Road Investment Strategy

East Area 6

A47 / A11 Thickthorn Junction Improvements

PCF Stage 2

Scheme Assessment Report (SAR)

HE551492-ACM-GEN-TJ-RP-ZM-00006

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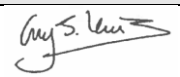
Guy Lewis		**Programme Lead (PL)**	**25/01/18**	**1**

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List of Acronyms

AADT	Annual Average Daily Traffic
ACM	Asbestos Containing Materials
ANPR	Automated Number Plate Recognition
APTR	All-Purpose Trunk Road
AQMA	Air Quality Management Areas
AS14	Autumn Statement 2014
ASC6	Asset Support Contract for Area 6
AST	Appraisal Summary Table
AVFM	Affordable Value for Money
BCR	Benefit Cost Ratio
BGL	Below Ground Level
BGS	British Geological Survey
CC	Climate Change
CCTV	Closed-circuit Television
CDM	Construction Design and Management Regulations
CEMP	Construction Environmental Management Plan
COBA	Cost Benefit Appraisal
CPO	Compulsory Purchase Order
CSR	Client Scheme Requirements
D2AP	Dual Two Lane All Purpose
DCO	Development Consent Order
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
EA	Environmental Assessment
EAR	Environmental Assessment Report
EAST	Early Assessment and Sifting Tool
EIA	Environmental Impact Assessment
ERT	Emergency Roadside Telephone
FRA	Flood Risk Assessments
GCN	Great Crested Newts
GNIP	Greater Norwich Infrastructure Plan
GNLP	Greater Norwich Local Plan
HA	Highways Agency (replaced by Highways England on 1 April 2015)
HADDMS	Highways Agency Drainage Data Management System
HAGDMS	Highways Agency GeotechnicalData Management System
HECSD	Highways England Commercial Services Division
ICD	Inscribed Circle Diameter
IDC	Investment Decision Committee
KPI	Key Performance Indicator
KSI	Killed or Seriously Injured
LEP	Local Enterprise Partnership
LRN	Local Road Network
LLTP	(lighting) Look Through Percentage
LTP	Local Transport Plan
MAC	Managing Area Contract
MfS	Manual for Streets
MOVA	Microprocessor Optimised Vehicle Actuation
MRSS	Maintenance and Repair Strategy Statement
NATS4	Norwich Area Transport Strategy
NATS	Norwich Area Transport Study
NCC	Norwich City Council
NDD	Network Delivery and Development Directorate
NDP	Neighbourhood Development Plan
NDR	Northern Distributor Road
NMU	Non-Motorised User
NPS	National Policy Statement
NPSNN	National Policy Statement for National Networks

NSIP	Nationally Significant Infrastructure Project
NSR	Noise Sensitive Receptor
NTIS	National Traffic Information Service
OAR	Options Assessment Report
O.D.	Ordnance Datum
OME	Order of Magnitude Estimate
PCF	Project Control Framework
PIE	Public Information Exhibition
PRA	Preferred Route Announcement
PRoW	Public Rights of Way
RAG	Red, Amber, Green
RFC	Ratio to Flow Capacity
RIS	Roads Investment Strategy
RPG	Registered Park and Garden
RSA	Road Safety Audit
RTMC	Regional Technology Maintenance Contracts
SAC	Special Area of Conservation
SAR	Scheme Assessment Report
SBP	Strategic Business Plan
SES	Safety Engineering and Standards (ex-PTS)
SGAR	Stage Gate Assessment Review
SOBC	Strategic Outline Business Case
SPA	Spatial Planning Arrangement
SPZ	Source Protection Zone
SRN	Strategic Road Network
SSD	Stopping Sight Distance
SSR	Solutions Summary Report
SSSI	Sites of Special Scientific Interest
TAR	Technical Appraisal Report
TEE	Transport Economic Efficiency
TM	Traffic Management
TPG	Transport Planning Group
TRADS	Traffic Flow Data System
TSR	Transport Summary Report
TSRGD	Traffic Signs Regulations & General Directions
TUBA	Transport appraisal and modelling tools
UXO	Unexploded Ordnance
VISSIM	Traffic microsimulation modelling software
VM	Value Management
VMS	Variable Message Signs
VPH	Vehicle Per Hour
WebTAG	Web based Transport Analysis Guidance

Executive Summary

In December 2014 the Department for Transport (DfT) published the Road Improvement Strategy (RIS) for 2015-2020. The RIS set out a list of schemes to be developed by Highways England over the period of April 2015 to March 2020.

The RIS identified six schemes along the A47/A12 Corridor including the A47 Thickthorn Junction. The objectives for this Alteration scheme were identified as:

"A47/A11 Thickthorn Junction: Improvement of the interchange between A47 and A11, improving access into Norwich".

The primary objectives of the scheme are to promote growth and facilitate development by improving the strategic road network to minimise negative impacts on users, local communities and the environment.

A Solutions Assessment Report, produced at PCF Stage 0, identified the unsuitability of the current junction layout to accommodate both the dominant movement between the A11 south and A47 east (in both directions), and the strong tidal movement through the junction on the A11, during both peak hours. This is predicted to worsen in future years due to the future growth in strategic traffic, and growth from the large local residential developments in Heathersett and Cringleford.

None of the leading options that were identified during PCF Stage 1 were considered suitable for presentation at the Public Information Exhibitions, as further refinement was needed in order to reduce the cost and improve the economic benefits.

Prior to the commencement of PCF Stage 2, an attempt was made to identify an affordable, value for money (AVFM) solution prior to the next Investment Decision Committee (IDC) review. This exercise, which was informally referred to as the 'Deep Dive', resulted in the Single Option.

The Single Option that emerged was similar in concept to the leading option from PCF Stage 1 in that it included bi-directional interchange links between the A11 south and A47 east, which provide relief by segregating the dominant traffic flows, and by removing traffic from the Thickthorn Junction gyratory.

The Single Option was considered to be the only potentially feasible option which could be presented to the public.

Since the bi-directional interchange links sever Cantley Lane South, it is necessary to provide an alternative way of reconnecting Cantley Lane South to the main highway network.

For the originally proposed Single Option, which was presented at the PIE, it was proposed to connect Cantley Lane South to Cantley Lane (north) via an underpass beneath the A47.

Public Information Exhibitions were held on 25, 27 and 28 March 2017, and the feedback indicated that, whilst there was a good level of support for the proposed junction, there was some opposition to the proposal to reconnect Cantley Lane South to Cantley Lane (north).

One of the main reasons for objection was concerns regarding the potential for 'rat running' to the A11 at Station Lane. There were concerns raised about the volume of traffic that uses Cantley Lane South and that this traffic would be routed onto Cantley Lane (north), which is considered by many to be too narrow, as it frequently suffers from parked cars.

The A11 Station Lane Junction, which was originally built as an all movement at-grade junction, has since been converted to a left-in, left out junction. This has prevented traffic fro m Station Lane (north and south) from turning right onto the A11. Therefore, traffic travelling on the A11 southbound to the recycling centre at Station Lane returns via Cantley Lane South, as the main alternative is a long

detour via the A11 Wymondham Junction. There was public concern that, if Cantley Lane South and Cantley Lane (north) were to be reconnected, this traffic would be routed along Cantley Lane (north).

Preliminary designs for a total of six options for the local road, that were developed by AECOM, and one option suggested by a member of the public, have been assessed.

Option 4, which is to connect Cantley Lane South to the B1172 Norwich Road, is considered to be the best option to overcome the public concerns arising from the Public Information Exhibition (PIE), while not compromising the access arrangements for the residents on Cantley Lane South.

However, for Option 4, there are engineering design and environmental aspects that need to be resolved. It is therefore recommended that confirmation of the feasibility of this option should be undertaken during PCF Stage 3.

The possibility of providing Option 3 has therefore been left open. This is a refinement of the originally proposed Single Option, which causes less severance to a triangle of land between Cantley Lane South, the A47, and Breckland railway line. Instead of connecting to Cantley Lane (north), local traffic would be routed to Round House Roundabout via an underbridge beneath the A47, and the estate roads within the West of Cringleford Development.

Option 3 would resolve the public concerns related to an increase in traffic on Cantley Lane (north). However, it may result in local trips through the development West of Cringleford by vehicles returning from the Recycling Centre at Station Lane.

Residents on Cantley Lane South, the B1172 Norwich Road, the A11 Newmarket Road, Cantley Lane, and those on the west of Cringleford are sensitive receptors to environmental impacts. One Schedule Monument (Bronze Age burial mounds), is in proximity to both Options 3 and 4, and visual receptors on Public Rights of Way (PRoW), properties, roads and settlements are identified. Within the biodiversity study area (for both options), a number of important ecological features (habitats and species) are present with linkages to Norfolk Valley Fens Special Area of Conservation (SAC) and Eaton Chalk Pit Site of Special Scientific Interest (SSSI).

The environmental assessment ascertained that there is potential for adverse effects (pre-mitigation measures) to occur to Biodiversity and Noise and Vibration receptors during the construction phase of both Option 3 and Option 4. However, based on the current understanding of the study area and the likely environmental effects and potential mitigation, it is likely that the significance of the effects will be reduced.

The Single Option with local road Options 3 and 4 are respectively estimated to require a total of 13.5 and 14.7 hectares of land outside of the existing highway boundary. Therefore both these options will be considered a Nationally Significant Infrastructure Project (NSIP) and is likely to be subject to a Development Consent Order (DCO) process.

Order of Magnitude cost estimates were prepared by the Highways England Commercial team for Options 3 and 4.

The Stage 2 traffic and economic assessment was based on an updated version of the Norwich Area Transport Study (NATS) strategic model. The economic assessment for the Core growth scenario yields a Benefit to Cost Ratio (BCR) of 1.38. A BCR of this value would place it in the 'low value for money' category.

An economic assessment of low and high growth scenarios has also been undertaken. This results in a BCR of 0.87 under the Low growth scenario placing it in the poor value for money category, whereas under the High growth scenario there is a predicted BCR of 1.60 which places the scheme in the medium value for money category.

A high level programme for scheme delivery has been prepared making allowance for the DCO process. Based on this programme, construction is scheduled to commence in the 2019/2020 financial year.

1 Introduction

1.1 Scheme Development and History

1.1.1 Highways England (previously the Highways Agency) is responsible for planning the long term future and development of the Strategic Road Network (SRN) including its maintenance, operation and improvement. Highways England published its Strategic Business Plan (SBP) in response to the Government's Road Investment Strategy (RIS). The SBP sets out Highways England's main activities and strategic outcomes and how the Investment Plan will be delivered. Highways England's Delivery Plan builds on the SBP, setting out in detail how strategic outcomes will be delivered and success measured, while identifying future goals and plans. Highways England's strategic outcomes are:

- Supporting Economic Growth
- A Safe and Serviceable Network
- A More Free-Flowing Network
- Improved Environment
- An Accessible and Integrated Network

1.1.2 Highways England developed a Route Based Strategy approach to identify key investment needs on the Strategic Road Network.

1.1.3 The Route Based Strategy brought together both national and local priorities which have been captured in 18 Route-Based Strategy Evidence Reports, used to inform the RIS.

1.1.4 In 2014 AECOM carried out feasibility studies for the then Highways Agency and the DfT to identify issues on the Strategic Road Network on the A47/A12 Corridor between the A1 west of Peterborough and Lowestoft (south of the A47's junction with the A12). The study was completed in three stages that, overall, broadly aligned with Steps 5 to 9 of the DfT's Transport Analysis Guidance (WebTAG).

1.1.5 Twenty two locations were identified that were considered to have current or imminent problems and these were considered further at high level using criteria from the DfT's Early Assessment and Sifting Tool (EAST). AECOM developed the Options Assessment Report (OAR) for each scheme and from this recommended a solution for which a Strategic Outline Business Case (SOBC) was produced.

1.1.6 As a result of this work, an initial recommendation was made to carry out the following improvements:

- A47 Wansford to Sutton Dualling;
- A47 Guyhirn Junction Improvements;
- A47 North Tuddenham to Easton Dualling;
- A47 Thickthorn Junction Improvements;
- A47 Blofield to North Burlingham Dualling;
- A12 Great Yarmouth Junction Improvements[1].

[1] This combines the schemes previously known as A47/A12 Vauxhall Junction improvements and A12 package of roundabout improvements

1.1.7 This study was published on the DfT website and can be found at

https://www.gov.uk/government/publications/a47-and-a12-corridor-feasibility-study-technical-report

1.1.8 In December 2014 the DfT published the RIS for 2015-2020. The RIS sets out the list of schemes that are to be developed by Highways England over the period of April 2015 to March 2020. The RIS confirmed the original commitment to the schemes listed above for the A47/A12 Corridor.

1.1.9 Following the publication of the RIS, AECOM were commissioned to produce a high-level appraisal of benefits for the identified schemes on behalf of the DfT. This work was summarised in the A47 & A12 Corridor Feasibility Study (February 2015).

1.1.10 In April 2015 Highways England assumed responsibility for the Strategic Road Network and for delivering the Government's vision for that network as set out in the RIS. As a result Highways England took ownership of the previously DfT lead Strategy, Shaping and Prioritisation phase of scheme development.

1.1.11 In March 2015, AECOM, supported by Amey, were appointed to lead on the work to be carried out on the A47 and A12 in Norfolk, to jointly progress the six schemes which comprise the A47 Improvements Programme through Project Control Framework (PCF) Stage 0. This was completed in October 2015 and the AECOM/Amey team were retained to complete PCF Stage 1 for all six schemes.

1.1.12 For the schemes within the A47 Improvements Programme, PCF Stage 1 was completed in November 2016. Then, prior to the next IDC review, an exercise – that was informally referred to as the 'Deep Dive' review – was undertaken as an attempt to identify a more affordable, value for money (AVFM) scheme.

1.1.13 In January 2017, AECOM was retained to undertake PCF Stage 2 for the A12 Junction Improvements and the A47 Thickthorn Junction Improvements.

1.1.14 This report will focus on:

A47 Thickthorn Junction Improvements

1.2 Project Control Framework

1.2.1 The Highways Agency, now Highways England, introduced the PCF for their Major Projects directorate in 2008. The framework sets out the governance requirements as to how development of major highways schemes should be managed and delivered. The scheme is currently in PCF Stage 2 of the project lifecycle. The PCF stages are broken down as follows:

Table 1-1 Major Projects Lifecycle

PCF Stage	Delivery Item	Phase
PCF Stage 0	Strategy, Shaping and Prioritisation	Pre-project
PCF Stage 1	Option Identification	Options Phase
PCF Stage 2	Option Selection	
PCF Stage 3	Preliminary Design	Development Phase
PCF Stage 4	Statutory Procedures and Powers	
PCF Stage 5	Construction Preparation	
PCF Stage 6	Construction, Commissioning and Handover	Construction Phase
PCF Stage 7	Close Out	

1.3 Approach and Scope

1.3.1 The report follows the content of a PCF Stage 2 Scheme Assessment Report (SAR). The report describes the originally proposed Single Option for the A47 Thickthorn Junction Improvements, summarises the outcome of the PIE, and gives recommendations for changes to the originally proposed Single Option in response to the feedback from the PIE.

1.3.2 The design development has included conducting an environmental assessment to assess whether the proposed scheme has the potential to result in significant environmental effects. The results of the assessment are documented in the Environmental Assessment Report (EAR) and summarised in this report.

1.3.3 The findings of the environmental assessment (EA) are detailed across the following topics, which were scoped into the EA in accordance with the Design Manual for Roads and Bridges (DMRB):

- Air quality;
- Cultural heritage;
- Landscape and visual impacts;
- Nature conservation;
- Geology and soils
- Materials;
- Noise and vibration;
- People and communities;
- Road drainage and the water environment; and
- Cumulative impacts.

1.3.4 A number of traffic forecasting and economic assessment reports have been produced as required under PCF Stage 2. The content of these reports is summarised in the traffic and economic section of this report, which describes the existing and future traffic conditions and includes an economic assessment of the preferred option for each junction.

