideration (see Figure 53).

7.5.61 A digital 3D model of the Scheme and surrounding context was generated for the visual impact assessment in the ES, and to provide an illustrative animation of the Scheme for statutory consultation. This also proved a useful tool for testing the design and viewing it digitally from various locations in Lowestoft.

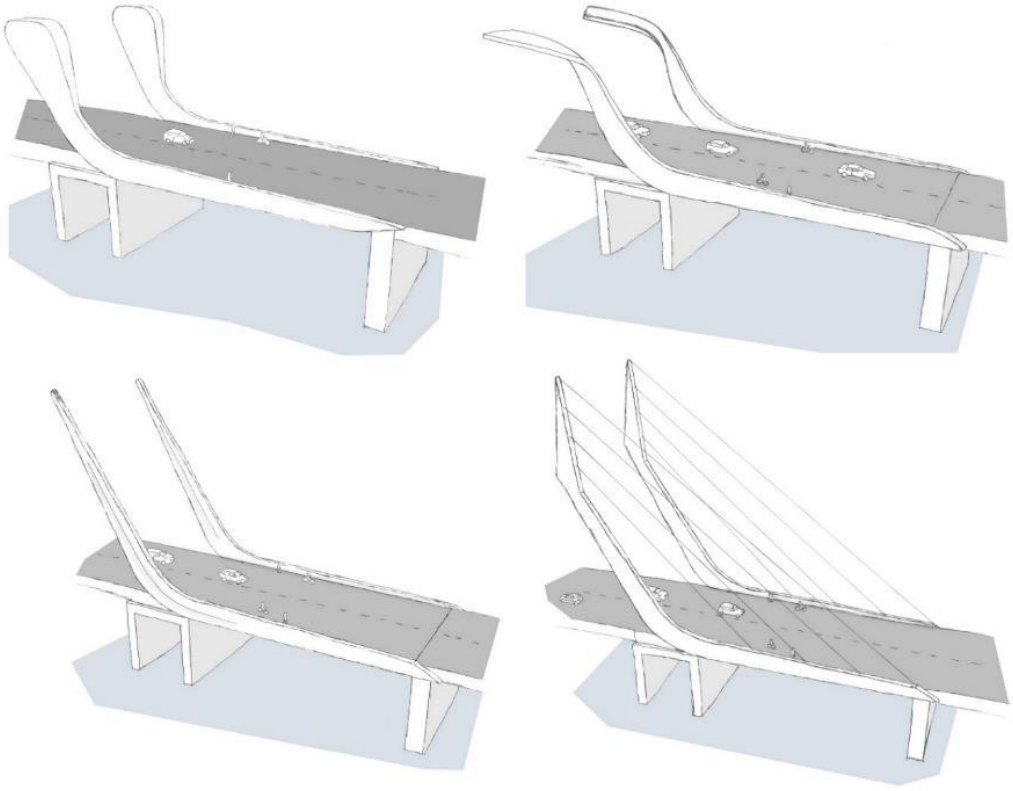


Figure 53: Indicative sketch options for the counterweight arm design

7.5.62 The mechanism for the reference design has an operational limit of 20m/s / 45mph / Gale force 8 which is typical for an opening bridge mechanism such as this.

7.5.63 Through detailed design, there is opportunity to refine the profile of the counterweight arms and their appearance (as shown in Figure 54). Through subtle sculpting of the forms to allow a multi-faceted structure, this will ensure the design is as light and sleek as possible, in line with the Vision. This consideration is included in the DGM.

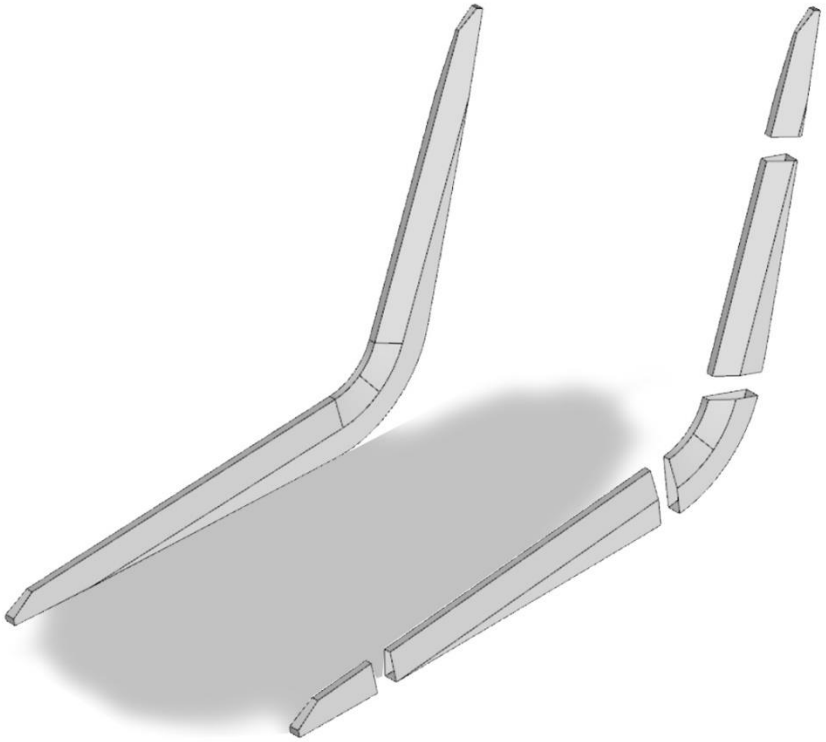


Figure 54: Example of 3D design development of superstructure arms

Q1. Why isn't the mechanism design more colourful?

The narrative of 'marine tech' is intended to deliver a simplistic, minimalist design that provides a form and feature through its function. The pale coloured superstructures are reminiscent of the striking and sculptural aerodynamic forms adorning the outer harbour and grouped out in the North Sea. The wind turbines are symbols of the growing renewable energy sector in Lowestoft, representing the future of Lowestoft.

The concrete required to construct the bridge deck and supporting piers has options for finishes that will be considered in detailed design. This will remain in its true form and colour to reflect the 'honest' Vision for the design. The use of additional material or paint in any location on the Scheme incurs additional cost at implementation, and ongoing costs associated with maintaining it.

The use of a pale colour on the steel superstructure ensures a simple yet striking form across Lowestoft's skyline. These surfaces offer an opportunity for bold, theatrical lighting to illuminate the skyline at night, through which a selection of colours can be projected across the Scheme.

The planting proposed (particularly on the northern approach area) is intended to be naturally varied in colour and texture, this is strengthened visually in its contrast with the minimal structural design and palette.

Q2. Why don't the proposals look like the current Bascule Bridge?

The mechanism design for the Scheme began as a twin leaf trunnion bascule bridge much like the existing A47 Bascule Bridge (see Figure 55). This has since been refined to deliver a more cost efficient, lower impact, visually striking design for the Scheme (as shown in Figure 56).

Figure 55: Initial feasibility design for the Scheme

Figure 56: Reference design for the Scheme

Q3. What happens if there is a power outage and the bridge needs to open?

The reference design includes provision for a back-up generator, to provide a power supply to the opening mechanism in the event of a mains power outage.

Currently the reference design allows for either a permanent on site generator to be installed, or means for a generator to be brought to site when required.

There are variable time and cost implications with a permanent or off-site generator to be considered and agreed at during detailed design. Where a permanent on site generator provides a back-up solution within minutes, there is a considerable initial cost for the apparatus. An off-site generator can be brought to site through a more cost effective contract setup with a local provider, but may incur greater delay due to the time required for transportation and setup.

Q4. Does the rolling bascule mechanism design cost more?

The development of the mechanism design and use of the 'rolling bascule' was to ensure the Scheme design was to a high standard and as efficient as possible. The reduction of in-water construction and pier volume required for this design provides a reduction in the cost of this component.

Paragraph 2.13 of the DMRB BA 41/98 explains that: "A commonly held but erroneous view is that a bridge which is attractive in appearance must be more expensive than one which is not. This is not necessarily so. In fact a good looking bridge is likely to have had more thought devoted to all aspects of its design; it will probably be a more fully integrated design and therefore could even cost less to build."

Geotechnical design

7.5.64 The ground investigations ("GIs") demonstrated the unsuitable condition of the quay walls to support any piers for the Scheme, meaning piers are required in the water to support the structure.

7.5.65 GI data informs the foundation and pile design required to support the in-water piers and the protective fenders.

Landscape and Public Realm Design

7.5.66 During the development of the reference design, the use of waiting areas were considered for the pedestrians and cyclists on either side of the opening span of the bridge deck (see Figure 57). These areas would provide a place for rest and gathering during a bridge opening sequence. They would be provided by a localised widening of the bridge deck to extend the footway area and include informal furniture and perches.

7.5.67 Waiting areas were considered unnecessary for the reference design as the proposed width provided for pedestrians and cyclists is generous enough to provide sufficient waiting space. It was also discounted due to the potential for additional structural load and cost associated with extending the bridge deck. There is also the potential for these areas to become undesirable due to misuse.

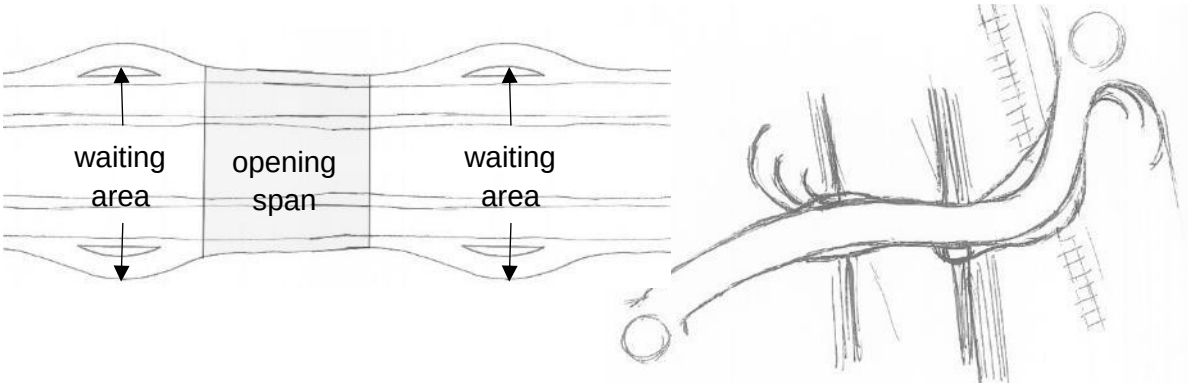


Figure 57: Example sketches of a discounted waiting area concept

7.5.68 There is an opportunity for subtle perch seats and integrated lighting to be considered as an integrated additions to the parapet near the vehicle barriers where people and cyclists will gather during a bridge opening sequence. These may be developed through detailed design using the DGM, as far as possible to ensure no impact on the structural integrity of the vehicle restraint system.

Fender and dolphin design

7.5.69 Fenders and dolphins have been positioned to ensure protection of the in water piers on either side of the navigation channel, and assist vessels with navigation. These are located in-water, mounted on Piers 4 and 5 within the navigation channel.

7.5.70 The reference design includes the following fender types; passage fenders, 30° approach dolphin fenders, perpendicular approach dolphin fenders (as illustrated in Figure 58). The potential impact loads must be considered in the pier and foundation design.

7.5.71 The restriction on proximity to the Service Tunnel east of the Scheme limits the positioning and orientation of the approach dolphin fenders.

7.5.72 Vessel simulations have been undertaken at various stages during the development of the reference design to ensure vessels can safely navigate through piers 4 and 5. The layout used and variables within the model, such as fender size and location, were developed and tested based on feedback from ABP port pilots.

7.5.73 Simulations were performed with a selection of vessel types and sizes including: a ferry, tugboat, barge, supply vessel, and a dredger. The fender design looks to ensure minimal impact on vessel navigation.

7.5.74 The positioning and angles of approach dolphin fenders have been developed using feedback obtained during vessel simulations. This takes into consideration the protection required for the piers, and any constraint that the fenders would place on port operations and vessel movements.

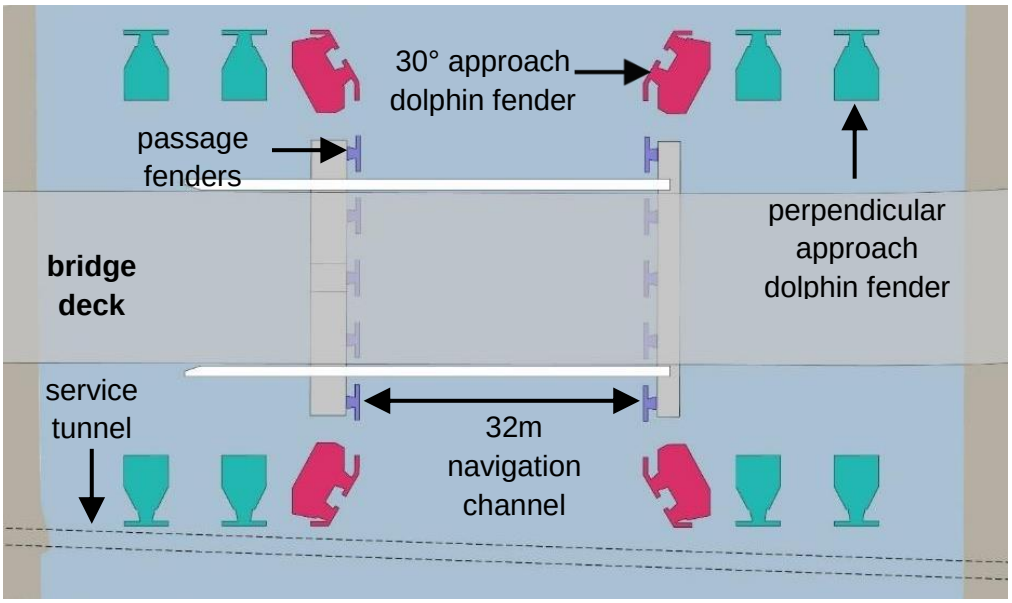


Figure 58: Fender design for the Scheme

7.5.75 The fender panels must be close enough to minimise the risk that a vessel could pass between units and collide with supporting structures.

7.5.76 For the passage fenders a spacing of 6m with panels of 4m is considered to give suitable coverage, giving exposed gaps of 2m between panels for the reference design.

7.5.77 The length of the dolphin panels is partially dictated by the potential torsional effect of an acute impact on the outer edge of a large panel and for this reason it is proposed that the approach fender panels should be restricted to a similar length.

7.5.78 In elevation the fender panels must provide an impact face at a suitable level for all states of the tide. It is considered that a lower panel level of lowest astronomical tide ("LAT") + 0.5m and an upper level of HAT+1.5m will provide sufficient height range for the anticipated vessels. This would give a total panel height of 4m.

7.5.79 All fender panels must be covered with a suitable low friction facing fixed to the panels with recessed bolts. There should be no protrusions on the fender panel faces.

7.5.80 Suitable chamfers should be allowed for in the panel designs to reduce the likelihood of a vessel becoming either trapped under or hung up on the fender panels.

7.5.81 The precise dimensions and spacing of the fenders will be determined during the detailed design of the Scheme.

7.5.82 For further information, see the Fender Design report in Appendix 11.

Pontoon design

7.5.83 Through consultation feedback and discussions had during the ongoing 'Navigational Working Group Meetings' with leisure and commercial vessel groups, it was established that there was a need for a pontoon system.

7.5.84 This addition to the Scheme design is in response to safety concerns raised by leisure craft users who would require a pontoon to moor to whilst awaiting a bridge opening.

7.5.85 Various options have been considered for the pontoon location (see Figure 59), which is informed by the following factors:

- Navigational safety
- Water availability
- Ease of approach and departure for vessels
- Construction cost

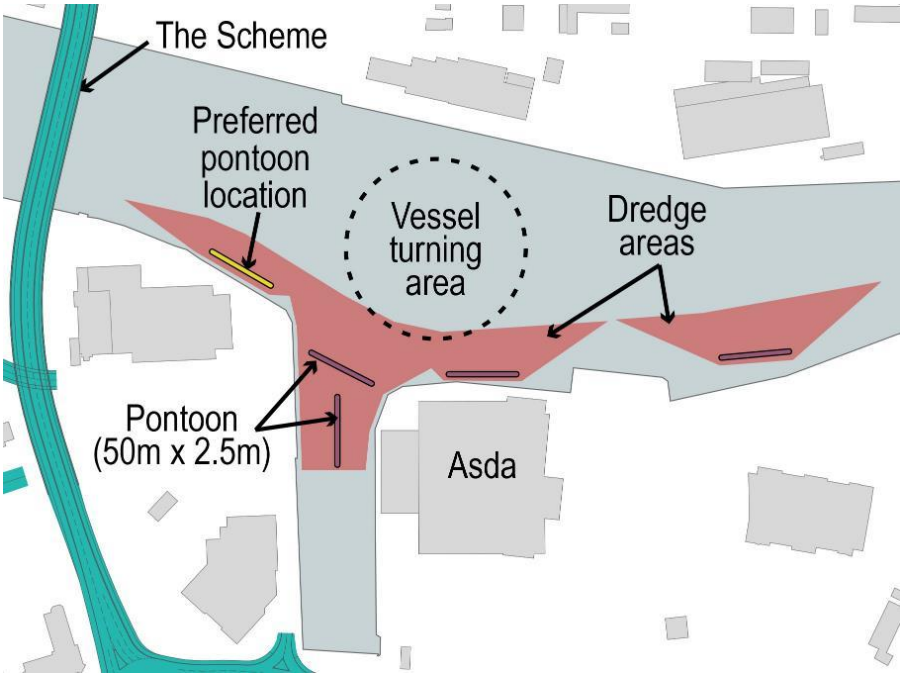


Figure 59: Diagram illustrating the potential and preferred pontoon locations with their associated dredging area

Lighting design

7.5.86 The superstructure design offers an opportunity for lighting to enhance the appearance of the Scheme during hours of darkness and allow it to be a feature in the skyline.

7.5.87 This can be achieved by flood lighting directed at the superstructures on the inside and outside of the deck. The pale coloured face of the superstructure offers a bright surface to reflect the light gently and be visible from a distance (as illustrated in Figure 60).

7.5.88 In contrast the lighting below the bridge deck can be coloured to provide subtle illumination and visibility.

7.5.89 The highway lighting is provided by a series of strategically located columns, to ensure sufficient light across the opening span, where there will be no columns located.

7.5.90 All lighting particularly over Lake Lothing should have regard to the importance of avoiding interference with vessel navigation.