1.4 Purpose of the Report

1.4.1 The purpose of this PCF Stage 2 Scheme Assessment Report (SAR) is to provide a summary of the Technical Appraisal Report (TAR) Ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032, the Addendum TAR Ref. HE551492-ACM-GEN-TJ-RP-ZM-00019, Report on the Public Consultation Ref HE551492-ACM-GEN-TJ-RP-ZM-00007, subsequent developments, and to recommend a preferred option.

2 Planning Brief

2.1 Introduction

2.1.1 This section summarises national and local policy which could influence the design and appraisal of the future proposed scheme.

2.1.2 The following documents have been identified as relevant to the A47 Thickthorn Junction Improvements Scheme:

- National Policy Statement for National Networks (NPSNN)
- RIS (2014) comprises three separate reports (Strategic Vision, Investment Plan and Performance Specification)
- Highways England Strategic Business Plan (2015)
- Highways England Delivery Plan 2015-2020
- Greater Norwich Infrastructure Plan (2017)
- Greater Norwich Joint Core Strategy (2014)
- Cringleford Neighbourhood Development Plan

2.2 National Policy

National Policy Statement for National Networks

2.2.1 The NPSNN sets out the need for Nationally Significant Infrastructure Projects (NSIPs) on the national road and rail networks in England, and the Government's policy to deliver these projects. The National Policy Statements supplement the National Planning Policy Framework. The NPSNN augments the RIS.

2.2.2 Given the scale of the existing junction, and the expectation that more substantial improvements may be needed in the area (based on the findings of the Feasibility Study, 2014), it is considered likely that Thickthorn Junction alteration works will meet the criteria for NSIP and will therefore be subject to the DCO process. In this case, the planning application will be judged primarily against the NPSNN, according to the decision-making framework set out in the Planning Act 2008.

2.2.3 Assessment of the future proposed scheme should consider the balance of potential benefits and adverse impacts (paragraph 4.3 of the NPSNN). Benefits to be considered include the facilitation of economic development, job creation, housing and environmental improvement, and any longer-term or wider benefits. Assessment of adverse impacts should include longer-term and cumulative adverse impacts, as well as planned mitigation of these impacts.

2.2.4 Environmental, safety, economic, and social impacts should be considered at a national, regional, and local level. The information provided will be proportionate to the development (paragraph 4.4).

2.2.5 All projects should be subject to an options appraisal. The options appraisal should consider viable modal alternatives and may also consider other options. Section 7 of this report responds to this requirement by describing how the Single Option was assessed.

2.2.6 Section 5 of NPSNN provides guidance for decision making relating to impacts on environment, habitat, landscape, accessibility, and existing infrastructure. In relation to environmental impacts, the guidance is clear that planning permission should not be granted

for schemes which will have a detrimental impact on irreplaceable habitats, including ancient woodland (paragraph 5.32).

The Government's Road Investment Strategy

2.2.7 The Government's RIS defines a national programme of improvements to the Strategic Road Network (SRN).

Strategic Vision

2.2.8 The RIS introduces long-term strategic planning and funding for the SRN, underpinned by a significant increase in investment in the SRN. It is the ambition of Highways England to substantially modernise the SRN within 25 years. This vision for improvement of the SRN is outlined in more detail through the Performance Specification and Key Performance Indicators (KPI's) in Table 2-1.

2.2.9 127 major schemes will be investigated over the course of the first Road Period (2015-2020), in order to deliver benefits quickly.

2.2.10 In the longer term up to 2040, Highways England will look to achieve an upgraded network which makes use of the latest technology in order to fulfil the Performance Specification.

Investment Plan

2.2.11 The RIS sets out a number of specific locations for improvements to the SRN.

2.2.12 The A47/A11 Thickthorn Junction Improvements scheme is included, based on evidence gathered in the A47 & A12 Corridor Feasibility Study (February 2015).

2.2.13 Pages 25 and 26 of the Road Investment Strategy: Investment Plan detail the announced investment package for improvements along the A47/A12 corridor. This lists the A47/A11 Thickthorn Junction Improvements scheme as one of the schemes which make up the package of improvements as:

"A47/A11 Thickthorn Junction: Improvement of the interchange between A47 and A11, improving access into Norwich".

2.2.14 Page 43 of the Road Investment Strategy: Investment Plan lists the same scheme description for A47/A11 Thickthorn Junction under "Committed schemes newly announced in this Investment Plan" and also details the location of the scheme in plan, a copy of of which is included in Appendix A.

2.2.15 Page 16 of the Road Investment Strategy: Investment Plan describes the six corridor feasibility studies which "investigated the priorities for the routes and tested that potential improvements demonstrate a robust case for investment, offer value for money and are deliverable". The document indicates that "summaries of these studies will be published shortly (these summaries have now been published – see Feasibility Summary Report section 3).

2.2.16 The RIS does not give details on specific schemes that could provide this improved access to Norwich.

Performance Specification

2.2.17 The RIS outlines the Performance Specification and KPI's for Highways England.

2.2.18 Table 2-1 below summarises the KPI's as they apply to each point of the Performance Specification.

2.2.19 The RIS requires Highways England to develop detailed Performance Indicators to provide further detail on how the Company is progressing on each KPI.

Table 2-1 Road Investment Strategy – Performance Specification and Key Performance Indicators

Topic	Measure	Key Performance Indicator Target	Performance Indicator
Making the Network Safer	The number of Killed or Seriously Injured (KSIs) on the SRN	Ongoing reduction of at least 40% by end of 2020 against 2005-09 average baseline	Suite of PI's to illustrate the impact of activities undertaken by the Company, and the influence of external factors with regard to making the SRN safer. These should include: • Incident numbers and causation factors for motorways; • Casualty numbers and causation factors for All Purpose Trunk Roads (APTR's); and • IRAP based road safety investigations, developed in conjunction with the Department, to feed into subsequent Route Strategies.
Improving User Satisfaction	The percentage of NRUSS respondents who are Very or Fairly Satisfied.	Achieve a score of 90% by 31 March 2017 and then maintain or improve it.	Suite of PI's to provide additional information about the performance of factors that influence user satisfaction.
Supporting the Smooth Flow of Traffic	Network availability: the percentage of the SRN available to traffic.	Maximise lane availability so it does not fall below 97% in any one year	Suite of PI's to illustrate the impact of the activities undertaken by the Company, and the influence of other external factors, on traffic flow. This should include, at a minimum, reliability of journey times.
	Incident Management: percentage of motorway incidents cleared within one hour.	At least 85% of all motorway incidents cleared within 1 hour	

Topic	Measure	Key Performance Indicator Target	Performance Indicator
Encouraging Economic Growth	Average Delay (time lost per vehicle)	No Target Set	Suite of PI's to help demonstrate and evaluate what activities have been taken to support the economy. These should, at a minimum, include metrics on: • Being an active and responsive part of the planning system; • Supporting the business, and freight and logistics sectors; and • Helping the government support small and medium sized enterprises.
Deliver Better Environmental Outcomes	Noise: Number of Noise important areas mitigated	At least 1,150 Noise Important Areas over RP1	Suite of PI's to provide additional information about environmental performance. These should, at a minimum, include: • Air quality; and • Carbon dioxide, and other greenhouse gas emissions for the • Company and its supply chain that occur as they carry out work on the SRN.
	Biodiversity: Delivery of improved biodiversity as set out in the Company's Biodiversity Action Plan	Publish Biodiversity Action Plan by 30 June 2015 & report annually against the Plan to reduce net biodiversity loss on ongoing annual basis	
Helping Cyclists, walkers and other vulnerable users	The number of new and upgraded crossings	No Target Set	Suite of PI's to demonstrate the safety of the SRN for cyclists, walkers, and other vulnerable users.
Achieving Real Efficiency	Cost savings: savings on capital expenditure	At least £1.212 billion over RP1 on capital expenditure.	Suite of PI's to demonstrate that the portfolio is being developed and the Investment Plan delivered in a timely and efficient manner. These should include the progress of major schemes and programmes in construction through reporting CPI and SPI for schemes at PCF Stage 5 and beyond.
	Delivery Plan progress: progress of work relative to forecasts set out in the Delivery Plan, and annual updates to the Plan, and expectations at the start of RP1	Meet or exceed expectations	

Highways England Strategic Business Plan (2015-2020)

2.2.20 Highways England's Strategic Business Plan responds directly to the RIS and describes how Highways England will "go about delivering the requirements of a demanding Performance Specification".

2.2.21 The Strategic Business Plan defines KPI's against which the performance of Highways England will be measured, based on the Performance Specification included in the RIS.

2.2.22 Section 4 gives the background to the subsequent publication of the Route Strategies for the entire national network, the relevant Route Strategy for the A47 Corridor being the East of England Route Strategy (listed and discussed in Section 4).

Highways England Delivery Plan (2015-2020)

2.2.23 Highways England's Strategic Delivery Plan builds on the Strategic Business Plan and sets out in detail how Highways England will deliver the strategic outcomes and sets out how the Investment Plan will be delivered.

2.2.24 The A47/A11 Thickthorn Junction Improvements scheme is listed under the "Major Improvements Investment Plan Scheme Schedule 2015-2020" as one of the "Schemes identified following the outcomes from the six feasibility studies."

Highways England Route Strategy: East of England

2.2.25 The East of England Route Strategy Evidence Report records requests made during consultation with local stakeholders for capacity upgrade at the Thickthorn Junction.

2.2.26 The Technical Annex of the Route Strategy notes current and future congestion issues at the Thickthorn Junction.

2.3 Structure of Local Policy in the Greater Norwich Area

2.3.1 The Thickthorn Junction is located within South Norfolk local planning authority area. South Norfolk Council shares a Core Strategy, the Greater Norwich Joint Core Strategy (JCS) (part of its Local Development Plan) with two other local authorities: Norwich City Council and Broadland District Council.

2.3.2 In addition to the Joint Core Strategy, South Norfolk Council maintains its own Local Development Framework, which includes Site Specific Allocations and Development Management Policies, Neighbourhood Development Plans (NDPs) and Area Action Plans specific to South Norfolk.

2.3.3 At a tier below, Cringleford Parish Council, which spans part of the Thickthorn Junction, has adopted a NDP. This plan is discussed in more detail later in this chapter. Hethersett, Ketteringham and Keswick, and Intwood parishes do not currently have an adopted or draft NDP.

2.3.4 The structure of planning policy within the Greater Norwich area is summarised in Figure 2-1.

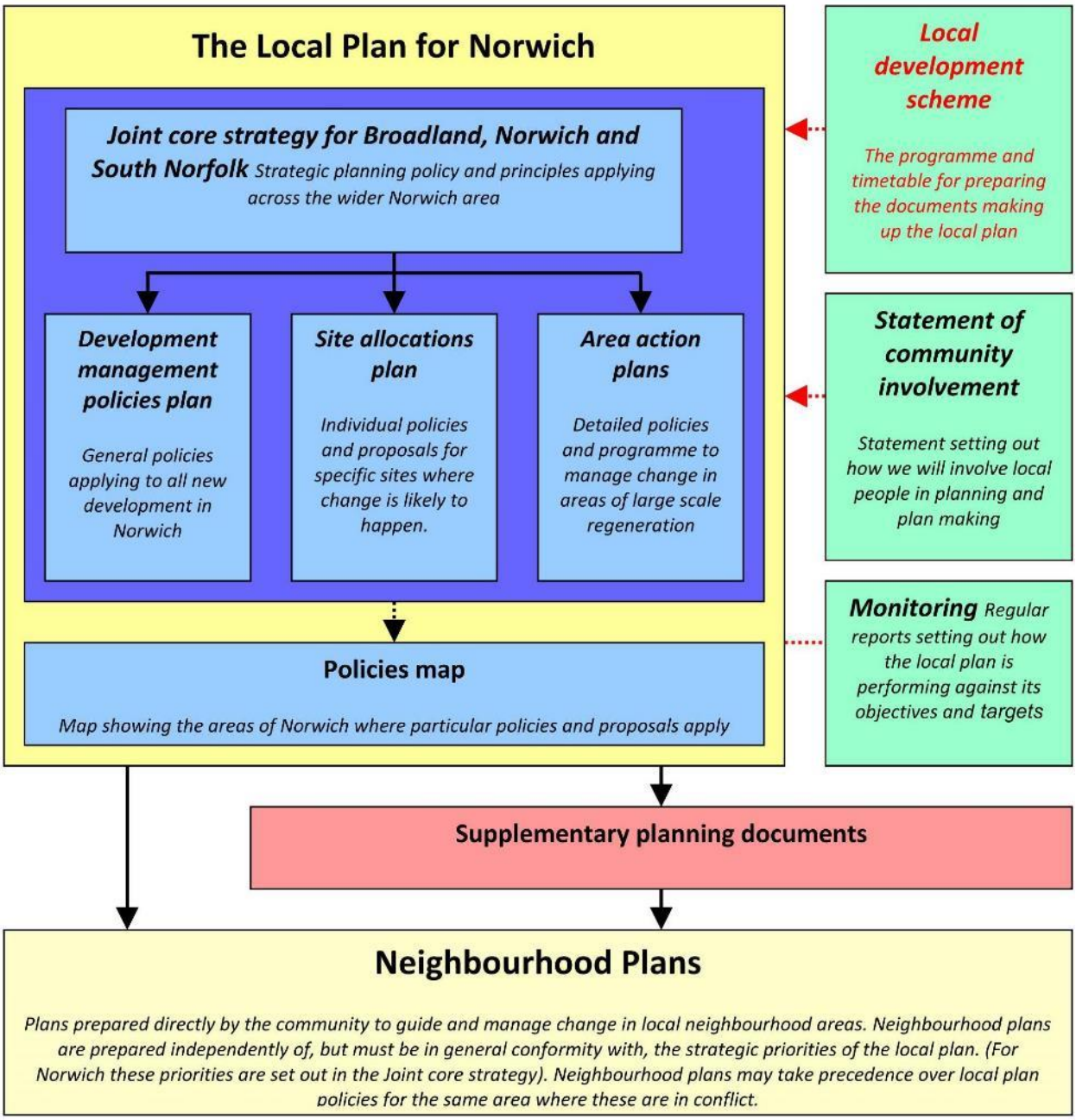


Figure 2-1 Planning Policy within Greater Norwich

Source: Local Development Scheme for Norwich 2014-2015

2.4 Local planning policy

Greater Norwich Joint Core Strategy (2014)

2.4.1 The Greater Norwich Joint Core Strategy was adopted in March 2011, with amendments adopted in January 2014.The JCS covers the period 2008 to 2026. It sets out long-term vision and objectives for the area, which includes strategic policies for steering and shaping development. The JCS also identifies locations for new housing, employment growth, changes to the transport infrastructure and other developments.

2.4.2 The JCS will be replaced by the emerging Greater Norwich Local Plan (GNLP) which is Scheduled to be adopted in December 2020.

Greater Norwich Infrastructure Plan (2017)

2.4.3 The Greater Norwich Infrastructure Plan (GNIP) is a document that helps coordinate and amanage the delivery of strategic infrastructure to support growth, high quality of life and an enchanced natural environment. It is a live document, updated annually to reflect the latest information.

2.4.4 The GNIP supports the delivery of the JCS, other Local Plan documents for the area and various other strategies, deals and plans. It also focuses on the key infrastructure requirements that support the major growth locations.

2.4.5 Table 4 of the GNIP sets out significant development sites in the south-west sector of the city identified for early delivery, all in the vicinity of Thickthorn Junction. These sites include:

- Approximately 120 dwellings remaining at Round House Park (permitted, construction underway);
- Up to 650 dwellings at Newfound Farm, Cringleford (permitted);
- Around 650 dwellings on land north and south of the A11, Cringleford (allocation, expected start 2016/17);
- 1,196 dwellings north of Hethersett (permitted);
- Approximately 80 dwellings remaining at Great Melton Road, Hethersett (permitted,construction underway); and
- And roughly 2,300 dwellings remaining in Wymondham (permitted, construction underway).