7.5.91 See Appendix 9 for further information on the Lighting Strategy for the reference design.

Figure 60: Indicative visualisation of the reference design lighting design at night

Drainage design

7.5.92 The Drainage Strategy for the Scheme is included in Appendix 18B of the ES (document reference 6.2). The fixed spans of the crossing will feature a combined kerb system where the surface water run-off from the footway and carriageway flow into the hollow kerb through regular openings.

7.5.93 Drainage of the carriageway on the opening span will be accomplished through a combination of the cross-fall on the highway which will drain water laterally towards the kerb line, and camber of the deck which will drain water longitudinally along the deck north and south towards the adjacent fixed spans.

7.5.94 It is proposed that this will be collected by gratings or grilles feeding into transverse channels running across the piers at each end of the lifting deck. These channels will connect back to the drainage system on the north and south of the bridge, and will minimise the risk of untreated runoff draining into the lake. A lip or other guide on the underside will assist with directing the water into the system.

7.5.95 Any flow which does not feed in to the channels will be collected by the combined kerb drainage system commencing immediately after the proposed joints on each side of the lifting section of the bridge.

7.6 Southern Approach

7.6.1 The southern approach includes the extent of the Scheme which lies south of Lake Lothing, with a proposed roundabout, a new Access Road, and reconfiguration of other private access arrangements. The Scheme lies on what is currently Riverside Road.

7.6.2 It is proposed that the opening span of the bridge is operated from a control tower which is located on the south western side of the bridge offset from the quay wall.

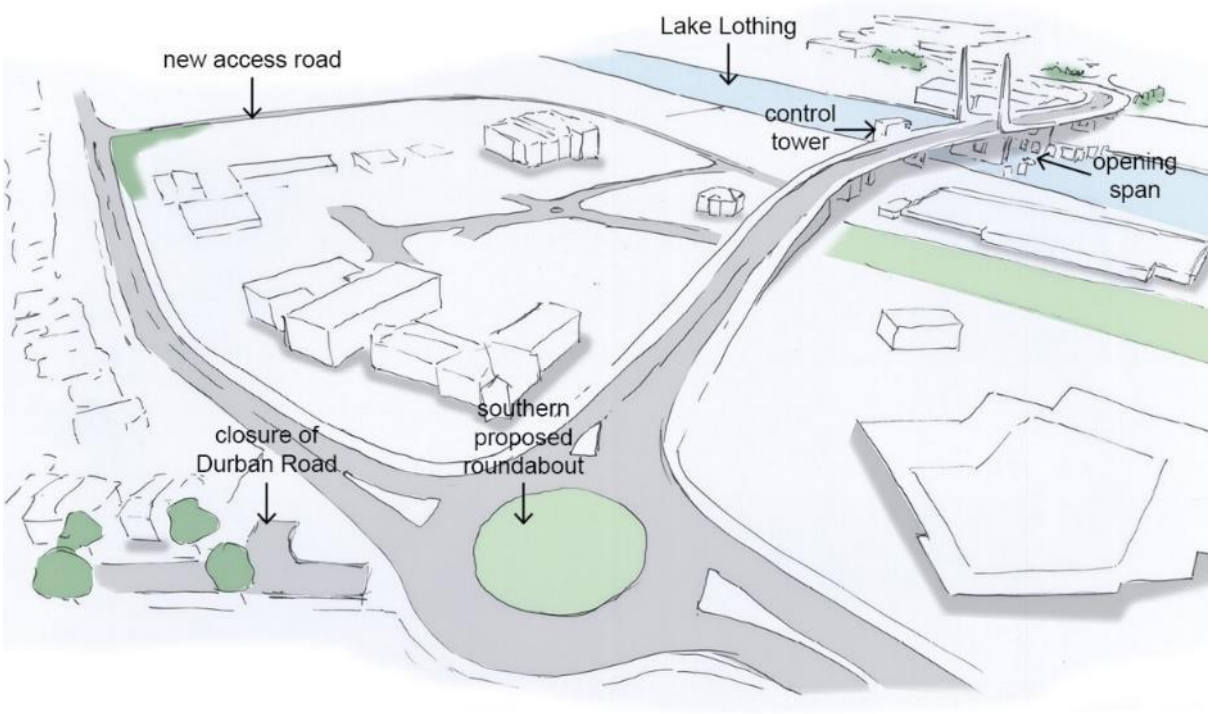


Figure 61: Sketch view of the southern approach area of the reference design

Highway Design

7.6.3 The highway design encompasses the extent of the carriageway, footway, cycleway and their connections to the existing networks. In the southern approach area, this includes a new roundabout to connect the crossing to the existing roads, and a new Access Road for the Riverside Road businesses and properties.

7.6.4 The highway alignment of the proposed crossing curves to the east on its descent down to the existing ground level. This is designed to a 5% or 1:20 gradient (maximum 6%) to meet the DMRB standards and ensure safety and comfort of all users, as used on the northern approach.

7.6.5 A roundabout junction is also proposed on the southern approach of the Scheme to connect to the existing road network, as here too it is the only junction option which delivers the traffic capacity required in the years to come.

Alternative junction types

- Signalised junction

  Discounted due to the additional land take that would be required to accommodate it. Consultation feedback also proved the negative perception of traffic signals currently implemented in Lowestoft and the additional delay they are believed to cause.

- Ghost island junction

  Only shown to work in traffic modelling with limited traffic flows during peak hours

7.6.6 Traffic modelling undertaken during the development of the reference design has demonstrated that the alternative junction options in this area would not alleviate congestion sufficiently.

7.6.7 This area of the Scheme is subject to numerous constraints and considerations, as discussed in Section 6 of this report, which inform the highway alignment to ensure minimal impact on surrounding land owners, businesses and the environment.

7.6.8 The roundabout of an appropriate diameter is required here has undergone a number of iterations to position it in an appropriate location to minimise land take, facilitate the turning movement of traffic, and ensure DMRB compliance (see Figure 62).

Figure 62: Alternative highway alignments considered in southern approach area

Q5. Why doesn't the crossing connect directly to Tom Crisp Way?

This alignment was discounted due to the additional land take that would be required to accommodate it, and higher cost incurred for the construction. This layout could also encroach on the turning circle of vessels located east of the Scheme. Sufficient clearance must be made from the Service Tunnel lying north-south beneath Lake Lothing, which also makes this option not suitable.

The Scheme lies perpendicular to the lake to ensure minimal construction in Lake Lothing, and simplicity of navigation for vessels passing through the third crossing. It would not be feasible to achieve both this perpendicular alignment across the water and tie directly into Tom Crisp Way Roundabout.

7.6.9 Led by the geometric requirements of the DMRB and the intention to minimise acquisition of land for the Scheme, the placement of the proposed southern roundabout requires the closure of the vehicular access to Durban Road at its junction with Waveney Drive.

7.6.10 Placement of the southern roundabout has also been determined by traffic modelling to ensure it will facilitate current and future demand.

Alternatives for Durban Road

- Remain open (current two-way flow)

  This was discounted due to the unacceptable level of traffic flows that were forecasted after implementation through traffic modelling of the Scheme. The geometry of the proposed roundabout in this location also made the connection to Durban Road non-compliant with the DMRB and would therefore be unusable by some vehicles.

- Remain open one way (entry or exit only)

  Due to the potential for this route to become a 'rat-run' as a result the Scheme, this was discounted.

7.6.11 The closure to motorised vehicles of the access to Durban Road at the southern approach means that traffic will access the area currently served by the Durban Road access via Kimberley Road and Kirkley Run.

7.6.12 The access to Durban Road will be maintained as a route for pedestrians and cyclists, providing a quiet route to the existing traffic free cycle lane located south of the Scheme parallel with Waveney Drive.

7.6.13 The proposed roundabout on the southern approach of the Scheme is connected to Tom Crisp Way roundabout by a section of twin lane dual carriageway. This connection also facilitates traffic that would be queueing during a bridge opening sequence.

7.6.14 A pedestrian crossing in this location was deemed unsafe, and would require additional width in the central reserve to accommodate it. This short stretch of two lane dual

carriageway is in close proximity to crossing points beyond the connecting roundabouts.

Q6. Why can't there be underpasses instead of crossings at the roundabout?

Underpasses are not used at the proposed junction arms due to the additional land take required to facilitate these additional structures. Underpasses are often associated with antisocial behaviour, and can be perceived as unsafe for vulnerable people, particularly during hours of darkness. The headroom required to facilitate an NMU underpass (a minimum of approximately 3m) would mean that it would be located further away from the junction beneath the proposed crossing and therefore not meeting the key desire lines of NMUs on their journeys, making them often more inconvenient. There is also additional cost associated with including such provision is not included in the Scheme funding. Further analysis during detailed design will ensure the most appropriate crossing types are used in each crossing location.

7.6.15 An underpass was considered at the end of Canning Road to provide pedestrians and cyclists an alternative route beneath the bridge. This was discounted due to the additional land take that would be required either side of the crossing approach. To the east of the alignment of the Scheme in this location is a car showroom who use their outdoor area for their business and assets. West of the crossing lies a UK Biodiversity Action Plan habitat of importance to invertebrates. The design aims to minimise impact to these land uses and businesses.

7.6.16 A new access to Ling's Motor Group is provided from this section of road between the proposed roundabout and Tom Crisp roundabout.

7.6.17 A new Access Road is required for businesses and properties currently using Riverside Road which is to be utilised by the Scheme.

7.6.18 The new Access Road is located through the former Jeld Wen site, west of the crossing, and connects to Waveney Drive as a standard side road junction.

Alternative locations for the new Access Road

- Through the Essex and Suffolk Water and associated offices car park

  Discounted due to the requirement to maintain existing parking provision required for the business premises

- At the eastern boundary of the former Jeld Wen site

  Discounted due to the impact on adjacent land owners and land take required to accommodate it. There are also utilities located in this area that would have been costly to relocate

- Through the former Jeld Wen site

  This location is preferred to avoid various constraints, and provide an appropriate connection to future developments anticipated in this area by AAP policy SSP3.

7.6.19 Options for the junction configuration for this new Access Road connection with Waveney Drive were also explored. Traffic signals were deemed unnecessary for this new minor road, and discounted due to the implications on the existing residential accesses on this road. As local development occurs in the future, this configuration could be reconsidered.

7.6.20 As the new Access Road is located in the AAP area, relevant design guidance included in the SUN Brief is applicable here. The SUN Brief outlines indicative networks with a hierarchy of links for vehicles and NMUs.

7.6.21 Paragraph 5.21 of the SUN Brief states: "*All roads within the SUN should be designed as 'streets' that prioritise pedestrian and cycle movements, following the principles set out in Manual for Streets 6 (DfT, 2007) and Manual for Streets 27 (CIHT, 2010).*"

7.6.22 Of the vehicular streets defined by the SUN Brief (see Figure 63), the most applicable to the new Access Road due to its proposed location and use, are the 'Secondary Street' and the 'Avenue'.

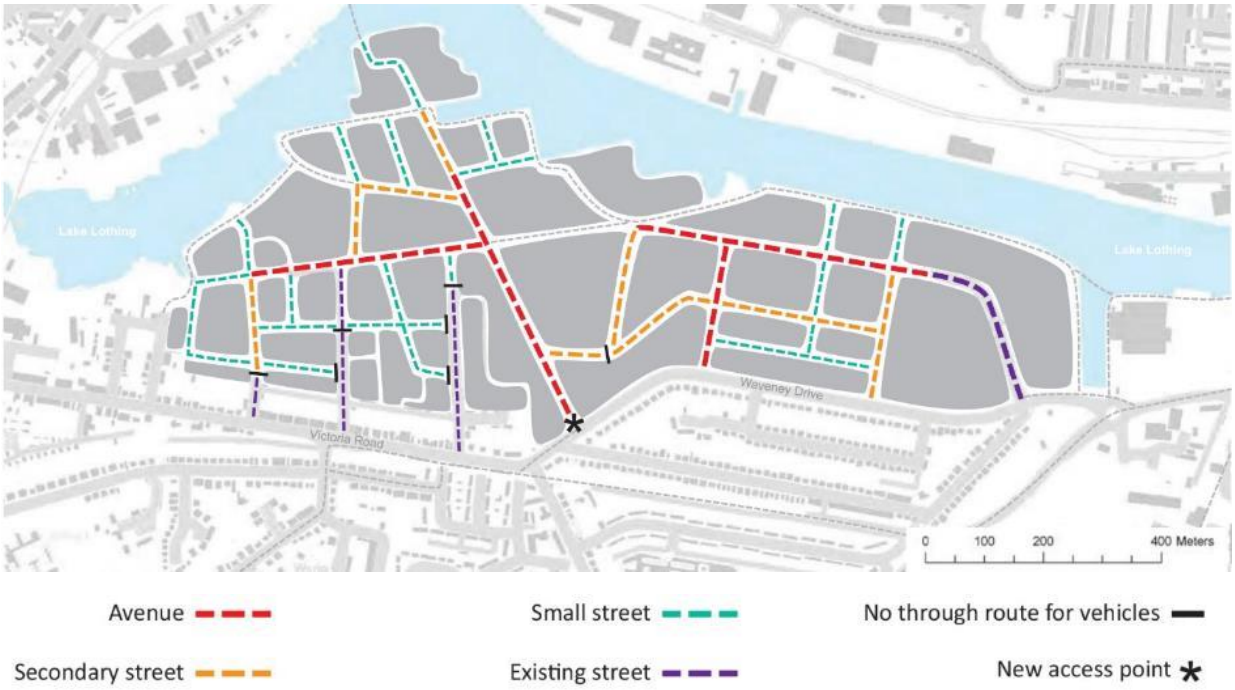


Figure 63: 'Indicative Vehicular Network' from the SUN Brief

7.6.23 *SUN Brief description of an 'Avenue'*

"This should be a wide single carriage way street with deciduous tree planting alongside. There should be wide pavements of approximately 4m either side of the road which accommodate a segregated cycle lane. Development should front on to these roads. Traffic speeds will need to be limited to 30mph and appropriate speed controls will need to be implemented, particularly on the main access road through the Jeld-Wen playing fields site."

7.6.24 *SUN Brief description of a 'Secondary Street'*

"These will be smaller through routes connecting different parts of the neighbourhood together. Traffic speeds will need to be lower on these roads with appropriate traffic calming measures. Secondary streets in industrial areas on the eastern part of the site should conform to the guidelines set out in the Suffolk "Industrial Estate Roads: Notes for Guidance of Developers"."

7.6.25 The location of the new Access Road has considered local future development through the site, though the masterplanning is at an early stage.

Figure 64: Sketches of the potential new Access Road with indicative development

7.6.26 The DGM will provide guidance for developing the new Access Road in detailed design, including the consideration of the alignment (see Figure 64) and treatment used.

Structural design

7.6.27 The structural design at the southern approach includes the bridge deck, associated support structures beneath comprising of an abutment (Abutment 1), two piers (Piers 2 and 3) and a portal frame providing vehicular access to the premises owned and occupied by Nexen Lift Trucks Limited.

7.6.28 South of Abutment 1 reinforced earth retaining walls support the bridge deck in its descent to connect with existing levels on Waveney Drive at the proposed roundabout. This method is used to ensure minimal land take on either side of the crossing. This method contrasts that of the northern approach where the site can accommodate a sloped earth embankment.

7.6.29 A concrete portal frame is included beneath the crossing to accommodate vehicular access with a clearance as high as practicable (a minimum of 5.3m in the reference design) for the adjacent site owned and occupied by Nexen Lift Trucks Ltd (as shown in Figure 65 and 66).

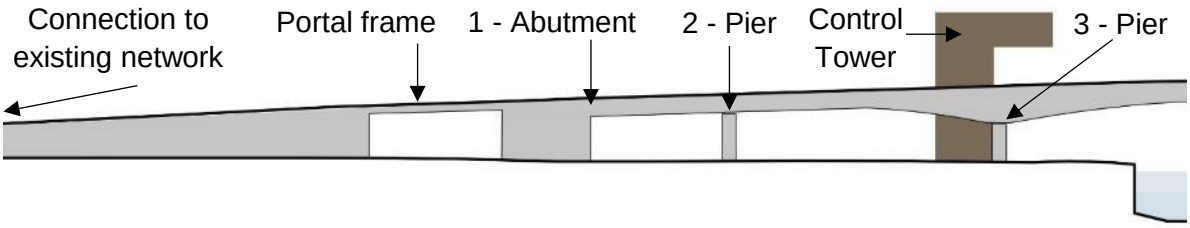


Figure 65: Elevation view of structures at the southern approach of the Scheme

Figure 66: Plan view of structures at the southern approach of the Scheme

7.6.30 To ensure continuity with the other spans of the crossing (apart from the opening span which is required to be steel), any structure to provide access to Nexen Lift Trucks Ltd was considered in concrete. This also offers the most cost effective solution for the reference design.

Alternative NMU accesses to Riverside Road area

A pedestrian and cycle ramp was considered on the western side of the crossing in this area of the Scheme, to provide access from the bridge deck, down to the Riverside Road business area. Figure 67 illustrates (in magenta) options that have been considered and discounted for the following reasons.

Due to the height of the bridge deck, providing a safe and comfortable gradient of no more than 5% or 1:20 for pedestrians and cyclists requires a lengthy ramp (as shown on image a of Figure 66), which would not provide a convenient or pleasant route for

NMUs. This would also require additional land take to accommodate the ramp structure.

An appropriate length of ramp would be achievable from the bridge deck approach adjacent to the Nwes Property Services Ltd land (as shown in image b of Figure 66), descending northwards to connect to Canning Road. This was discounted due to the land take required in the managed habitat site, and the proximity to the roundabout making it not much more convenient than the route with no ramp.

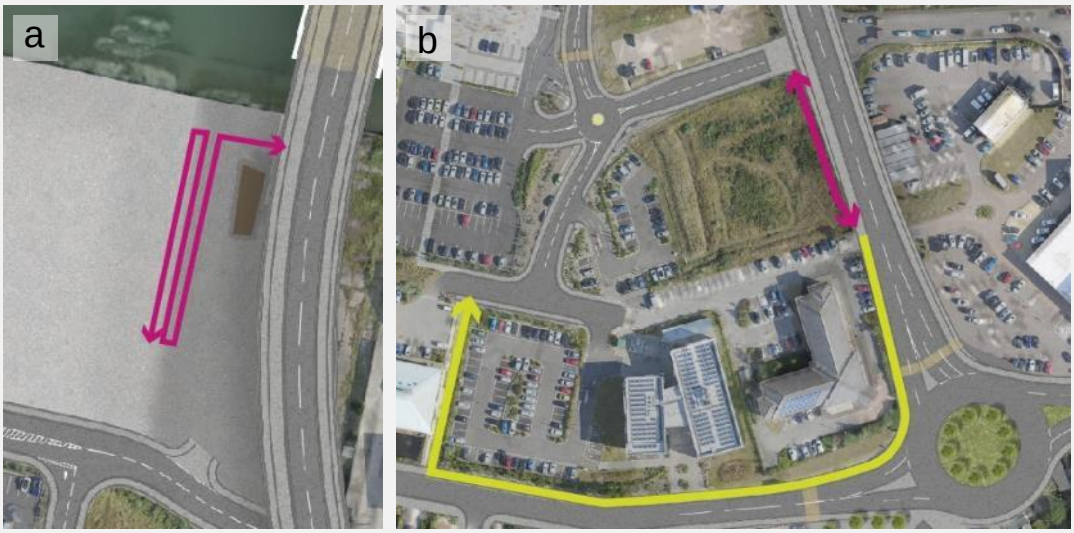


Figure 67: Diagrams illustrating length of ramp required to accommodate NMUs

7.6.31 The addition of a ramp for NMUs in this location could be considered during detailed design, for a solution that would not incur additional land take or impact on habitat area.