2.4.6 In addition to the development sites detailed above, planning permission has been granted for 893 dwellings in Easton and a major retail development of 6,660m^2 in Costessey. These are some distance away adjacent to the Longwater Junction, however given the significance of Thickthorn Junction as a major junction between east-west and north-south movements, development over a wide area could be of significance.

2.4.7 Permitted and under construction development at Norwich Research Park includes 1,000 student bedrooms and expansion of research facilities.

2.4.8 Growth at Wymondham, Hethersett, Cringleford and Norwich Research Park is considered dependent on junction improvement at Thickthorn Junction according to the GNIP 2017.

2.4.9 The Infrastructure Plan includes Park and Ride expansion at Thickthorn using land secured from a S106 agreement.

2.4.10 The RIS has now committed central government funding for junction improvement at Thickthorn, local funding is now available for other transport infrastructure schemes.

2.5 Spatial strategies

South Norfolk Site Specific Allocations and Policies

2.5.1 Consultation on the South Norfolk Local Plan documents ended on 5th June 2015. With regards to Thickthorn Junction, the site specific allocations and policies identify a 'landscape protection zone (LPZ)' along the A47 between Longwater and Postwick, including to the

south-west of Thickthorn Junction. The purpose of this zone is to protect long distance views and gateways to the city.

2.5.2 Therefore, it is not expected that significant development will come forward immediately to the west of the A47 at Thickthorn Junction.

2.5.3 Reference is made to Cringleford NDP and Wymondham Area Action Plan for detailed development site allocations.

2.6 Neighbourhood Development Plans

Cringleford NDP

2.6.1 The Cringleford NDP augments the JCS and sets out guidance and requirements for the parish of Cringleford. Cringleford Parish is located mainly to the east of the A47, extending from Thickthorn Stream in the south to the Norfolk and Norwich Hospital in the north. The plan includes all proposed and committed development that would access the A11 via the Round House Way Roundabout, east of Thickthorn Junction.

2.6.2 The Cringleford NDP Planning Policy hierarchy is shown in Figure 4-2.

Figure *2*-1 Planning Policy Hierachy in Relation to Cringleford's NDP
Source: Cringleford NDP 2013-2026

- Decisions on planning applications are made using both the Local Plan (Greater Norwich JCS) and the Neighbourhood Plan, and any other materials considered.The Cringleford NDP sets a number of non-negotiable requirements, including:the enhancement of green infrastructure along a corridor of 145m depth from the A47 carriageway to maintain the LPZ; and
- creation of a 30-50m Gateway Zone along the A11 to the east of Thickthorn Junction.

2.6.3 These requirements are in line with South Norfolk Site Specific Allocations and Policies, in ensuring the separation of Norwich from surrounding settlements, and providing landscape gateways (or buffers) to the city.

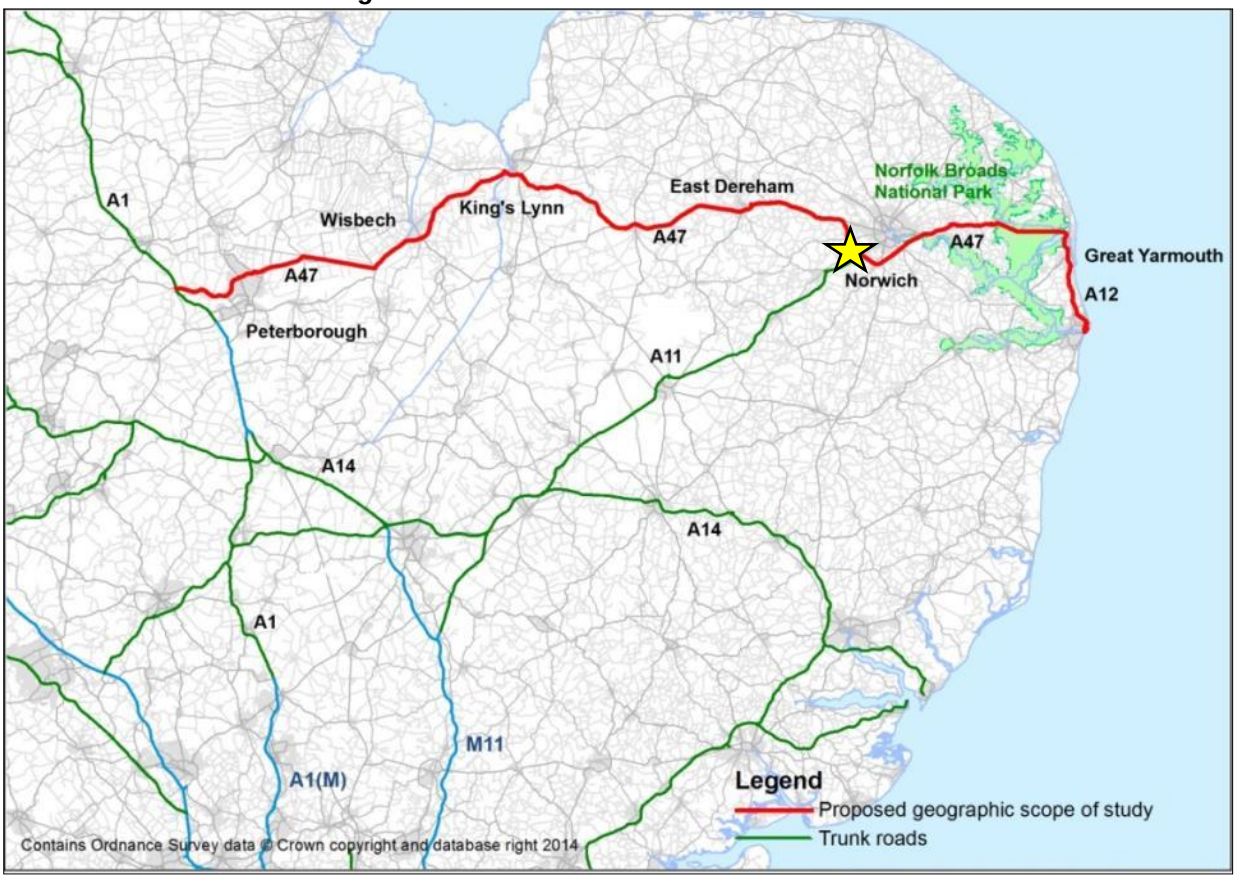
3 Existing Conditions

3.1 Description of the Locality

Strategic

3.1.1 The A47 and A12 trunk roads form part of the Strategic Road Network and provide for a variety of local, medium and long distance trips between the A1 and the eastern coastline. The corridor connects the cities of Norwich (population over 210,000) and Peterborough (population over 180,000), the towns of Wisbech, Kings Lynn, Dereham, Great Yarmouth and Lowestoft and a succession of villages in what is largely a rural area. The route also passes through the Norfolk Broads National Park. The location plan of the A47 corridor is shown in Figure 3-1 and Thickthorn Junction is indicated with a yellow star.

Figure 3-1 A47 Corridor Location Plan



3.1.2 Norwich and Peterborough have developed service-based economies and the towns along the route have retained market town and other functions including agricultural-related industry. In recognition of the potential for development of the eastern coast, the Chancellor announced in the 2011 budget the establishment of the Great Yarmouth and Lowestoft Enterprise Zone particularly for energy related businesses to maximise support for the offshore energy sector. In December 2013 the Government announced a Greater Norwich City Deal to enable knowledge based industries to develop.

3.1.3 There has been a rapid growth over the past decade, and the area is expected to continue to grow. The cities of Peterborough and Norwich attract additional traffic along the route, particularly during the morning and evening peak periods.

3.1.4 The route is approximately 115 miles long; 54 miles (47%) is dual carriageway whilst 61 miles (53%) is single carriageway. Previous studies have proposed dualling a number of sections of the A47 in the short and long term, together with a number of junction improvements.

3.1.5 Comprehensive improvement of the A47 is a strategic aspiration of local MPs, local government, business, and other stakeholders who have organised themselves to form the A47 Alliance. The aim is to capitalise on the potential economic benefits of improved accessibility to the Midlands and the North as well as addressing safety issues.

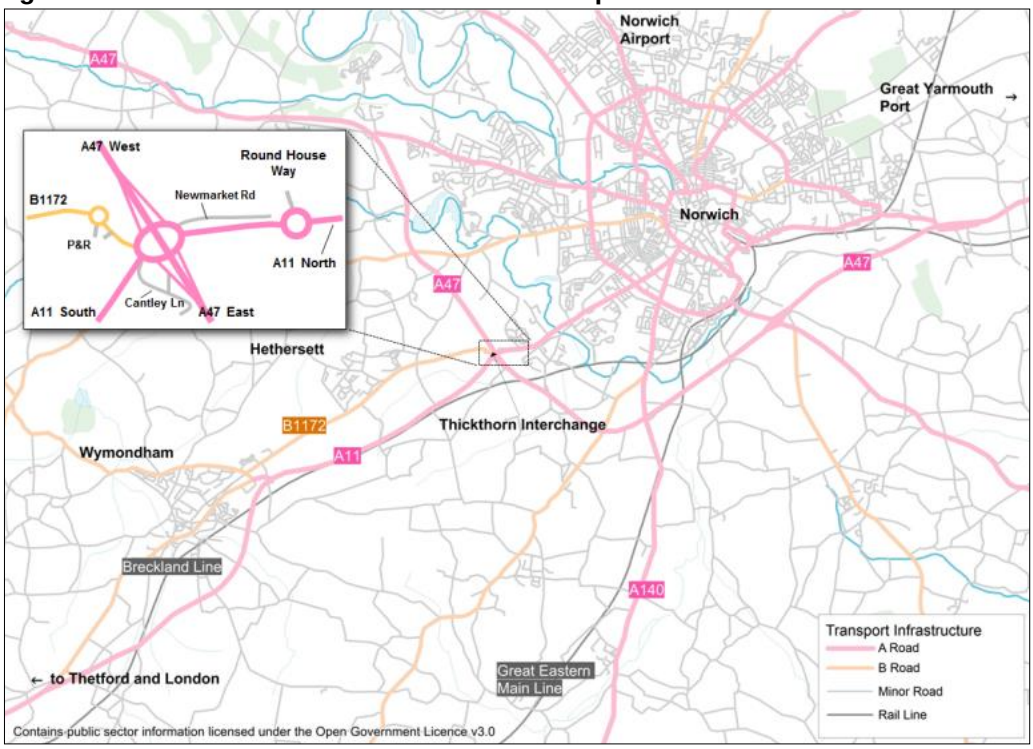
Locality of the Scheme

3.1.6 Thickthorn Junction is located on the south-western edge of Norwich, and provides access to the A47 via the A11 for Eaton, Cringleford, Hethersett and Wymondham. The A47 connects Norwich with Great Yarmouth to the east and Peterborough to the west via King's Lynn and Wisbech. The A11 is the main route connecting Norwich with Thetford, Cambridge and London (via the M11 and A14). The junction is therefore important for commuter, business, and commercial traffic, and for both short and long distance trips. The junction has three key roles within the wider network:

- To allow traffic on the A11 between Norwich, Cambridge, Suffolk and Hertfordshire to cross the A47.
- To provide Cringleford, Hethersett, and areas in south Norfolk with access to the Strategic Road Network.
- To carry long distance traffic between the eastern section of the A47 and the A11.

3.1.7 The location of the junction in relation to surrounding settlement and transport networks is shown in Figure 3-2 below.

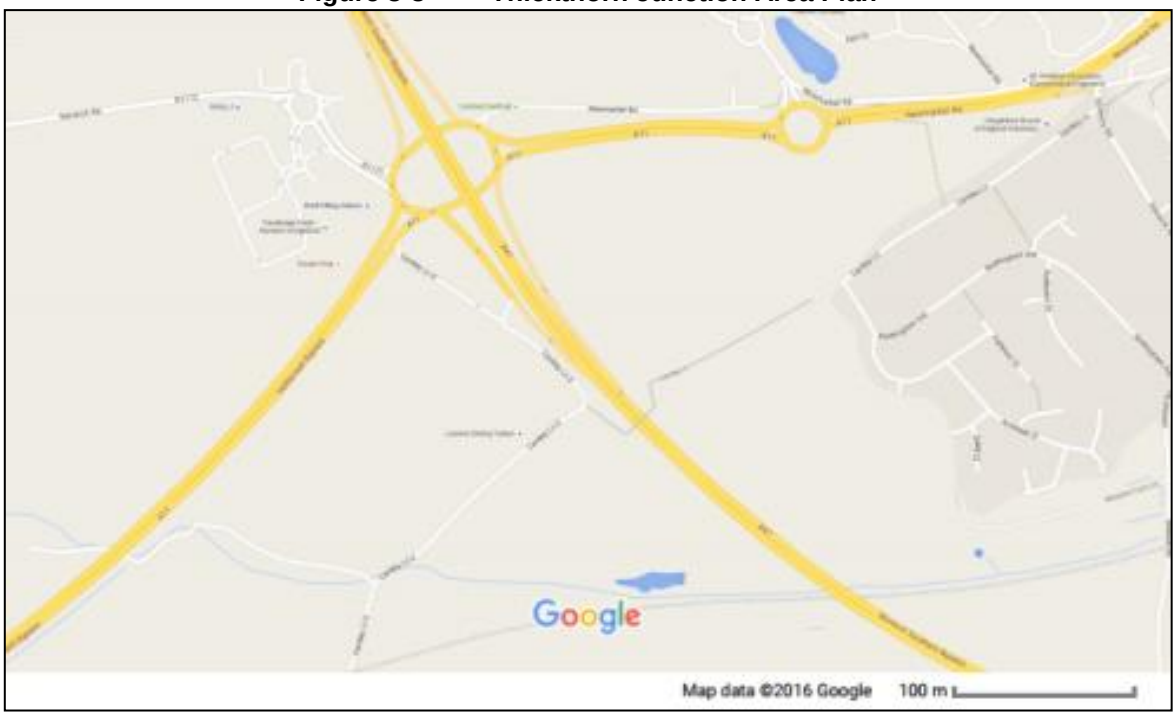
Figure 3-2 A47/A11 Thickthorn Junction Improvements Scheme Location Plan



3.2 Existing Highway Network

3.2.1 The A47, the A11 to the west of the junction, and the junction gyratory and slip roads are maintained by Highways England. The A11 Newmarket Road and Old Newmarket Road to the east of the junction, and the B1172 Norwich Road to the northwest are maintained by Norfolk County Council. The location of the junction in relation to the local area is shown in Figure 3-3 below.

Figure 3-3 Thickthorn Junction Area Plan



Highway Alignment and General Arrangement

3.2.2 Thickthorn Junction is a 6 arm, signal controlled and grade separated gyratory at the intersection of the A47 and A11, as shown in Figure 3-4 below. The A11 approaching the junction from the south west is a trunk road, which becomes a local road to the east of the junction, which is under the jurisdiction of Norfolk County Council. The A47, which is carried over the junction gyratory, is the main trunk road, which has Type A merge and diverge tapers (DMRB TD 22/06) at the junction.

3.2.3 The main carriageway of the A47 at this location is a rural dual two-lane all-purpose (D2AP) cross section with 7.3 m wide carriageways, 1m wide hard strips and a central reserve strip of 2.5 m wide. The A11 to the south of the junction has the same cross section as the A47. The A47 is subject to the national speed limit of 70mph for dual carriageway and the gyratory and A11 approaches in both the eastbound and westbound directions are restricted to 40mph. Additional lanes are developed on each approach to the roundabout.

3.2.4 The roundabout (see Figure 3-4) is a standard gyratory with traffic signal controls on all the approaches, except for the B1172 Norwich Road and Old Newmarket Road, which have normal priority give way approaches. The circulatory island of the Thickthorn Junction gyratory has an elliptical geometrical layout with a width of 100 m at its narrowest and 165 m at its widest point. The circulatory carriageway has a width varying between 12 to 15 m. The northern part of the gyratory has four lanes, whilst there are only three lanes provided on the southern part. The gyratory has a connection to the B1172, which also serves a Park and Ride facility, a trunk road service area, and a connection to a little used section of Old Newmarket Road.

3.2.5 From the east in a clockwise direction, the gyratory's approach roads are:

- The A11 Newmarket Road is signalised and joins the gyratory from the east. This flares to three lanes approximately 70 metres prior to the stop line, and increases to four lanes at the stop line;
- The A47 westbound off-slip is signalised and joins the gyratory from the south-east. The slip road gradually flares to provide three lanes at the stop line. The nearside lane is marked with a left turn arrow, the middle lane with left turn and straight ahead arrows, whilst the outside lane is marked with a straight ahead arrow;
- The A11 approaches the gyratory from the south-west and is signalised. This widens from two lanes to four lanes approximately 130 metres before the stop line;
- The B1172 approach road is located to the north-west of the gyratory and is not signalised. The road connects the gyratory to the B1172 Norwich Road. A bus lane occupies 100m of the nearside lane, which ends approximately 27m prior to the roundabout;
- The A47 eastbound off-slip road is signalised and is located to the north-west of the gyratory. The slip road widens to three lanes approximately 40 m from the gyratory; and
- Old Newmarket Road runs parallel with the A11 Newmarket Road. The road serves as a private access to agricultural land and private properties along its northern side. The approach road is not included in the existing traffic signal arrangement.

Figure 3-4 Thickthorn Junction Layout

Existing Structures

3.2.6 The A11 North and South bridges for the Thickthorn Junction (SMIS structure keys 19939 and 19940) carry the A47 mainline trunk road over the A11 gyratory (see Figure 3-4). They are underbridges of identical construction and dimensions, designed to carry the cross section of the A47 dual two lane carriageway, which has two 3.65m traffic lanes, two 1m hard strips and one 1.5m wide raised verge in each direction, separated by a 4.5m central reserve, including hard strips.

3.2.7 Both are closed aspect, simply supported single span structures with a span of 22.9m over the junction gyratory, which has a carriageway of approximately 12m in width. An equestrian

route passes in the raised southern verge beneath the southern bridge, and there is a combined footway/cycleway in the raised northern verge beneath the northern bridge. The bridge decks are made of 24 No precast pre-stressed concrete beams with a 130mm in-situ reinforced concrete top slab.

3.2.8 The substructure for both bridges consists of reinforced concrete abutments with spread foundations and cantilever wing walls.

3.2.9 The A11 North and South bridges for the Thickthorn Junction were constructed in the early 1990s as part of the A47 Norwich Southern Bypass. No information has been made available relating to their present condition, so Principal Inspections are recommended in order to determine this, and to establish whether any modifications have been made to the structures since their construction.

3.2.10 The A47 Cantley Lane Footbridge (SMIS structure key 19941) crosses over the A47 450m to the south-east of the junction connecting Cantley Lane to Cantley Lane South (see Figure 3-5). The footbridge is constructed as a reinforced concrete arch with bank-seat abutments founded on piled foundations.

3.2.11 This 48.2m single span footbridge, which accommodates a 1.8m wide footway, has a voided deck with a trapezoidal cross section, which comprises a 225mm thick top slab, a 300mm thick bottom slab and 200mm sides. The superstructure construction varies in overall depth from 2m over the bank-seat to 0.65m at mid-span.

3.2.12 The upper surface of the footbridge is stepped, with 115mm risers and 1725mm goings. A ramp is provided on the west side of the deck to allow for cycles to be wheeled across. The bridge has 1.1m high aluminium parapets with galvanized fabricated steel handrailing for the approach ramps.

3.2.13 A47 Cantley Lane Footbridge was constructed in 1992 as part of the A47 Norwich Southern Bypass and according to the latest General Inspection report that was made available, dated 2014, was in good condition with only minor defects.

Figure 3-5 Footbridge over A47 which connects Cantley Lane to Cantley Lane South

3.2.14 Further to the east, the A47 Cringleford Rail Bridge (SMIS structure key 19958) carries the A47 over the Breckland Railway line; this structure and the railway line beneath are discussed in further detail in Section 3.2.39.

3.2.15 The A47 Cantley Culvert (SMIS structure key 19961) consists of a 98m long galvanized corrugated steel culvert resting on granular bedding with reinforced concrete outlets at both ends. It carries the Cantley stream under the A47 behind the A47 Cringleford Rail Bridge west abutment. The culvert section is 2880mm high and 2730mm wide with an average steel thickness of 4mm. The invert is protected by a 125mm thickness of concrete benching.

3.2.16 This culvert was constructed in the early 1990s as part of the A47 Norwich Southern Bypass. No information has been made available with regards to its present condition, so a Principal Inspection is recommended in future stages in order to determine this, and to establish whether any modifications have been made to the structure since its construction.

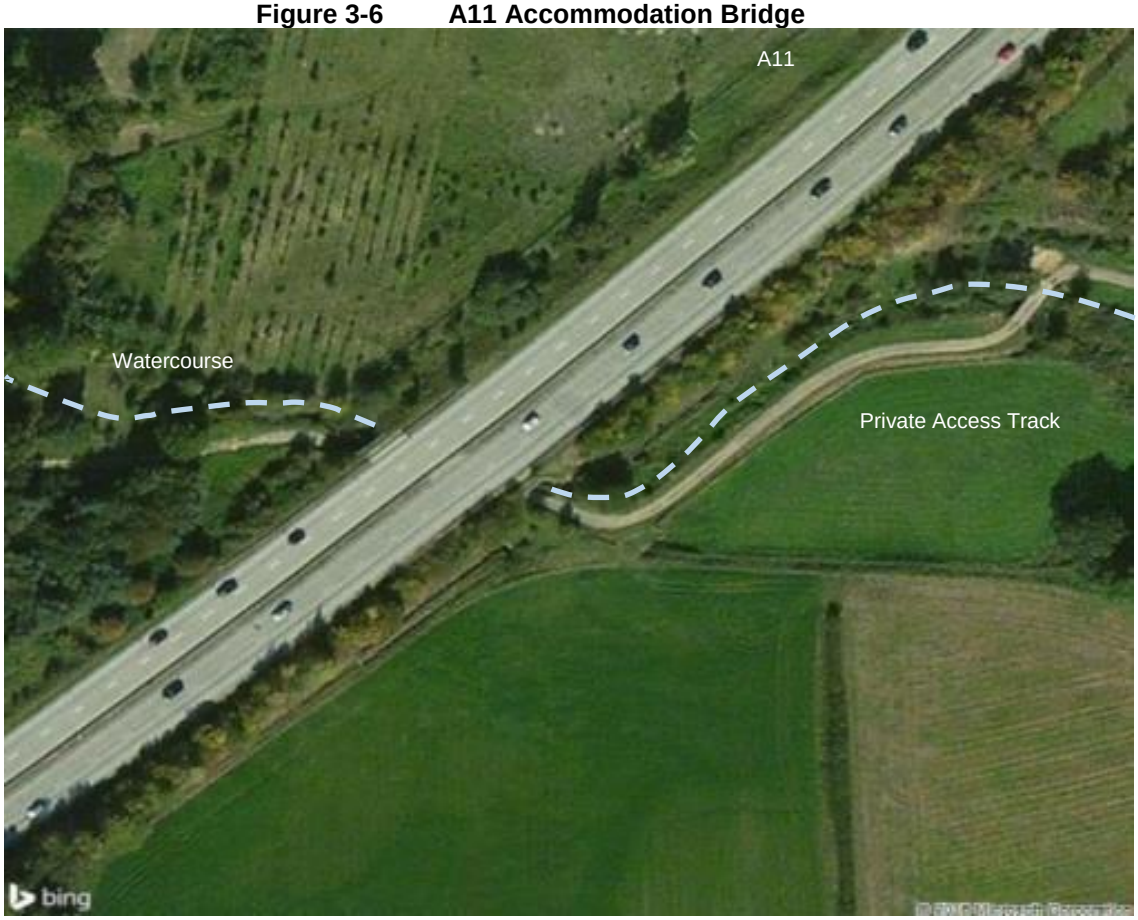
3.2.17 The A47 Cringleford Culvert (SMIS structure key 19957) is a 95m long, galvanized corrugated steel structure founded on a granular bedding, with reinforced concrete outlets at both ends. It carries a drainage ditch under the A47 behind the A47 Cringleford Rail Bridge east abutment. The culvert section is circular, with a diameter of 2m and an average steel thickness of 3mm. The invert is protected by a 125mm thickness of concrete benching.

3.2.18 The A47 Cringleford Culvert was constructed in the early 1990s as part of the A47 Norwich Southern Bypass. No information has been made available with regards to its present condition, so a Principal Inspection is recommended in future stages in order to determine this, and to establish whether any modifications have been made to the structure since its construction.

3.2.19 The A11 Cantley Stream Underpass accommodates a private track and a stream crossing beneath the A11, just over 700m south-west of Thickthorn Junction (see Figure 3-6). The underpass consists of a 35m long in-situ reinforced concrete box with 500mm thick walls, with a 5m high by 6m wide open cross section. It was designed to accommodate a 3m wide track alongside a 1.5m wide and 650mm deep water channel, separated by a guard rail. At the ends of the structure there are reinforced concrete wing walls, founded on spread foundations and gabion walls.

3.2.20 The A11 Cantley Stream Underpass was constructed in 1987 and according to the latest General Inspection report that was made available, dated 2016, was in good condition with only minor defects.

Figure 3-6 A11 Accommodation Bridge



Lighting

3.2.21 The A47 is unlit on the approaches to and through the grade separated junction.

3.2.22 The A11 northbound approach is lit for a distance of approximately 100m from the roundabout stop line. Equipment comprises 12m lighting columns with twin bracket arms and high pressure sodium flat glass luminaires located in the central reserve.

3.2.23 Thickthorn Junction gyratory is lit using 12m lighting columns with single bracket arms and high pressure sodium flat glass luminaires located on the outside verge. Where the A11 passes under the A47, the underbridge has wall mounted high pressure sodium luminaires on both bridge abutments.

3.2.24 The extent of the lighting on the A11 southbound approach runs continuously from the Round House Roundabout using 12m lighting columns with twin bracket arms and high pressure sodium flat glass luminaires located in the central reserve.

3.2.25 All four slip roads for the Thickthorn Junction are lit for a distance of approximately 100m from the gyratory using 10m lighting columns with single bracket arms and high pressure sodium flat glass luminaires located in the verge.

3.2.26 The lighting on the B1172 Norwich Road approach extends continuously from the Thickthorn Park and Ride roundabout using 6m lighting columns with both twin arm and single arm brackets and high pressure sodium flat glass luminaires located in both the central reserve and the verge. The reason the column height is reduced is due to the presence of a 400kV and 11kV overhead electricity line which runs roughly parallel with and above the B1172.

3.2.27 The Cantley Lane South access off the A11 has a single 5m lighting column with post top high pressure sodium flat glass luminaire to highlight the immediate area of the junction for turning traffic.

3.2.28 Given the remote location of the site and the presence of a large three phase feeder pillar located just off the A11 roundabout on the B1172, it is assumed that all the present lighting obtains its electrical supply by means of a private cable network.

Vehicle Restraint System

3.2.29 There is barrier protection along the entire length of the A47 and A11 in the central reserve. Generally there is double sided tensioned corrugated beam in the A47 central reserve. The A11 to the south-west also has mainly double sided tensioned corrugated beam in the central reserve, which splits into two rows of single sided tensioned corrugated beam to protect the lighting columns on the approach to the gyratory. The A11 Newmarket Road to the east has two rows of open box beam which protects the lighting columns in the central reserve along the entire section between Thickthorn Junction and Round House Roundabout. There are also steel safety barriers and parapets in the verges where the A47 is grade separated over the Thickthorn Junction gyratory.

Pedestrians and NMU's

3.2.30 Figure 3-7 shows the existing Public Rights of Way (PRoW) Network for Non-Motorised Users (NMUs) in the vicinity of Thickthorn Junction. This PRoW Network is based on the A47/A11 Thickthorn Junction Non-Motorised User Context Report (Ref: HE551492-ACM-GEN-TJ-RP-TR-00002).

3.2.31 Footpath (reference Cringleford FP1) connects the A11 Newmarket Road to Cantley Lane South. An unpaved footway (reference Cringleford FP4a) is also present from Cantley Lane over the A47, via a footbridge, which provides a link to Cantley Lane South.

3.2.32 The Cringleford-Sprowston Cycle Route passes along Old Newmarket Road, through Thickthorn Junction along the northern side of the gyratory, and continues via the B1172 Norwich Road (Including Thickthorn P&R) west of the junction towards Hethersett. Toucan crossings are provided at the A47 eastbound off-slip, A47 westbound on-slip, and to the west of Round House Roundabout. The Old Newmarket Road does not however have a formal footpath/cyclepath along its whole length. NMU's using this route, including pedestrians, are expected to travel on the carriageway. Although the route has no through route for vehicles and only cyclist have access, Old Newmarket Road is very lightly trafficked. Survey results from the NMU Context Report identifies this route as the most common and frequent route for cyclists.

3.2.33 There is also an informal foot/cycle route, which the NMU Context Report describes as the desire line for north to south movement over the A11 Newmarket Road via a toucan crossing.

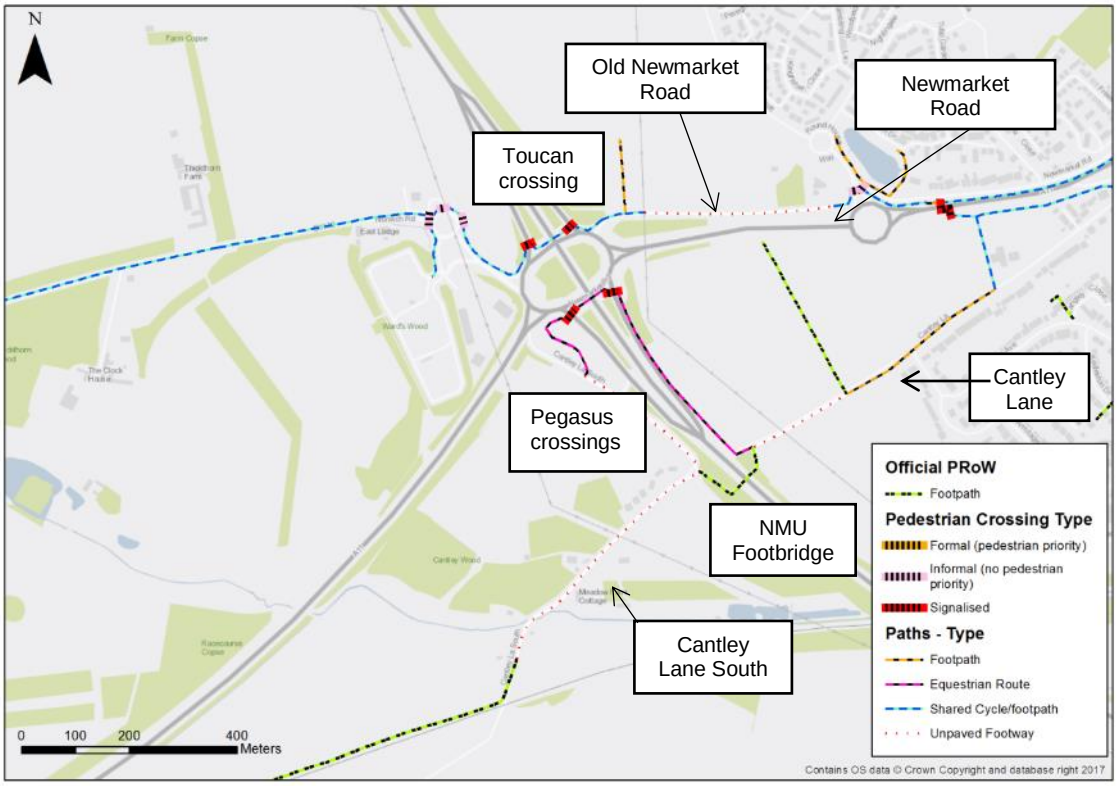
3.2.34 It is noted as the most frequented NMU desire line within the scheme area and the only north to south crossing point within the scheme. The crossing alsolinks Cantley Lane footbridge to the A11 Newmarket Road via Cantley Lane.