Control tower design

7.6.32 A control tower is required as part of the Scheme for the safe operation of the opening span on the crossing. For the application, this has been considered in terms of LoD to retain flexibility during detailed design, with a preliminary control tower design included in the reference design.

7.6.33 The reference design features a control tower building on the south-western side of the crossing from which the mechanism for the opening span is operated.

7.6.34 This tower is designed to house the control room apparatus, plant rooms and ancillary space required for operating the opening span.

7.6.35 The control room itself is located appropriately above bridge deck level to maximise visibility of the bridge deck and navigation channel for safety purposes.

Alternative controls for the opening mechanism

- CCTV operated remotely
- Single control room centrally located between the existing A47 Bascule Bridge and the Scheme to operate both mechanisms
- The Scheme's opening span operated from existing control room at the A47 Bascule Bridge

Through engagement with ABP (the likely operator of the bridge), it was decided that a new control tower would be incorporated in the Scheme in addition to the A47 Bascule Bridge control room. It is considered that a physical presence in the vicinity of the bridge increases safety and security.

7.6.36 It is envisaged that supplementary CCTV will be used to ensure operators have complete visibility of all areas for operations.

7.6.37 The bridge will be available for operation in accordance with the Scheme of Operation which will be prepared in accordance with the draft DCO. The control room is designed on the basis that it is occupied 24-7.

7.6.38 The initial feasibility design for the Scheme proposed the control tower be located on one of two in-water piers immediately beside the opening span. This additional structural load would require a larger pier to accommodate it, and not provide the operator ease of access as the proposal in the reference design does.

7.6.39 Through the development of the design, locating the control tower on the quayside offered the advantage of both bridge deck and quayside level access to it. This also aided the reduction of the in-water construction required and ensures the safety of the operators for access and egress.

7.6.40 The control tower was not positioned on the northern side of the crossing due to the possession of operational port land that would have been required. The southern side offers optimum visibility east and west of the crossing, with vehicular access to the tower for the operators' convenience and maintenance purposes from the new Access Road.

7.6.41 The south eastern side of the crossing was considered as an alternative location for the control tower. However, this was discounted due to the impact on the adjacent land owner and due to the limited space available for the structure and access to it.

7.6.42 Locating the control tower on the south-western side of the crossing also offers future opportunities as a link between the bridge deck and local future development on the southern quay through for example a public staircase or lift.

Figure 68: Photograph of existing A47 Bascule Bridge control tower

7.6.43 The existing control tower for the A47 Bascule Bridge was considered as a reference the spatial allocation and circulation required for this work place (see Figure 68).

7.6.44 Further engagement with the harbour master, bridge operators, and appropriate parties can inform of any of any further operational improvements of the current control tower or additional requirements to be considered, during detailed design.The reference design does not propose public access through the initial implementation of the Scheme due to the uncertainty of the timescales for development of the southern quay although it does not preclude such features being brought forward at a later date when there is sufficient demand.

7.6.45 Architectural advisor Jonathan McDowell from Matter Architecture Ltd was appointed to generate outline proposals for the control tower. The proposal ensures that the structure aligns with the Vision, and particularly the design narrative for the Scheme, whilst ensuring flexibility for detailed design of the structure.

7.6.46 The visual appearance of the control tower required careful consideration to ensure it does not detract from the ‘main event’ of the mechanism and superstructure design, but contributes to the design through its connections to its surrounding context and as a functional building.

7.6.47 Exploration of the visual relationship between the control tower, the superstructure, and the Scheme as a whole informed the simplistic and utilitarian appearance of the structure. Its scale alongside the crossing did not lend itself to a bold contrasting appearance as used on the superstructure.

7.6.48 The reference design is intended to complement the superstructure design and reflect its function through its form.

7.6.49 Given the necessity for the control tower to be located above bridge deck level for visibility, this offered an opportunity for interaction with the bridge deck level where the public could utilise the space as a ‘viewing platform’.

7.6.50 This sheltered space offers views of the superstructure, and west towards Oulton Broad. Through detailed design this space can be refined with interactive and informative features for visitors and children.

7.6.51 Where a space in the parapet is required to allow pedestrian access to the viewing platform of the control tower, 'defensive furniture' may be positioned in its place. These may consist of solid cube forms of an appropriate size and spacing to ensure no entry of vehicles, but additionally provide informal seating for people to use. Such furniture items must provide the appropriate protection, whilst adding to the street scene so as not to inhibit circulation for pedestrians. These will be developed through detailed design, with guidance provided by the DGM.

7.6.52 The control tower design does not preclude later adaptation to provide stair and/or lift access from the bridge deck to the southern quayside. While the southern quayside is allocated for future development, it is currently predominantly brownfield land.

7.6.53 The opening mechanism requires a plant room for necessary apparatus and a power supply. Originally intended to be housed by the control tower itself, development of the mechanism requirements showed that this would benefit from its own separate structure and associated compound area of an adequate size.

7.6.54 The positioning of this essential equipment beneath the footprint of the bridge is advantageous in ensuring a good connection to the opening span from the pier, along the bridge deck to the mechanism. This utilises the space beneath the bridge deck and does not inhibit any future development, links, or use of the southern quayside in future.

7.6.55 There is an opportunity to provide secure access into the bridge deck structure at this location for inspection and maintenance purposes if required.

7.6.56 There is a possibility that the opening mechanism and associated lighting and barriers may be operated from existing power supplies in the vicinity. The reference design includes the substations provisionally in the event that they are required, and can be suitably integrated in the detailed design.

7.6.57 To provide an intriguing appearance for the control tower, there is a potential for it to be clad in coloured stainless steel. This material can be treated to offer a tactile and unique surface, changing appearance in different lights. A design such as this for the control tower will provide solution which aligns with the design narrative, and will be included in the DGM. The 'Control Tower Design Report' produced by Matter Architecture Ltd can be found in Appendix 7.

7.6.58 The reference design for the control tower allows flexibility for development during detailed design, to respond to operational requirements.

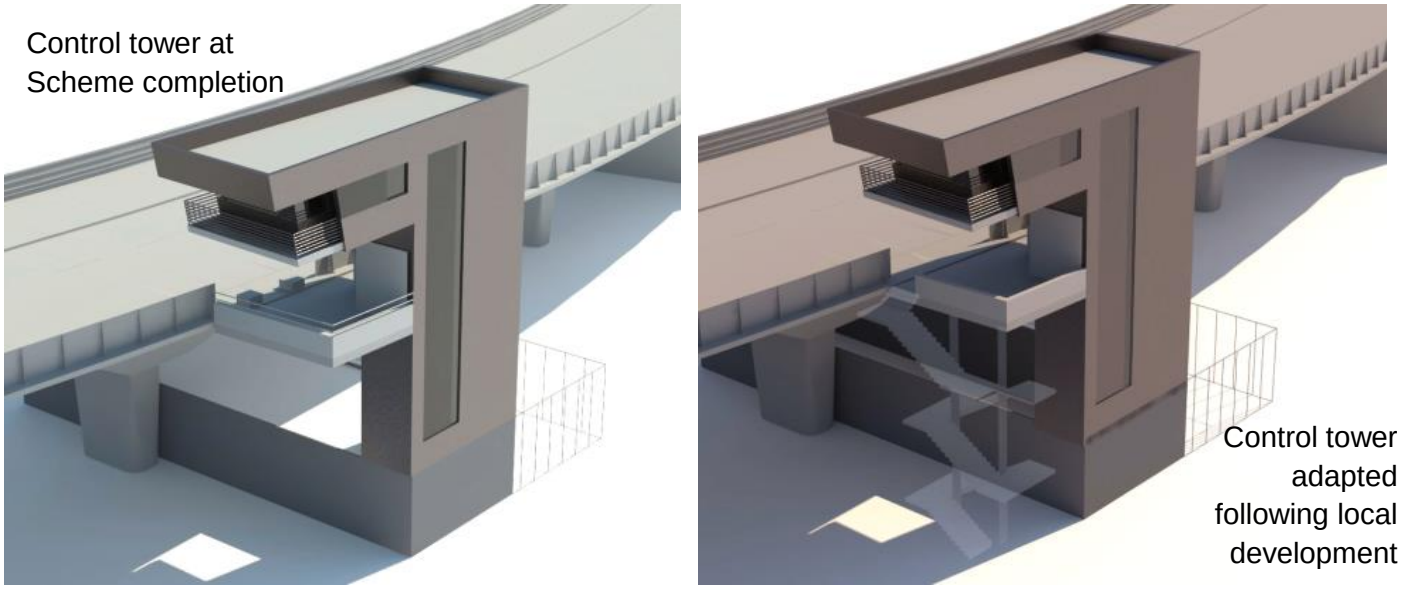


Figure 69: An artists' impression of how control tower could be adapted in future

Figure 70: Indicative view from the control tower structure in the reference design

Drainage design

7.6.59 The Drainage Strategy for the Scheme is included in Appendix 18B of the ES (document reference 6.2). Similar to the northern approach, the footway and combined footway / cycleway will drain to the carriageway. Run off from the carriageway will be collected by a combined kerb drainage system running south towards the southern junction.

7.6.60 It is proposed to discharge the run-off from the main carriageway and associated footways and combined footway / cycleway to two separate locations:

- For the section south from the opening span to the structure providing access to the Nexen Lift Trucks site, the run-off will be collected in a storage tank situated below

the footprint of the bridge. It is proposed that this tank will be located to the south of the proposed control tower location.

The tank will be appropriately sized to store the run-off from a 1 in 100 year storm event with a six hour duration. Initial calculations indicate that the tank will need to be capable of storing approximately 477m³ to be discharged in to the existing drainage system.

- South of the proposed access serving Nexen, the drainage run-off will be routed in to oversized pipes which will also provide storage capacity. These will be located within the vicinity of Waveney Drive, and will discharge in to the existing drainage system in Waveney Drive. A flow control device will be incorporated into the layout to ensure that the rate of discharge is acceptable to the appropriate drainage authority.

7.6.61 The proposed drainage for the new Access Road in to the Riverside Road business area will be a conventional chamber and gully system. It is assumed that the new systems will outfall to the existing drainage system which is present in Waveney Drive, Canning Road and the remaining length of Riverside Road west of the Scheme. Chambers will be located in the verge at maximum 100 metre centres.

Alternative drainage chamber location

Positioning the chambers within the carriageway was considered

This option was discounted as it is preferable for maintenance access for the chambers to be in the verge.

7.6.62 The proposed manholes, gullies and pipe runs would be constructed in accordance with either Suffolk County Council's standard drawings, or the Manual of Contract Documents for Highway Works details.

7.6.63 Footways and cycleways which are provided adjacent to the carriageway shall generally drain towards the carriageway.

Landscape and public realm design

7.6.64 In this location, tree planting is utilised to soften streetscapes and replace any lost through construction.

7.6.65 The proposals align where possible with guidance and aspirations for the public realm provided in the AAP and SUN Brief. The DGM will contain specific guidance on the aspirations for the new Access Road in line with appropriate guidance and policy to facilitate comfort and convenience for NMUs.

7.6.66 The closure of vehicular access to Durban Road from Waveney Drive, and consequent reduction in traffic volumes on this road offers an opportunity for NMUs, particularly cyclists, who can access the traffic-free route which is parallel with Waveney Drive.

8 Scheme: The reference design

8.1 The reference design: illustrative images

8.1.1 This section illustrates the reference design through images derived from a digital 3D model of the Scheme with assumptions and indicative components shown in place of that which will be developed further in detailed design.

8.1.2 It then provides tabulated explanations of the Scheme's adherence to the design principles, Design Council CABE principles (from Section 2 of this report).

8.1.3 As shown in previous sections, here the Scheme is divided geographically into the following areas:

- Northern approach
- The crossing and opening mechanism
- Southern approach

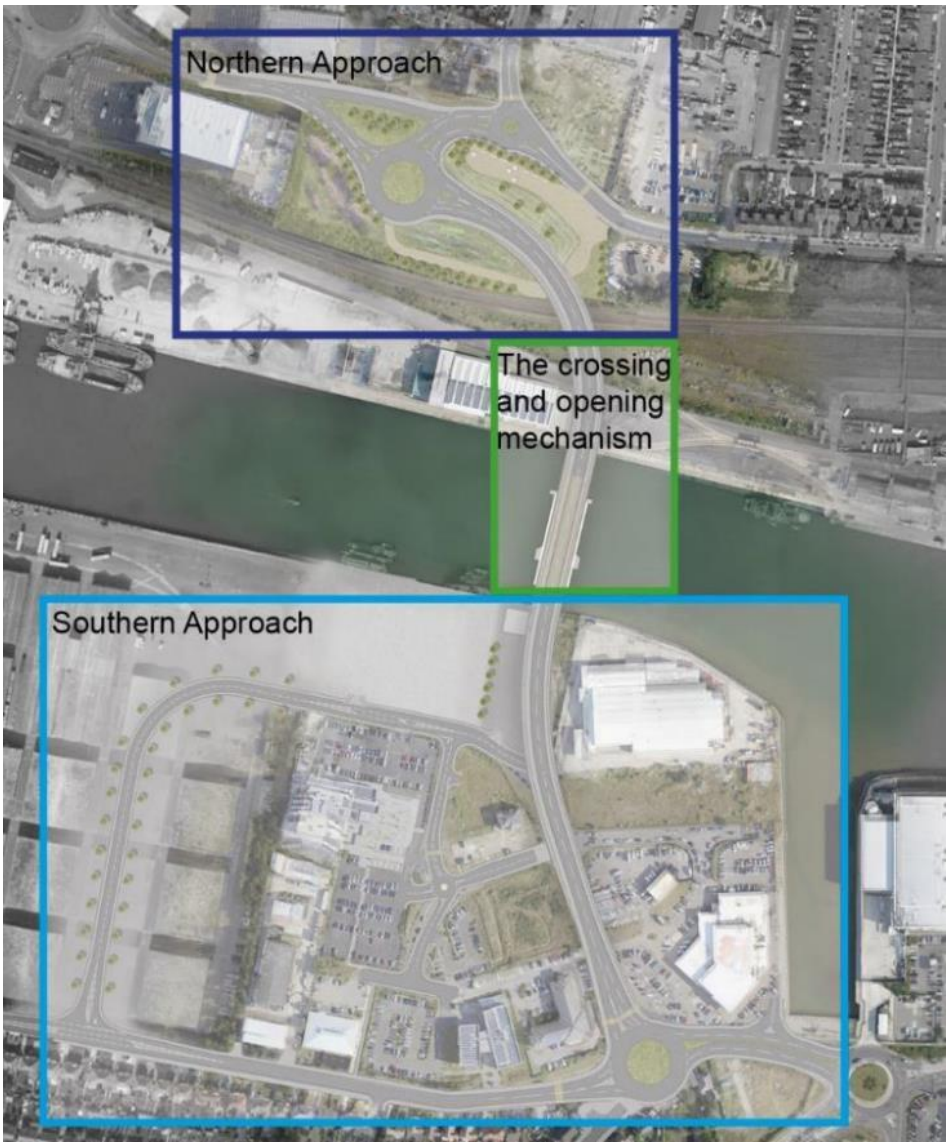


Figure 71: Areas of the Scheme

Figure 72: Illustrative image of the reference design of the Scheme

8.1.4 The plan in Figure 72 demonstrates how the Scheme could look, in line with the Vision for the Scheme. This reference design demonstrates the feasibility and ambitions for the Scheme, the detail of which will be developed in accordance with the DGM.