3.2.35 There is a short section of dedicated equestrian route which connects Cantley Lane and Cantley Lane South via Thickthorn Junction (refer to Figure 3-7). Pegasus crossings are provided at the A47 eastbound on-slip and A47 westbound off-slip on the south-eastern side of the gyratory to facilitate the link beneath the A47 overbridge. This route is reported as not frequently used by equstrians and access to the crossing points appears obstructed by overgrown vegetation. The NMU context report also observed a few occurance of pedestrians using this crossing as the shortest possible movement from Cantley Lane South to Old Newmarket Road.

3.2.36 There are no formal crossing points across the A11 immediately to the easy of the gyratory and NMUs Crossing at this point are potentially at a high risk of collision..

3.2.37 Analysis of signal controller logs at the junction has confirmed that the Pegasus crossings were not called over a 14 day period. The status of the connection between the Pegasus crossings and equestrian route will need confirmation, and further consultation is required with the affected stakeholders. However, at this stage, the route is assumed to be unused, making the Pegasus crossings effectively redundant.

Figure 3-7 Existing Provision for NMU's



There is an arched, single span reinforced concrete footbridge, which passes over the A47 south east of Thickthorn Junction, which is not compliant with the Equality Act 2010 and would not be suitable for use as equestrian crossing. A view of the footbridge crossing is shown in Figure 3-8.

Figure 3-8 Footbridge Crossing

Public Lay-bys

3.2.37 There is one public lay-by on the A47 in the vicinity of the site, as shown in Figure 3-9, which is located on the eastbound carriageway, approximately 1400 m to the south east of Thickthorn Junction. This lay-by has an Emergency Roadside Telephone (ERT).

3.2.38 This is a 'Type A' lay-by. However the merge taper, which is less than 40m in length, does not comply with the requirements of TD 69/07, which requires a minimum taper length of 130m for a mainline design speed of 120kph.

Figure 3-9 Lay-by on A47 Eastbound Carriageway

3.2.39 There is one public lay-by on the A11 in the vicinity of the site, as shown in Figure 3-10. This is located on the northbound carriageway approximately 260m to the south west of Thickthorn Junction. At this location the mainline has a national speed limit.

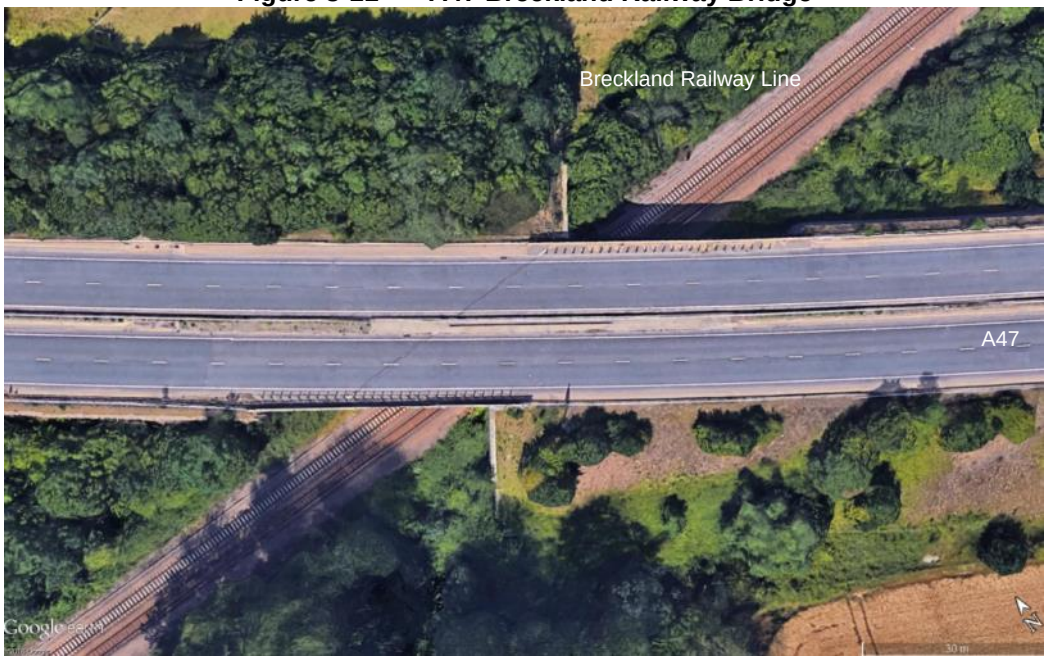
3.2.40 This is similar to a 'Type B' lay-by. TD 69/07 now restricts the use of this type of lay-by to roads with speed limits not exceeding 40mph. The length of the lay-by is 220m, which exceeds the maximum length of 170m which is permitted in TD 69/07. The distance of the lay-by from Thickthorn Junction does not comply with the weaving length requirements of TD 22/06, which requires lay-bys to be located a minimum of 1km from a junction.

Figure 3-10 Lay-by on the A11 Northbound Carriageway

Railway crossings

3.2.41 Approximately 900m south-east of the junction, the A47 crosses over the Breckland Railway Line (refer to Figure 3-11). The Breckland Line is a secondary railway line in the east of England, which is used by East Midlands Trains and Greater Anglia to operate rail services connecting Norwich to Cambridge and onward destinations. The structure is a 24 m single span bridge at a skew angle of about 54 degrees. Traffic is contained over the bridge by P5 aluminium parapets, 1.5 m high, with solid infill panels.

Figure 3-11 A47 Breckland Railway Bridge



3.2.42 The abutments are constructed of reinforced concrete and cantilevered from reinforced concrete spread foundations. They are approximately 5.8 m high and also retain the road embankment. The spread bases are founded on imported granular fill contained within a sheet piled cofferdam. The road embankments approaching the bridge are retained by four crib walls, which link up with the abutment retaining walls.

3.2.43 The railway line is double-track throughout but is only electrified between Cambridge and Ely and also between Norwich and Trowse Junction.

Local Highways Network

3.2.44 The A11, Newmarket Road to the east of Thickthorn Junction is a Local Authority road, which is maintained by Norfolk County Council. The A11 Round House Roundabout is located approximately 450m to the east of Thickthorn Junction, as shown in Figure 3-12. This roundabout serves as an access to a housing development to the north of the A11.

Figure 3-12 Round House Roundabout

3.2.45 The B1172 Norwich Road is the minor road arm of the Thickthorn Junction gyratory and it is non-signalised (See Figure 3-13). This road provides access to the Thickthorn service area, which includes a hotel, restaurant and filling station, and the Thickthorn Park and Ride facility, and is a route to the settlement of Hethersett. There are plans for the future expansion of the Park and Ride facility.

Figure 3-13 B1172 connection to Thickthorn Junction

3.2.46 There are no direct residential or private accesses onto the trunk road. There are residential properties off Cantley Lane South and off the Old Newmarket Road. The trunk road service area and Park and Ride are accessed from the B1172. Old Newmarket Road, which connects to the gyratory, provides access to one listed dwelling near Round House Way and provides a route for NMUs as described earlier.

3.2.47 Cantley Lane South, which is severed by the A47, has a connection onto the westbound A47 off-slip road and from the A11 southbound carriageway, as shown in Figure 3-14**.** These connections are a departure from standard from TD 22/06 Par 5.30, which states that private means of access and junctions on connector roads are not permitted.

3.2.48 Where Cantley Lane South has been severed by the A47 it is joined over the A47 by the footbridge as shown on Figures 3-5 and 3-8. On the eastern side, this footbridge re-joins Cantley Lane, which connects to residential properties further east.

Figure 3-14 Cantley Lane South connections

3.2.49 Approximately 1900 m south-west of Thickthorn Junction on the A11 there are two ‘left-in’ ‘left-out’ accesses on opposite sides of the carriageway, as shown in Figure 3-15. These are for Station Lane, which provides accesses for local traffic to residential properties, farms, small businesses and, a Norfolk County Council highways depot and recycling centre. This was formerly a right/left staggered junction, but the central reserve crossing has been closed to prevent right turning movements.

Figure 3-15 Station Lane Accesses

3.3 Operational Assessment of Thickthorn Junction

3.3.1 An operational assessment of the existing Thickthorn Junction merge/diverge tapers was undertaken in order to understand the deficiencies in the capacity of the junction. For this it was necessary to establish the base year (2015) traffic flows, and those predicted for the design year (2036).

3.3.2 The traffic that was used for this analysis was based on the PCF Stage 1 traffic assessment, which relied upon a micro-simulation traffic model (VISSIM). Further details can be found in Section 3.3 of the TAR Ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032.

3.3.3 Traffic assessment based on an updated version of the NATS model is expected to be completed before the end of PCF Stage 2, but not before the PRA. The information that was available at the time of the preferred route decision being made was deemed robust enough to provide a clear verdict on the option being taken forward.

3.3.4 Therefore, if further assessments of the operational performance of the existing junction should be required, it is recommended that these are undertaken in PCF Stage 3.

3.3.5 The outputs from the PCF Stage 1 traffic model were used to assess:

- the operational performance of the existing junction for the base year (2015) traffic; and
- the operational performance of the existing junction against the forecast traffic demand for the 2036 design year.

3.3.6 Based on this assessment, the current and future requirements for the A47 merge and diverge tapers at Thickthorn Junction are summarised below:

Method of Assessing the Existing Thickthorn Junction Merge and Diverge Tapers

3.3.7 The existing A47 slip roads have Type A Taper Merges and Diverges. For merge and diverge types see figures 3-16 and 3-17.

3.3.8 Analysis was undertaken to establish the merge and diverge types, and slip road cross sections that would be needed for the current and design year traffic.

3.3.9 Since, as previously discussed, the analysis is based on a preliminary traffic assessment, it is recommended that the assessment of the merge and diverge tapers is kept under review for future stages of the design, when the updated traffic information becomes available.

3.3.10 The analysis was undertaken in accordance with TD 22/06 'Layout of Grade Separated Junctions', using Figure 2/3 AP and Figure 2/5 AP.

3.3.11 The output from the analysis is summarised in the sections below, and for further information see Appendix B.

Existing A47 westbound diverge

3.3.12 While the existing westbound off-slip currently has a Type A diverge taper, the analysis indicates that in order to comply with the requirements of TD 22/06:

- a Type B Ghost Island Diverge is required for the base year (2015) traffic
- a Type D Ghost Island Diverge for Lane Drop is required for the future (2036) design year traffic.

3.3.13 This indicates that the existing Type A diverge arrangement for the A47 westbound off-slip is already inadequate for the current level of traffic, and that for the design year, three lanes are required on the A47 in order to facilitate an upgraded diverge incorporating a lane drop. Since widening of the A47 to three lanes is beyond the scope of the project, provision of a Type D Diverge with a lane drop is not feasible.

Existing A47 eastbound diverge

3.3.14 The existing eastbound off-slip currently has a Type A diverge taper, and the analysis indicates that in order to comply with the requirements of TD 22/06:

- a Type A diverge taper is required for the base year (2015) traffic
- a Type D Ghost Island Diverge for Lane Drop is required for the future (2036) design year traffic.

3.3.15 The assessment indicates that while the existing Type A diverge taper is adequate for the current traffic, a Type D diverge taper with a lane drop on the A47 will become necessary before the design year. Since widening the A47 to three lanes is beyond the scope of the project, the current Single Option does not include alterations to the A47 eastbound diverge. Furthermore, the transport problem identified in Stage 0 did not identify this slip road as a cause of congestion at the junction and improvements have therefore been excluded from the current proposal. However, at a future stage, consideration could be given to improving this to a Type B Diverge, which would not require widening of the A47 to three lanes. This would not provide sufficient capacity for the design year, but would be an improvement compared the existing Type A diverge taper.

Existing A47 westbound merge

3.3.16 While the existing westbound on-slip currently has a Type A taper merge, the analysis indicates that in order to comply with the requirements of TD 22/06:

- a Type A Taper Merge is required for the base year (2015) traffic
- the requirement for the future (2036) PM peak hour design year traffic is borderline between a Type B Parallel Merge and a Type E Merge with lane gain.

3.3.17 The assessment indicates that the existing Type A Merge Taper is adequate for the current traffic and for the AM Peak hour traffic in the design year. However, for the future PM peak hour traffic in the design year the assessment indicated that the need is borderline between a Type B Parallel Merge and a Type E Merge with lane gain. Since widening of the A47 to three lanes is beyond the scope of the project, provision of a Type E Merge with lane gain is not currently feasible. Furthermore, the transport problem identified in Stage 0 did not identify this slip road as a cause of congestion at the junction and improvements have therefore been excluded from the current proposal. However, at a future stage, consideration could be given to improving this to a Type B Parallel merge, which would not require the A47 to be widened to three lanes. This would be adequate for the PM Peak hour traffic in the design year.

Existing A47 eastbound merge

3.3.18 While the existing eastbound on-slip currently has a Type A taper merge, the analysis indicates that in order to comply with the requirements of TD 22/06:

- a Type E Merge is required for the base year (2015) traffic
- a Type F Ghost Island Merge for Lane Gain is required for the future (2036) design year traffic.

3.3.19 This indicates that the existing Type A merge arrangement for the eastbound on-slip is already inadequate for the current level of traffic, and for the design year three lanes are required on the A47 in order to facilitate an upgraded merge incorporating a lane gain. Since widening of the A47 to three lanes is beyond the scope of the project, provision of a Type F Merge with a lane gain is not feasible.

Summary of the results from the assessment of the Merge and Diverge Tapers for the Existing Thickthorn Junction

3.3.20 The results show that the current traffic flows for the east facing slip roads (A47 westbound diverge and eastbound merge) at the existing junction already exceed the recommended traffic flows. By the 2036 Design Year these slip roads are predicted to exceed capacity by over 70% for the case of the westbound diverge, and by over 50% for the case of the eastbound merge. These levels of saturation of diverge and merge flows could result in an increased collision risk, and could affect the performance of the A47 mainline.

3.3.21 For the A47 two-lane dual carriageway the predicted 2036 peak hour traffic flow for the westbound and eastbound carriageways are predicted to be 3800 and 3550 respectively. Therefore, these traffic lanes will be over the theoretical capacity of 3200 for a D2AP, as defined in Cl 3.3 of TD 22/06 in the design year.

3.3.22 Since widening of the A47 to three lanes is beyond the scope of this project, it is not feasible to incorporate merges or diverges with lane gains or lane drops.

3.3.23 The restriction in capacity of the west facing slip roads is far less acute than for the east facing slip roads, since they are adequate for the current traffic flows and have capacity to spare. Furthermore, the transport problem identified in Stage 0 did not identify these slip roads as a cause of congestion at the junction and improvements have therefore been excluded from the current proposals. However, it is likely that improvements will be required in order to accommodate the future traffic levels for the design year. Improvements to these slip roads could be considered in future design stages.