8.1.5 The design shown allows some flexibility for the Scheme to be developed further in detailed design.

Figure 73: Northern approach area of Scheme

Figure 74: View east from proposed pedestrian cycle path towards underpass

Figure 75: View east over proposed public space towards Denmark Road

8.2 The crossing and opening mechanism

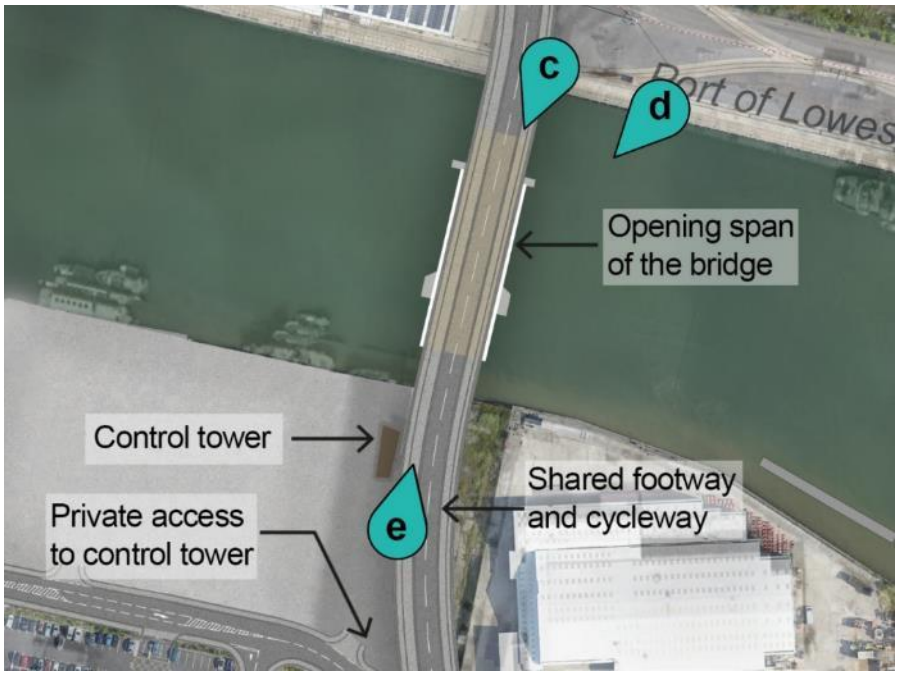


Figure 76: The crossing and opening mechanism area of the Scheme

Figure 77: View from bridge deck looking south-west towards opening span

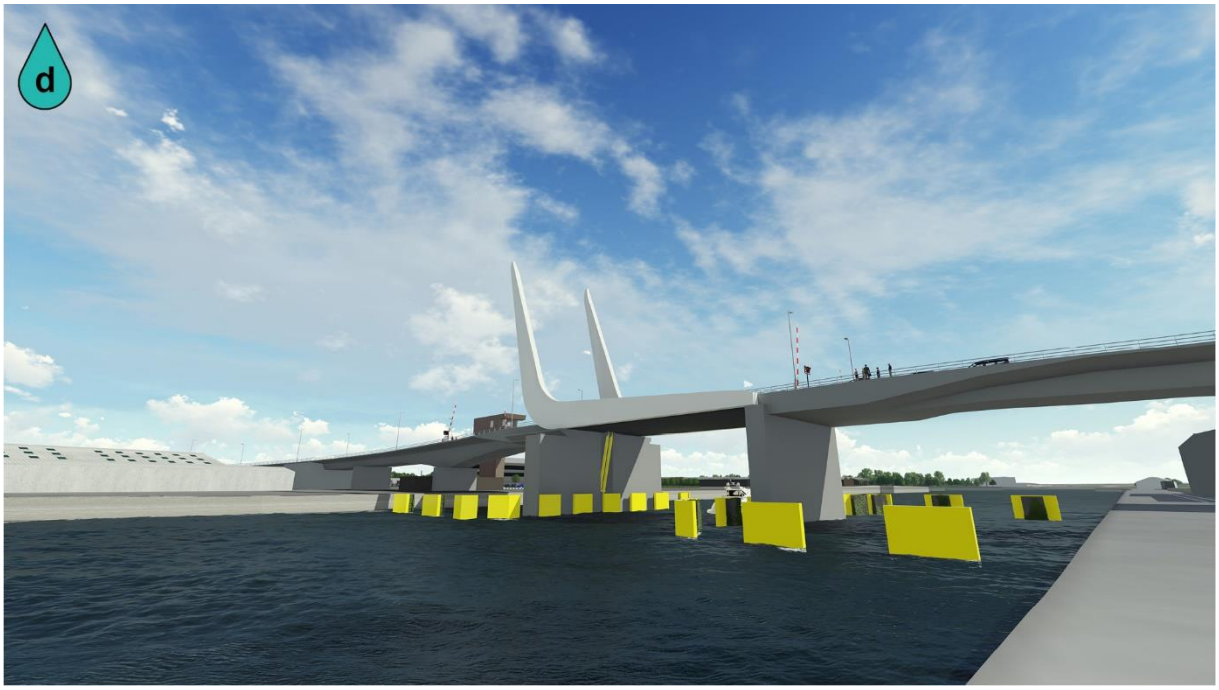


Figure 78: View from northern quay looking south-west towards opening span of Scheme

Figure 79: View from south-western side of bridge deck looking north towards control tower location

8.3 Southern approach

Figure 80: Southern approach area of the Scheme

Figure 81: View from proposed southern roundabout looking west towards Waveney Drive

8.4 The reference design review

8.4.1 The following tables provide a summarised explanation of how the reference design for the Scheme has met the requirements and aspirations set out in:

- The Design Principles (derived in collaboration with the LPAs)
- The Design Council CABE 'A design-led approach to infrastructure' principles
- The Scheme considerations and constraints (as described in Section 6 of this report)

8.5 The Design Principles:

8.5.1 The design principles set out for the scheme in Section 2 of this report provide a criteria against which the design for the Scheme can be reviewed. These design principles underpin the design from inception to implementation.

8.5.2 The following explanation considers the design principles in relation to the reference design. The DGM refers to the design principles as part of the Vision, to inform further development of the Scheme through detailed design.

Design Principle (DP)		Explanation
DP1	**The Scheme shall enhance the identity, culture, character, and nature of Lowestoft and make a positive aesthetic and actual contribution to the conservation and enhancement of Lowestoft's natural, historic and built environment**	The design of the Scheme utilises its prominent location in the town to provide a striking new feature through the function of the opening bridge mechanism. The simple and contemporary design has the opportunity to become a new symbol or landmark for the town. The design narrative for the Scheme reflects the town's port and coastal identity, and emerging industries through its design. The approaches to the bridge utilise the areas surrounding the highway alignment to provide new public realm and biodiversity planted areas.
DP2	**The design shall acknowledge its role in place making and promoting regeneration particularly through its relationship to adjacent land**	As a key new route in the town, the Scheme ensures safe and convenient routes are provided for all users; vehicles, pedestrians, and cyclists. The design, particularly at the southern approach, offers adaptability to accommodate future development and potential accesses from the bridge deck to this area. The new Access Road is designed to be adapted for future development connections too.

DP3	**There shall be a cohesive design narrative bringing together the distinct elements of the scheme, the primary and secondary structures, including the control tower**	The 'marine tech' narrative developed with the LPAs provided a way to ensure a unified design of the Scheme. This idea can therefore be applied to the Scheme design as a whole, in each component, and for consideration in the detailing and finishes during detailed design. The narrative reflects a form that is derived through its function, in this case, the function of the rolling lift bascule mechanism with a vertical counterweight has informed the appearance of the design.
DP4	**The design shall respond to the external constraints imposed by statutory bodies and internal constraints including capital and maintenance costs**	Throughout the Scheme design, the Applicant has maintained engagement with statutory bodies and affected parties to input to the design where practicable. This will continue through detailed design to implementation.
DP5	**The scheme shall result in a positive user experience for all users, be it vehicular, pedestrians, cyclists or less abled individuals, and water borne vessels through its own design and its practical connectivity to the existing network.**	The Scheme looks not only to provide a key connection across Lake Lothing, but a 'place' for people to enjoy. The experience and safety of all users has informed the design development, whilst ensuring its reliability and convenience as a new route.
DP6	**The design shall strive to minimise impacts on amenity and seek sustainability in its use of materials, and inclusion of multi-functional green infrastructure which encourages health and wellbeing.**	The Scheme aims to acquire the minimum land take required to facilitate the crossing design. Space surrounding the highway alignment have been utilised for biodiversity planting and public space for people to enjoy. Through the convenience and good design used, more sustainable modes of transport will be a more attractive option for people, particularly for their short journeys in Lowestoft. Through development of the design, the size and volume of every component has been reduced as far as is practicable and functional to ensure no unnecessary material or form.

Table 4: A review of the reference design with the design principles

8.6 The Scheme and the Design Council CABE Principles:

8.6.1 A review of the reference design in relation to the DCC principles explained in Section 3.5.15 of this report.

DCC Design Principle		Explanation
1	**Setting the scene**	The Design Principles derived with the LPAs provided a clear approach to the Scheme design beyond its functional and structural requirements. The design narrative builds on this consideration of design which responds to its context and ensures good quality design is integral.
2	**Multi-disciplinary teamwork**	The Applicant has sought the advice and expertise of industry experts as part of the design team, and for third party reviews of the design. The design team comprises of landscape architects, urban designers, architects, transport planners, and engineers specialising in highways, structures, geotechnical, mechanical and electrical, maritime, lighting, and drainage.
3	**The bigger picture**	The Scheme has been a long-standing ambition for Lowestoft to improve connections and alleviate the strategic road network. Further to this, the Scheme has the opportunity to reduce severance between the northern and southern communities, offering a route for sustainable modes of transport – contributing to healthier lifestyle choices. The Scheme design looks to provide adaptable space and good connections to the surrounding context, and adjacent sites for future development. The control tower design goes beyond its function to provide a space for the public to utilise and observe the operations of the bridge and the operational port.
4	**Site masterplan**	The Scheme design considers it connection to the existing networks and surrounding context, responding to the identity of the town through the design narrative. The design narrative provides an approach to good design to ensure the Scheme offers more than just its function to the town by providing a new ‘place’. The alignment of the

		highway left opportunity areas for planting and public realm to be maximised in the Scheme.
5	**Landscape and visual impact assessment**	The Scheme is not considered to be making a notable impact on the visual aspect of the town. The reference design with striking counterweight arms is considered to be a positive contribution to the town visually, contributing to its emerging identity as a renewable energy centre in the United Kingdom. The visual impact assessment contributed to the development of the reference design. By using 3D modelling as a tool for design development, it was possible to test how the emerging design appeared from various locations in the town, and how it compared in height with the surrounding context.
6	**Landscape design**	The Landscape and Urban design component aims to enhance the Scheme and its connection to the surrounding context. The public realm proposed for the Scheme provides amenity space and offers alternative routes up to and around the northern junction of the crossing for NMUs. The planting considered in the reference design aims to provide bio-diversity benefit and mitigate any impact on existing habitat on the northern approach. These areas offer a place for materials to be reused on site during construction for interactive elements, or as hibernaculum for fauna species.
7	**Design Approach**	The approach to 'good design' has been well considered to ensure opportunities are maximised for the Scheme. The use of a multidisciplinary team, and an Architectural Advisor ensures the Vision is maintained by all parties contributing to the design. The design narrative was developed with the local planning authorities to ensure that an appropriate approach was taken to all components of the design and detailing. The Architectural Advisor role was utilised to ensure a suitable solution was derived for the Control Tower design, a structure which must perform a function without competing with the crossing structure visually. The use of a Design Guidance Manual ("DGM") to inform the contractor of the requirements through detailed design ensures this approach is