Figure 3-16 Merge Type Diagrams (TD 22/06)

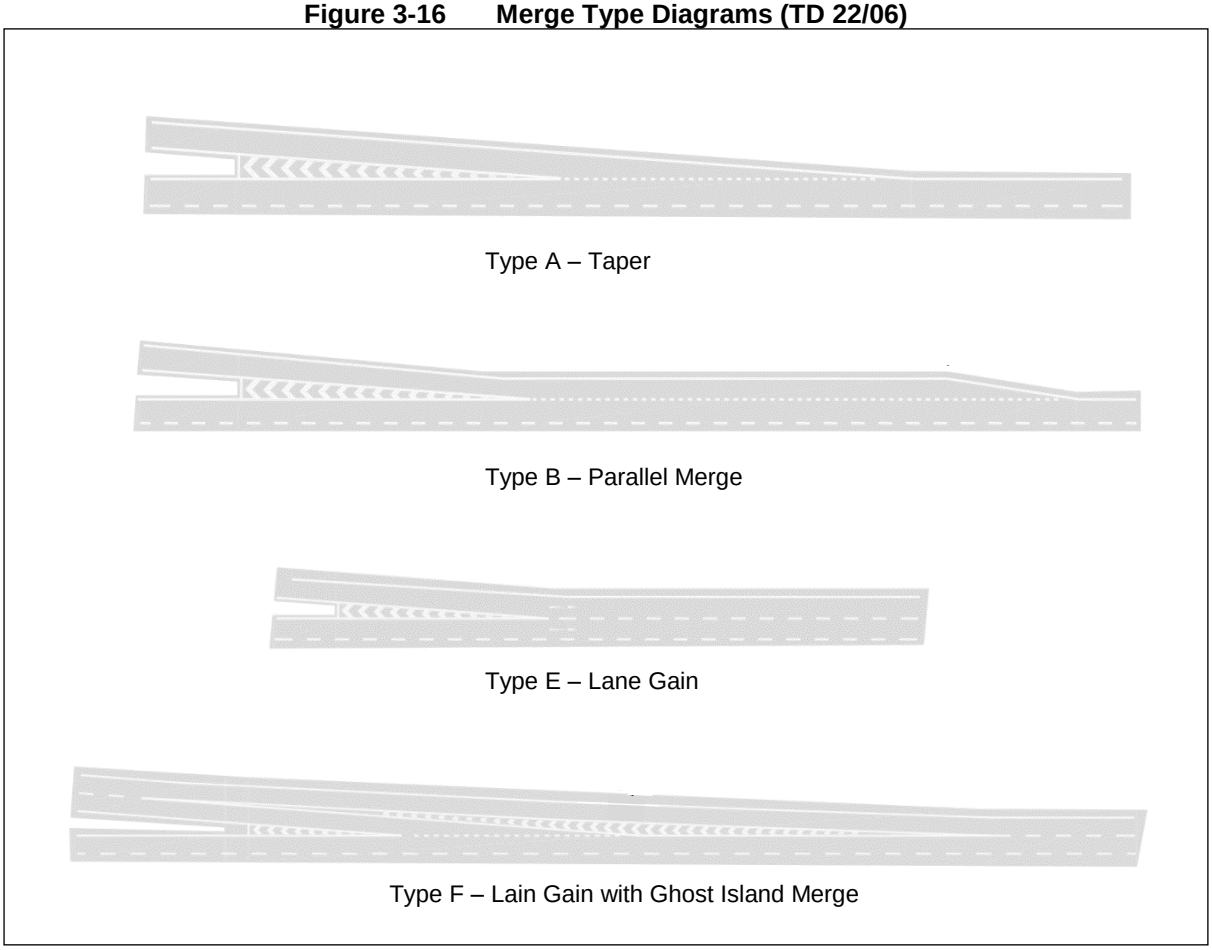
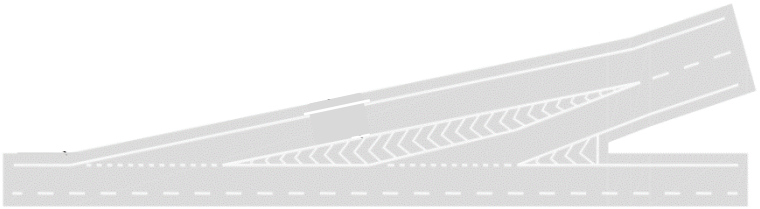


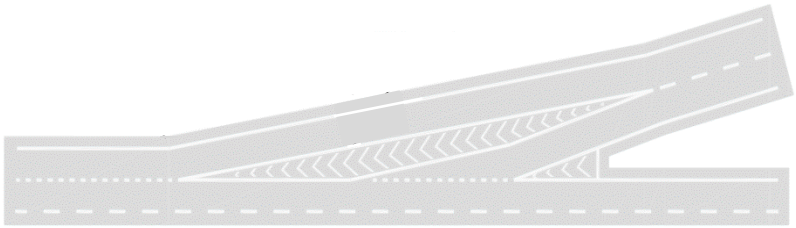
Figure 3-17 Diverge type Diagrams (TD 22/06)

Type A – Taper Diverge



Type B – Ghost Island Diverge

Type C – Lane Drop at Taper Diverge



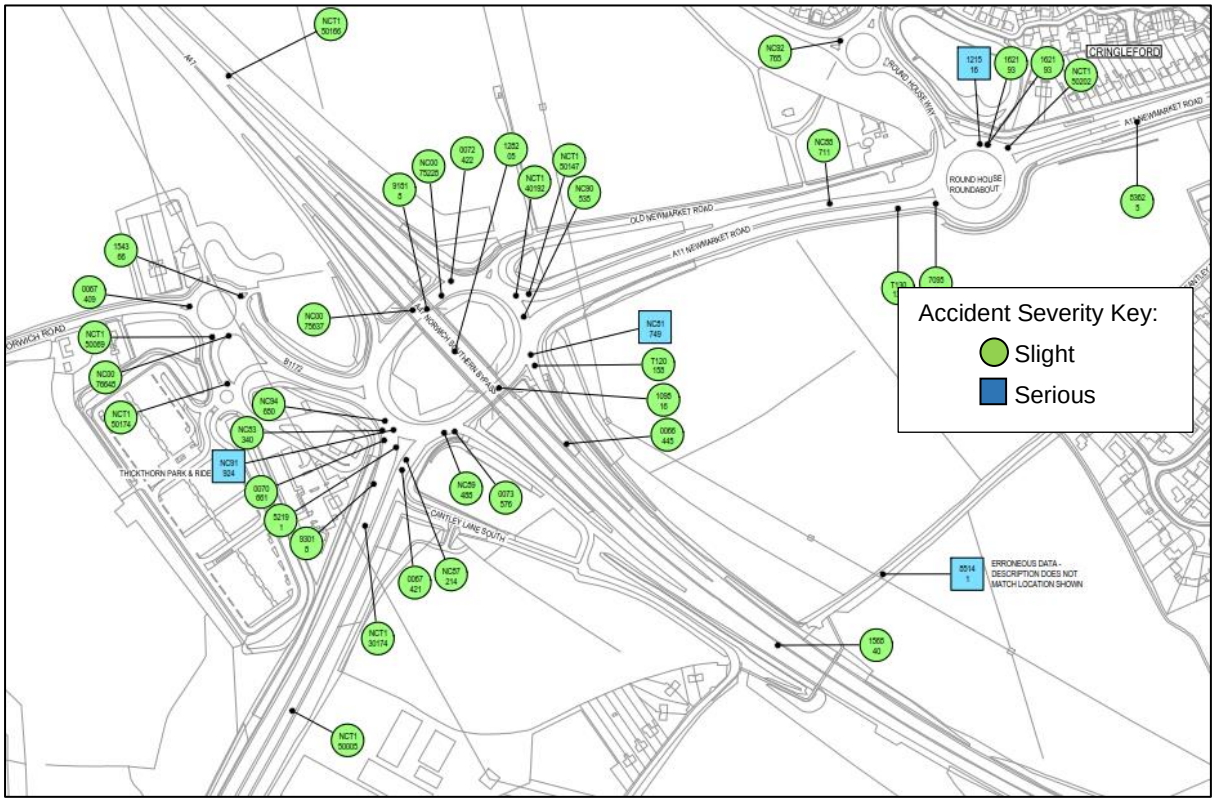
Type D – Ghost Island Diverge for Lane Drop

3.4 Collision Data

3.4.1 Collision data for Thickthorn Junction has been obtained from the Asset Support Contract for Area 6 (ASC6) dating from 1st April 2012 to 31st March 2017. See Figure 3-18 for an overview of the collision data and accident severity.

3.4.2 There were a total of 39 collisions recorded in this period, of which none was fatal, 3 serious and 36 slight. These 39 collisions resulted in 54 casualties and involved a total of 72 vehicles. For full summary tables see Appendix C.

Figure 3-18 Map of Collision Data for Thickthorn Junction between 01/04/2012 and 31/03/2017



3.4.3 As shown in Table 3-2, the majority of recorded collisions within the study period were at the gyratory. The majority of these were due to queuing vehicles, which were either stationary or reducing to the low traffic speed.

3.4.4 Of the three serious incidents two were recorded as occurring at the Thickthorn Junction gyratory with the other occurring at Round House Roundabout. The 3 serious accident occurred due to a rear end shunt pushing the car in front into the gyratory roundabout respectively, and cutting in front of a vehicle on the gyratory in order to access the on-slip road. These collisions most likely occurred due to a vehicle travelling too fast for the conditions, and failing to judge another vehicle's path or speed.

3.4.5 The high rate of accidents in the area is a key safety challenge for the A47/A11 Junction Improvements scheme, since the A47 is currently ranked 2nd nationally for fatalities on A roads and the accident severity ratio is above average.

3.4.6 The current traffic flows generally exceed capacity and rapid growth is planned in the area. Norwich, Cambridge and Peterborough are amongst the fastest growing cities in the country. Based on the statistics in Table 3-3, the rate of accidents is likely to increase owing to the increase in traffic flow and need for increased capacity due to future growth in area.

Table 3-2 Number of Collisions per Location Characteristics

Location Detail	Number of collisions	Percentage
Gyratory	25	64
Not at Junction	12	31
Slip Road	2	5

Table 3-3 Thickthorn Junction Collisions Statistics

Thickthorn Junction									
12 month period from	**Collisions**					**Casualties**			
	Fatal	Serious	Slight	TOTAL		Fatal	Serious	Slight	TOTAL
01/03/2012	0	0	4	**4**		0	0	4	**4**
01/03/2013	0	0	8	**8**		0	0	13	**13**
01/03/2014	0	1	6	**7**		0	1	8	**9**
01/03/2015	0	1	9	**10**		0	6	9	**15**
01/03/2016	0	1	9	**10**		0	1	12	**13**
TOTAL	**0**	**3**	**36**	**39**		**0**	**8**	**46**	**54**

3.4.7 These figures are taken from observed data acquired from March 2012 to March 2017.

3.5 Statement of the Problem

3.5.1 The junction capacity assessments undertaken in 2014 for the A47/A12 Corridor Feasibility Study indicated that Thickthorn Junction was operating over capacity on a number of approaches. By 2031, this is predicted to worsen owing to the proposed developments in the vicinity that could increase traffic at this junction.

3.6 Topography, Land Use, Property and Industry

Topography

3.6.1 The topography of the surrounding area is gently undulating, with the junction sited on a fairly level area. To the south-west of the A11 the land drops towards a stream which flows under the A11 via an underpass approximately 700m from the junction, as shown on Figure 3-6. The A47 flies over the A11 and the Thickthorn Junction gyratory and is constructed on an embankment.

Land use

3.6.2 The land immediately to the north-east, south-east, and south-west quadrants of Thickthorn Junction is currently predominantly agricultural land, although land to the north-east and south-east has planning permission for housing developments. The land in the north-west quadrant accommodates Thickthorn Park and Ride, Thickthorn Services; a hotel, a restaurant, an electricity substation, and a petrol filling station.

3.6.3 The western extent of the current Norwich built-up area is less than 500m to the north of the junction. There is also a pocket of residential land along Cantley Lane approximately 400m to the east of the junction. Several residential properties located to the north-west of the junction on the B1172 Norwich Road, and to the north-east along the Old Newmarket Road.

Property and Industry

3.6.4 A service area including hotel, restaurant and petrol filling station, and large Park and Ride facility, are located on the western side of the junction. Cantley Lane has a small number of private properties around the A47 with more major housing developments from Round House Roundabout towards Norwich. Details of these accesses are provided in Section 3.2.44 to 3.2.46.

3.7 Climate

3.7.1 All information in this section is sourced from the Met Office Website:

http://www.metoffice.gov.uk/climate/uk/regional-climates/ee

3.7.2 The mean annual temperature over the region varies from around 9.5 °C to just over 10.5 °C. Temperature shows both seasonal and diurnal variations. January and February are the coldest months with mean daily minimum temperatures across the region close to 1 °C. Mean daily maximum temperatures range from just over 6 °C to 8 °C during the winter months and from 20 °C to 23 °C in the summer.

3.7.3 Across most of the region there are, on average, about 30 rain days (rainfall greater than 1 mm) in winter (December to February) and less than 25 days in summer (June to August). Much of eastern England receives less than 700mm per year and includes some of the driest areas in the country.

3.7.4 Eastern England is one of the more sheltered parts of the UK. As Atlantic depressions pass by the UK the wind typically starts to blow from the south or south-west, but later comes from the west or north-west as the depression moves away. Directions between south and north-west account for the majority of occasions and the strongest winds nearly always blow from this range of directions. Eastern England has the greatest frequency of tornadoes in the UK.

3.8 Drainage

3.8.1 The ground around the Thickthorn Junction generally falls towards the secondary river to the south, the tertiary river to the north and to the River Yare to the east. The secondary river and the tertiary river are both tributaries of the River Yare, as can be seen in Figure 3-19.

3.8.2 The outfalls for the road drainage on the A47 and A11 south are shown in Figure 3-20. The A47 road drainage on the approach to the junction also discharges into soakaways. The area is on chalk which allows the effective use of soakaways.

Figure 3-19 Land profile, contours and watercourses (ref: HADDMS 18th August 2016)

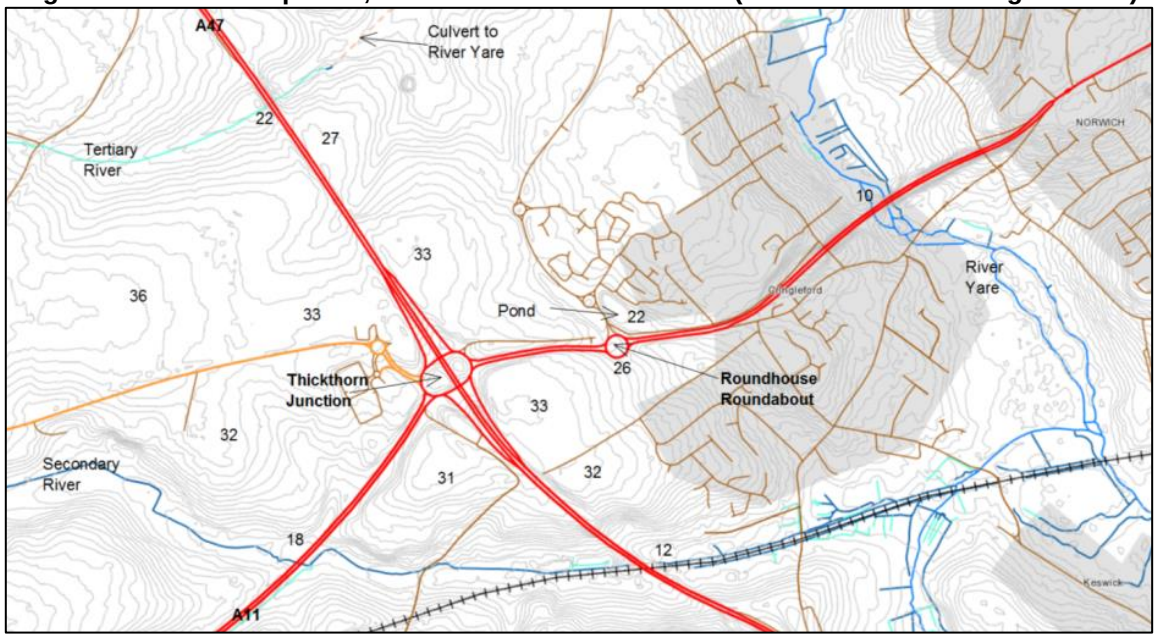
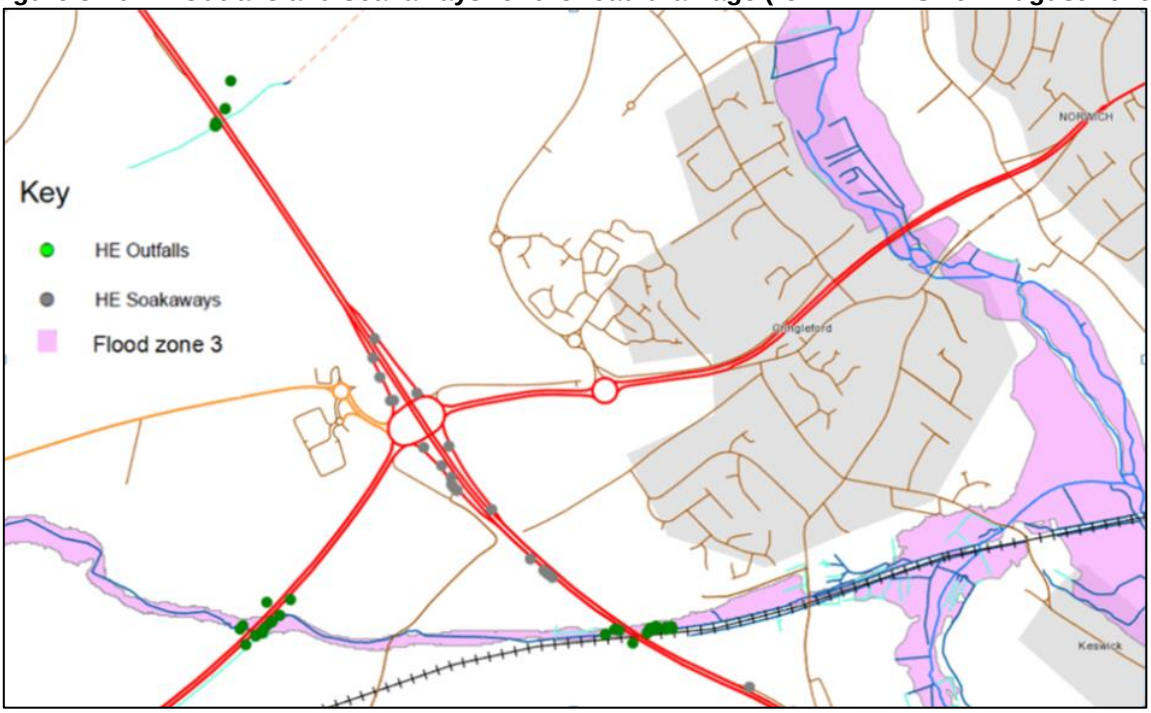


Figure 3-20 Outfalls and soakaways for the road drainage (re: HADDMS 19th August 2016)



3.8.3 Highways England Drainage Data Management System (HADDMS) reports nine flood incidents in the area from 2011 to 2016. These are mainly caused by blocked gullies and

drains. One incident on the A47 bridge refers to the system not being able to take the volume of water away; this was on the 7th January 2016. Thickthorn Junction and Round House Roundabout are in the Environment Agency Flood Zone 1 (white area in Figure 3-20). The different flood zones are described as follows:

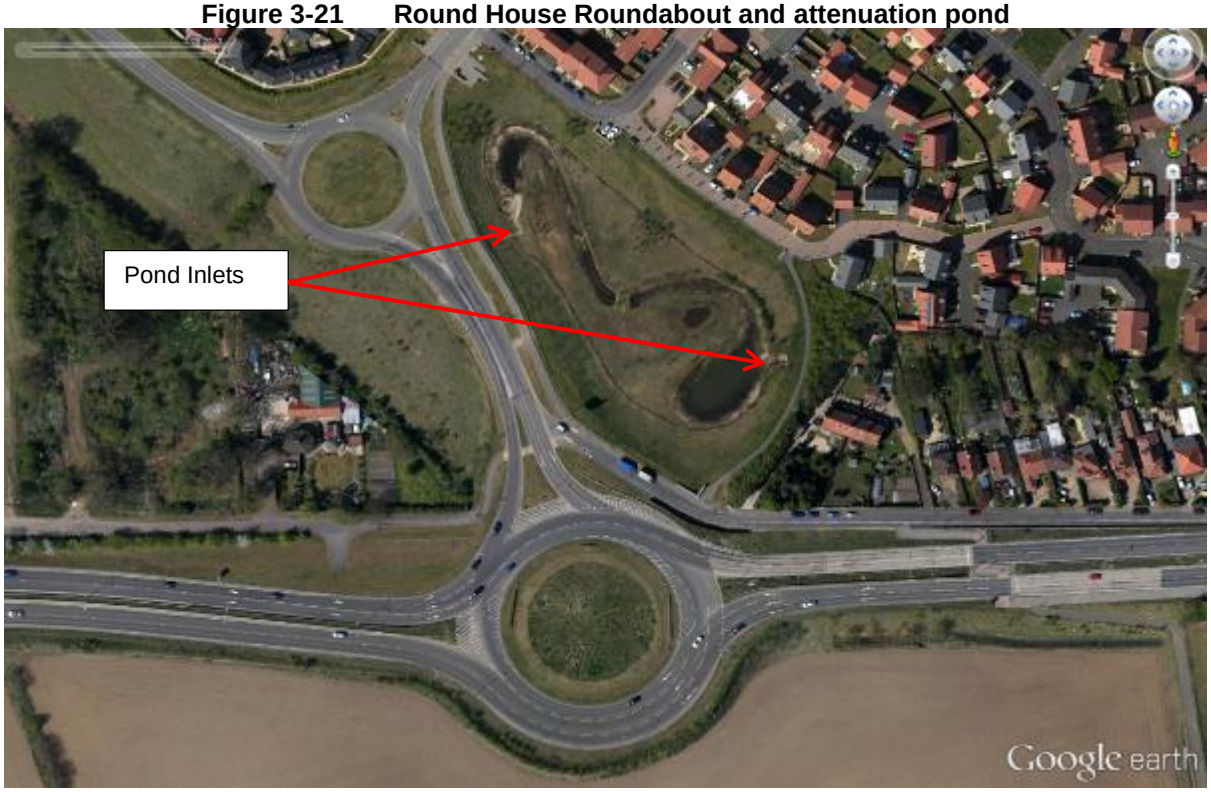
- Flood Zone 1 - land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%);
- Flood Zone 2 - land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year; and
- Flood Zone 3 - land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

3.8.4 At Thickthorn Junction, HADDMS does not include the drainage assets for the A11 south. However, it does include drainage assets for the A47 mainline and A47 Thickthorn Junction slip roads. The recorded assets include soakaways, gullies and catchpits; but the records for the connecting pipework and filter drains are incomplete or have been excluded. Records of the connecting pipework begin on the A47 mainline approximately 350m from the centre of the gyratory.

3.8.5 Since Round House Roundabout is on the local road network, HADDMS does not include records of the drainage assets. From a desktop study, it was observed that there is a combined kerb and drainage system around the inner kerb-line of the roundabout and gullies along the outer channels on the approach roads directly adjacent to the roundabout.

3.8.6 There is only a small volume of water in the attenuation pond on the north side of the roundabout. There appears to be two inlets into the pond; one from the new Round House Park development to the north, and one from the approach road to the roundabout, see Figure 3-21.

Figure 3-21 Round House Roundabout and attenuation pond



3.9 Geology

3.9.1 From British Geological Survey (BGS) records viewed on the Highways England Geotechnical Data Management System (HAGDMS) it is noted that the study area is underlain by the following geological sequence. A geology map of the area is included in Appendix D.

Bedrock Geology

3.9.2 Bedrock in the area comprises Chalk of the White Sub-Group, formerly known as the Upper Chalk Formation. The BGS lexicon indicates that the sub-group includes the Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation.

3.9.3 The Chalk is shown to outcrop in the lower valley sides where the A47 crosses Cantley Stream and is indicated to extend at least 30m below ordnance datum.

Superficial Geology

3.9.4 The surface geology consists of intermittent beds of Glacial Sand and Gravel (Sheringham Cliffs Formation) and Glacial Till (Lowestoft Formation).

3.9.5 Available ground investigation information indicates the immediate junction area overlies glacial till of the Lowestoft Formation (approximately 8-10m in thickness) which in turn overlies glacial sands and gravels of the Sheringham Cliffs Formation (approximately 5-6m in thickness).

3.9.6 The glacial till is typically described as soft to firm, orange to brown with black mottling slightly sandy slightly gravelly clay. The gravel is angular flint and chalk. Bands of sands and gravel are present within the glacial till.

3.9.7 The glacial sands and gravels are typically described as medium dense light brown fine to medium sand, becoming orange brown with depth, and slightly clayey with some gravel. These deposits are shown to outcrop in the lower areas around the junction.

3.9.8 Deposits of Alluvium comprising clay, silt, sand and gravel are present along the line of the watercourse 700m south west of the junction under the A11, and under the A47 to the south-east. This tract of Alluvium follows the course of the Cantley Stream which flows alongside the railways line eastwards towards the River Yare.

Fault Geology

3.9.9 There are no known fault features in the vicinity.

Sensitive Geological Areas

3.9.10 The Environment Agency classifies the Chalk bedrock as a Principal Aquifer i.e. a major aquifer that may support water supply on a strategic scale. The superficial deposits are classified as a Secondary A aquifer i.e. minor aquifers where permeable layers may support local water supply or base flow to rivers. The area north-west of the A11 is denoted as an Outer (zone 2) Source Protection Zone whereas south-east of the A11 is outside the Source Protection Zone. The groundwater vulnerability maps show the area as a Major Aquifer of intermediate vulnerability. The available borehole information indicates the groundwater table lies within the Chalk at approximately 15 metres above Ordnance Datum (O.D), 16 metres below ground level (BGL) at Thickthorn Junction reducing to approximately 10m O.D. (2m BGL) at the A47 railway crossing.

3.9.11 There are no SSSIs or sites of geological interest within 2km of Thickthorn Junction.

3.9.12 An historic landfill site is recorded by the Environment Agency north of Cantley Stream close to where it is culverted below the A11. Cantley Lane landfill was operated between 1961 and 1969 receiving inert, industrial, commercial and household waste.

3.9.13 The alluvial deposits along Cantley Stream near the railway bridge include highly compressible amorphous peat between 1.0m to 2.25m in thickness underlain by water bearing sand and gravel.

3.9.14 The elevation of the chalk rockhead varies from around 18m O.D. at Thickthorn Junction to 1m O.D. immediately east of the railway bridge. There is potential for localised variation in the rockhead level and the presence of loose zones within the overlying glacial deposits associated with solution features in the Chalk.

3.9.15 The granular lenses within the Lowestoft Formation have the potential for perched water to be encountered in excavations.

Geomorphological Review

3.9.16 The geomorphology of the area is typical of the till (boulder clay) plateau of central Norfolk dissected by the buried valley of the River Yare and associated tributaries.

3.9.17 In the area the glacial sand and gravel is shown to outcrop in the lower valley slopes and alluvial deposits are present along the bottom of the shallow valleys such as Cantley Stream.

3.9.18 The geomorphology has been modified by the construction of embankments and cuttings of the A47 trunk road and Thickthorn Junction. The Norwich to Ely railway line crosses the A47 in shallow cutting immediately south of Cantley Stream.

3.9.19 Two tumuli are shown on the OS maps south-west of the Thickthorn Junction.

3.10 Unexploded Ordnance

3.10.1 According to the Regional Unexploded Bomb Risk map for Norfolk (Zetica), the site is located close to an area where the probability of encountering unexploded bombs is high. Therefore, a further unexploded ordnance (UXO) risk assessment is recommended.

3.11 Mining

3.11.1 No records of mine workings are recorded for this site although localised excavations within the Glacial Sand and Gravel may be present.

3.12 Public Utilities

3.12.1 C2 and C3 enquiries have been submitted, and all eight C3 estimates have been obtained for the area around Thickthorn Junction. These are included in the Statutory Undertakers Estimate PCF Product Ref. HE551492-ACM-VUT-TJ-RP-ZM-00001.

3.12.2 There are 400kV and 132kV overhead cables mounted on pylons traversing the site, which run roughly parallel with the A47 mainline:

- The 400kV power lines run south of the A47; and
- The 132kV power lines run north of the A47, and cross the A11 to the north of Thickthorn Junction Gyratory.

3.12.3 There are 11kV overhead cables to the north of the A47. These cross the A47 to the west of Cantley Lane, and then run to the south of the A47, and cross the A11 to the south of Thickthorn Junction gyratory.

3.12.4 Based on the C2 / C3 responses, a composite drawing of existing utilities has been produced. Refer to Drawing HE551492-ACM-VUT-TJ-DR-HE-01060 in Appendix E.

3.13 Technology

3.13.1 A walkover site visit and desk study of existing technology in the vicinity of Thickthorn Junction was undertaken; this is a preliminary study and initial overview, see Figure 3-22. A detailed survey, check of available records, and consultation with the affected stakeholders should be undertaken.

3.13.2 The Thickthorn Junction gyratory is controlled by traffic signals supported by the Microprocessor Optimised Vehicle Actuation (MOVA) system. There are MOVA loop systems on the A47 westbound diverge and the A47 eastbound diverge. The gyratory has signalised approaches from the A47 eastbound off-slip, the approach from A11 south, the A47 westbound off-slip and the approach from A11 north.

3.13.3 Access steps to a camera have been identified, the camera is an NTIS (National Traffic Information Service) ANPR (Automated Number Plate Recognition) camera, equipment number JLT2850, which is used to monitor traffic counts and is maintained by the RTMC (Regional Technology Maintenance Contracts).

3.13.4 There is an Emergency Roadside Telephone (ERT) located in a lay-by on the A47 eastbound, approximately 1400m to the south east of Thickthorn Junction.

3.13.5 There are separate signalised crossings across the A47 westbound merge for a Toucan crossing and the A47 eastbound merge for a Pegasus Crossing. The traffic signals for the Toucan crossing across the eastbound diverge and for the Pegasus crossing for the westbound diverge are integrated with the traffic signals for the gyratory. There is also a signalised crossing to the east of Round House Roundabout.

Figure 3-22 Existing Technology

3.14 Maintenance Access

3.14.1 A preliminary desk study of Thickthorn Junction and the surrounding area was undertaken in order to identify the maintenance access facilities. These include grass cell maintenance lay-bys, access paths and steps. The locations of these facilities are indicated in Figure 3-23 and scheduled in Table 3-3 below.

3.14.2 Public lay-bys, public footpaths, local roads and verges may also be used to access equipment. For locations of public lay-bys see Sections 3.2.35 to 3.2.38, and for locations of public footpaths refer to Section 3.2.30 to 3.2.34.