		maintained and executed in line with the vision and design narrative.
8	**Materials and detailing**	The design narrative for the Scheme informs the use of a simple palette of materials and finishes, ensuring the function is evident through appearance of each structural component. The DGM will ensure that quality will not be compromised through the detailing of the design. Whilst the reference design allows for flexibility and innovation, the overarching vision, design narrative, and approach to good design must be retained.
9	**Sustainability**	Sustainability is a key consideration in any infrastructure project such as the Scheme, through the objectives it seeks to meet, and the approach to design and construction. Through the nature of offering an additional route in the town, sustainable modes of transport can be encouraged for locals and visitors of Lowestoft. The design narrative implies the need for a simplistic solution avoiding any unnecessary material or forms on the structure. The landscape and urban design offers planted areas for materials to be reused on site for interactive furniture or hibernaculum. These areas may provide habitat conditions for bio-diversity benefits. Public realm areas consider the need to be adaptable for multiple uses, and the connection to new development in the future.
10	**Visitor centre**	The function of the crossing and opening mechanism is evident through its appearance, and does not require a visitor centre dedicated to communicating this. There is however a viewing platform provided within the control tower structure, the positioning of the structural components ensure these functions can be viewed by the public safely. The user experience has been considered through the approach to good design.

Table 5: A review of the reference design with the Design Council CABE Principles

8.7 The Scheme constraints and considerations:

8.7.1 A review of the reference design in relation to the Scheme constraints and considerations explained in Section 6 of this report.

Scheme constraint or consideration type		Explanation
6.1	**Overarching / Scheme-wide**	The reference design provides a solution for the Scheme which demonstrates its ability to achieve the Vision within the LoD. It also considers future local development in its design, to ensure adaptability and good connections.
6.2	**Parameters for design**	The LoD provide an envelope in which the Scheme design must fit, to ensure that any impacts can be suitably assessed for the application for DCO. The reference design, whilst providing a feasible solution within this envelope, maintains flexibility where required for further development and innovation through detailed design.
6.3	**Physical**	Through a number of iterations, the reference design provides a solution which responds to the physical constraints and aims to incur as little impact on affected parties and land take as possible. The Scheme design is shaped by the standards it must meet, by the needs of affected parties, and of future users of the crossing (on land, and in water) as far as is practicable. *Topography* The highway alignment has been developed to offer an air-draught as high as possible over Lake Lothing, whilst considering the need to tie into the existing levels at either side of the Scheme. *Port and leisure vessel activity* The alignment of the Scheme considers the turning circle of vessels near Kirkley Ham, and is located west of this area. The alignment is perpendicular to Lake Lothing to minimise the construction required

		in water, to reduce the amount of port land over-sailed by the bridge, and to simply navigation for vessels. The reference design features an available air-draught of 12m to allow vessels below this height to pass without requiring a bridge opening. The efficiency of the lifting sequence has been a key consideration in the development of the reference design to aim to minimise disruption for vessels and road traffic when bridge lifts are required. The navigable width provided by the reference design of 32m between fenders exceeds that available at the existing A47 Bascule Bridge. The lighting design considers the need to minimise glare or interference with approaching vessels. Consultation with leisure craft users concluded that a pontoon was required as part of the Scheme to provide safety and convenience for small vessels awaiting a bridge lifting sequence. The Scheme provides a pontoon for this purpose. *The East Suffolk Line* The vehicle restraint system on the bridge deck, and the clearance provided beneath the bridge deck accommodate the current railway service, and the requirements were it to become an electrified line in the future. The construction methodology for the structure over the East Suffolk Line considers the need to facilitate uninterrupted services as far as is practicable. *Accessibility* The Scheme complies with the relevant standards to provide a safe and comfortable route and connections to existing networks for all users. The bus stops located on the north-western extent of the Scheme have been relocated slightly further west on Peto Way, for safety and convenience. The reference design includes a continuous footway on

		the westbound side of Peto Way where currently none is provided. *Access and maintenance requirements* The reference design considers the need for a robust but quality solution to simplify the maintenance requirements and provide a 120 year design life. The need for maintenance and inspection access has been considered for all components of the design, which aims to minimise disruptions for all users of the crossing. *Connections to the existing road network* The reference design provides safe connections to the surrounding networks considering convenience and decision making points of all users. *Ground conditions* The GI work undertaken informed the foundation design for the reference design, including the placement of structural components away from the existing southern quay wall. *Service tunnel* The Scheme is located a suitable distance away from the service tunnel in the lake bed. Consideration was given to how this tunnel could be utilised for the Scheme and its electrical connections, but concluded as not being feasible. *Private and business accesses* The location of the Scheme on what is currently Riverside Road requires suitable access provision to be provided as part of the reference design by means of an underpass structure to provide access to premises to the east of Riverside Road and a new Access Road on the Southern Approach.

		Utilities and underground assets These have been considered and relocated where appropriate in the reference design. *Order Limits* Consideration has been given to how the Scheme will be constructed, operated, and maintained to derive the Order Limits in which the reference design is situated.
6.4	**Environmental**	Consideration of environmental factors from the outset has ensured the Scheme design aims to minimise impact as far as is practicable, providing bio-diversity benefits and mitigation where necessary. The reference design has developed to provide an iconic architectural solution for the Scheme which will contribute positively to the identity of the town.
6.5	**Affected parties**	The Scheme looks to ensure as little impact on affected parties as practicable within the requirements of the design. Special consideration has been made to how the Scheme will be constructed to meet the needs of statutory consultees and affected parties where needed.
6.6	**Public acceptability**	As a long-standing ambition in the town, the Scheme looks to provide more to Lowestoft than purely a SRN alleviation function. The appearance, legibility, and functionality of the Scheme as a new route are important factors of the inclusive user experience which are important considerations in the approach to good design. The Scheme has the opportunity to contribute to the identity of Lowestoft, and how locals, visitors and businesses perceive it. Contributing to a positive image for the town, the Scheme can encourage sustainable modes of transport, and investment in local development.

6.7	**Financial**	Whilst the Scheme is constrained by the available funding, the design aims to maximise opportunities, including bio-diversity benefits, adaptable public spaces, and creating a new 'place' in the town.

Table 6: A review of the reference design with the Scheme considerations and constraints

9 Approach to detailed design

9.1 Introduction

9.1.1 The reference design considers flexibility for further development, innovation, and enhancement through detailed design within the parameters assessed by the environmental statement and secured through the limits of deviation in the Applicant's draft development consent order

9.1.2 Consideration has been given to how components of the reference design can be developed to ensure continuity with the Vision that underpins the design.

9.1.3 To capture the approach to be taken during detailed design, a Design Guidance Manual (“DGM”) has been prepared in collaboration with the LPAs.

9.2 The purpose of the DGM

9.2.1 The DGM details components of the reference design which are fixed in principle, and those that shall be developed by the contractor within the criteria defined by the manual.

9.2.2 This ensures continuity of design and design quality standards across the entirety of the Scheme when it is developed further in detailed design and subsequent construction.

9.2.3 The purpose of the manual is to ensure that expectations for contractor commitments in the detailed design process are clearly communicated and understood.

9.2.4 The manual therefore provides a mechanism for safeguarding the principles of good design that are embedded within the reference design through the detailed design and construction of the Scheme.

9.2.5 The DGM (document reference 7.6) is secured by the requirements of the draft DCO.

10 Glossary

Terminology	Description
Abutment	A structure to support the fixed span of the crossing
Air-draught	The distance between the underside of the crossing (the soffit) and the highest astronomical tide
Bearing	A resting surface between the soffit and the support structure beneath it, designed to transfer loads whilst reducing the stress caused by movement and rotation
Dolphin	An independent marine structure for assisting vessels in navigation, designed to withstand impact
Fender	Marine structures designed to absorb kinetic energy from vessels to prevent damage to vessels and structures
Ghost Island	A form of traffic island made with road marking, rather than raised kerbs or a physical obstruction.
Hibernacula	A place where creatures can seek refuge or hibernate, they can be constructed from felled timber, tree roots, and rubble
Integral connection	A direct connection between the soffit and the support structure beneath, it without a joint such as a bearing
Place-making	An approach to design which considers the betterment of places for people; to improve community interactions, promote healthy lifestyles, and quality public space
Pier	An upright structure to support a superstructure above it and transfer loads to the foundations
Substructure	The part of the structure supporting the bridge deck, including the piers, abutment, and other support structures.
Soffit	The underside of a construction element, in this Scheme, the bridge deck
Superstructure	The part of the structure forming the spans of the bridge deck or receiving live loads

Appendices

Appendix 1 – Departure from Standards Report

Appendix 2 - Outline Approval in Principle for Approach Viaducts

Appendix 3 - Outline Approval in Principle for Central Bascule Span

Appendix 4 - Outline Approval in Principle for Riverside Road Access Portal Frame

Appendix 5 - Outline Strengthened Earthworks Appraisal Form

Appendix 6 - Design Council CABE Feedback

Appendix 7 – Control Tower Design Report / Matter Architecture Ltd

Appendix 8 - Road Safety Audit Stage 1 Report

Appendix 9 – Lighting Report

Appendix 10 – Network Operations Strategy

Appendix 11 – Fender Design Report