Figure 3-23 Locations of Maintenance Access Facilities

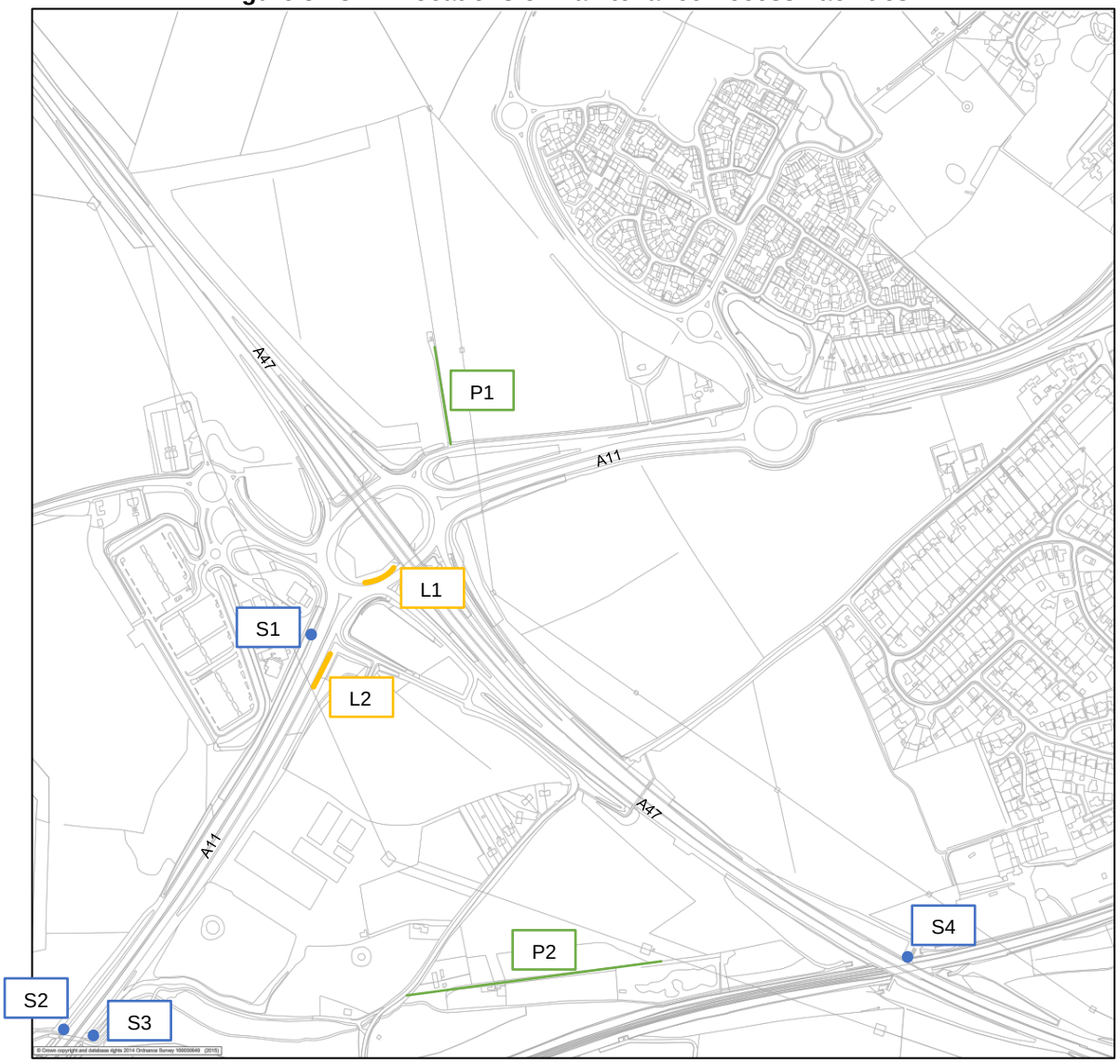


Table 3-3 Schedule of Maintenance Access Facilities

Maintenance Access Facility Reference	Description
L1	Grass cell maintenance lay-by located on the central island of the gyratory, opposite to the A47 westbound off-slip, providing access to traffic signals and central island.
L2	Grass cell maintenance lay-by located on the A11 southbound carriageway, approximately 150m to the south-west of the Thickthorn Junction. Purpose of the maintenance lay-by could be to maintain the overhead power cables.
P1	Unsurfaced path off Old Newmarket Road, providing access to a mast.
P2	Unsurfaced path located to the east of Cantley Lane South, providing access to properties, farm land and an electricity pylon.
S1	Steps on A11 northbound, approximately 100m to the south-west of Thickthorn Junction, providing access to an ANPR camera
S2	Steps on the A11 northbound and southbound carriageways, approximately 700m south-west of the Thickthorn Junction, providing access to a bridge which accommodates a farm track and stream below the A11.
S3	
S4	Steps on the A47 eastbound, providing access to the Breckland Railway Line bridge.

4 Accessibility and Integration

4.1 Impact of the Scheme

4.1.1 The impact of the scheme on accessibility and integration relates to the provisions for the public transport corridors, and the amenities for social groups in the area (TAG Unit A4.1 S8, Social Impact Appraisal, November 2014).

4.2 Existing NMU Provision

4.2.1 The existing NMU provisions are described in Section 3.2 above.

4.3 Existing Severance

4.3.1 Community severance is defined here as the separation of residents from facilities and services they use within their community caused by substantial changes in transport infrastructure or by changes in traffic flows. Severance will only be an issue where either vehicle flows are significant enough to significantly impede pedestrian movement, or where infrastructure presents a physical barrier to movement (TAG Unit A4.1 S8, Social Impact Appraisal, November 2014).

4.3.2 National Policy Statement (NPS) [14] Paragraph 3.22 states that severance can be a problem in some locations. Where appropriate, applicants should seek to deliver improvements that reduce community severance and improve accessibility.

4.3.3 There is a historic severance of Cantley Lane and Cantley Lane South to the east of Thickthorn Junction, caused by the construction of the A47. Cantley Lane South is connected to Thickthorn Junction via a left-out connection onto the A47 off-slip, and a short diverge off-slip from the A11 south, southbound carriageway, see Figure 3-13. Cantley Lane connects into the wider road network for the Cringleford conurbation. The reconnection of Cantley Lane with Cantley Lane South was initially seen as a potential benefit of the proposed improvements to Thickthorn Junction by Highways England. However, feedback from the PIE, as discussed in Section 10 of this report, demonstrated that there was substantial opposition to this from the public.

4.4 Existing Access to Transport Systems

Rail Services

4.4.1 The Breckland Railway Line crosses the A47 approximately 900m to the east of the Thickthorn Junction, and is a key constraint to the design of the Single Option described in Section 7 of this report.

4.4.2 Thickthorn Junction is located approximately midway between Norwich City Station (6km) and Wymondham Station (8km). The Breckland Railway alignment is broadly parallel to the A11 between Ely, Thetford, and Norwich.

4.4.3 The rail line is used by East Midlands Trains and Greater Anglia, who operate rail services connecting Norwich to Cambridge and onward destinations. These services provide an alternative to travel by road, for trips between urban centres along the A11. Rail service frequency along this corridor is summarised in Table 4-1.

Table 4-1 Train Services parallel to the A11 calling at Wymondham

Route	Train Service (per day) (including express and part-route services)		
	Monday – Friday	Saturday	Sunday
East Midlands Trains (Liverpool – Manchester – Sheffield – Cambridge – Ely – Peterborough – Thetford – Norwich)	21 trains	28 trains	Up to 14 trains
Greater Anglia (Cambridge – Ely – Thetford – Attleborough – Wymondham – Norwich)	32 trains		22 trains

4.4.4 Owing to the proximity of the rail line, there could be some scope to reduce the number of trips made by road between Norwich and towns along the A11 corridor, by improving rail services along the Breckland Line, although the extent to which this could influence traffic flows at the Thickthorn Junction, which serves other movements, is uncertain.

Bus services

4.4.5 In order to enhance local public transport connections, there is a bus priority corridor along Newmarket Road linking Wymondham, Hethersett, Cringleford, and central Norwich.

4.4.6 Local Transport Plan (LTP) 3 Implementation Plan 2021-2026 includes a commitment to further roll out Bus Rapid Transit, including the route along the A11 Newmarket Road corridor between Wymondham and Norwich. It is understood that this would include additional bus priority measures, increased frequency of services, and improved bus stop facilities with real time information.

4.4.7 Thickthorn Park and Ride encourages people, traveling on the A11 or A47 into Norwich by car, to switch to public transport. The Park and Ride is located to the west of Thickthorn Junction, between the B1172 and the A11 south, and has approximately 726 parking spaces. The 501 bus service from Thickthorn Park and Ride enters Norwich via the priority bus route on the A11 Newmarket road. There are plans to expand this service.

4.4.8 A total of six bus services are known to route through the junction. The most frequent of which is the 501 bus service, linking the Thickthorn P&R to the city centre and Norwich International Airport.

4.4.9 The routes and frequencies of these services are presented in Table 4-2.

Table 4-2 Bus Services passing through Thickthorn Junction.

Service	Route	Max Frequency per Hour		
		Mon-Fri	Sat	Sun
501	Thickthorn P&R - Norwich City Centre - Airport P&R	6	5	0
6	Watton - Hingham - Wymondham – Norwich	1	1	0
6A	Attleborough - Wymondham – Norwich	1	1	0
X6	Attleborough - Wymondham - Norwich (via A11)	0.5	0.5	0
9	Wydmondham - Hethersett - N&NU Hospital	1	0	0
9A	N&NU Hospital - Cringleford - Hethersett Academy (School bus)	1	0	0

5 Planning Factors

5.1 Planning Procedure

5.1.1 In order to secure planning approval, all significant highways schemes are subject to statutory processes in order to demonstrate that they have followed due process and guidance set out in relevant Acts of Parliament.

5.1.2 The key Acts of Parliament to consider for this scheme are:

- Highways Act 1980
- Planning Act 2008
- Housing and Planning Act 2016

5.1.3 A determination is required to establish which Act is relevant to this scheme. This is dependent on a number of factors including:

- The type of scheme;
- The area of land required for the scheme; and
- The environmental impact of the scheme.

5.1.4 Consultation with Highways England's legal representatives and the DCO Statutory Processes Manager was undertaken, where the options were discussed in detail and information was shared between all parties, to enable an assessment of the scheme.

5.1.5 From the above, the statutory process is option dependent but, in order to develop an outline process and programme for the scheme, an assumption has been made that this scheme will be subject to the Planning Act 2008. Furthermore it has also been assumed that the scheme will be considered an NSIP and will be subject to a DCO process.

5.1.6 This determination will remain under review throughout PCF Stage 2, as the scope and scale of the preferred route emerges.

5.1.7 In consultation with Highways England, a DCO defined programme is discussed in further detail in Section 13 of the TAR addendum.

5.2 Committed Developments

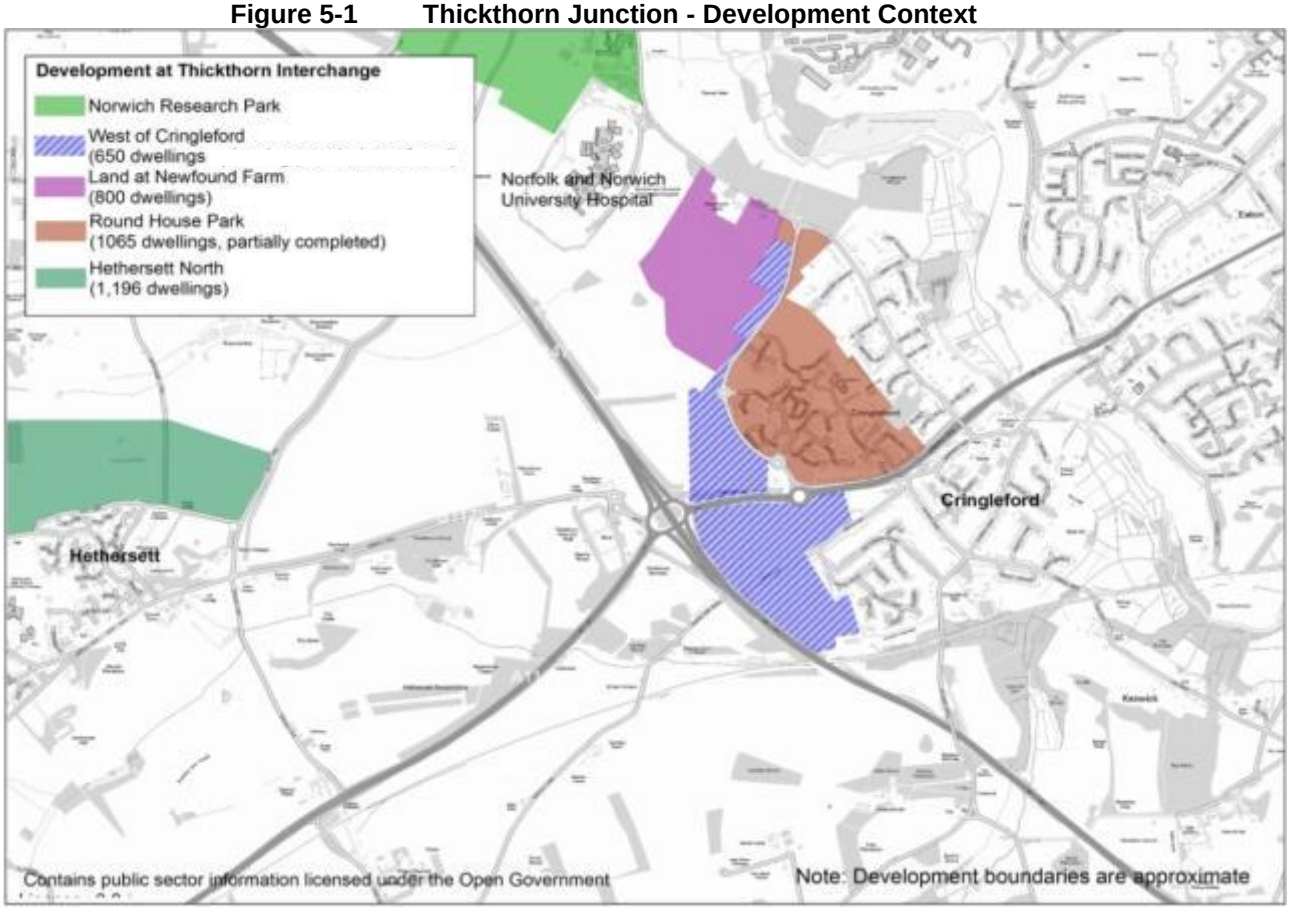
5.2.1 There are a number of committed developments, planning applications and Local Plan allocations currently identified in the area, which are likely to have a significant effect on the traffic in the vicinity of the scheme.

5.2.2 Based on their close proximity to the Thickthorn Junction, five major developments are likely to affect the balance of flows at the junction:

- Round House Park Phase 1 and 2 (1,065 dwellings, partially completed);
- Land at Newfound Farm (800 dwellings);
- West of Cringleford (650 dwellings);
- Hethersett North (1,196 dwellings); and
- Norwich Research Park (Research facilities including 100,000 sqm laboratory/office spaces).

5.2.3 The approximate boundaries of these developments are shown in Figure 5-1.

Figure 5-1 Thickthorn Junction - Development Context

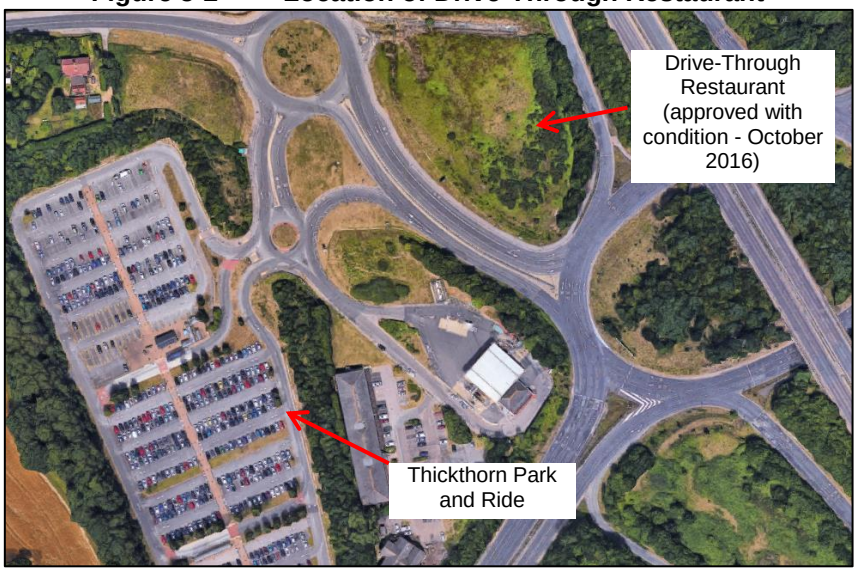


5.2.4 Further afield, planning permission has been granted for 880 dwellings and a major retail development in Easton and Costessey, with a further 900 dwellings uncommitted. These are some distance away adjacent to the Longwater Interchange, however given the significance of Thickthorn Junction as a major junction between east-west and north-south movements, development over a wide area could be of significance.

5.2.5 The close proximity of the West of Cringleford development to the north side of the A47 is a key constraint since there would be a high cost for the land if it needed to be acquired by Highways England. The importance of this development with regards to route selection is referred to in Sections 5.5 and 5.6.

5.2.6 The planning application has recently been approved with conditions for the construction of a drive-through takeaway restaurant, on land between the B1172 and A47, adjacent to the Thickthorn Junction, with its access from the B1172, opposite to Thickthorn Park and Ride. The location of this site is shown in Figure 5-2. The likely trip generation is not yet known.

Figure 5-2 Location of Drive-Through Restaurant



5.2.7 The following major developments have been granted outline planning permission, with conditions requiring improvements to Thickthorn Junction and/or the Round House Roundabout. Drawings showing the mitigation scheme proposed by each developer are shown in Appendix F.

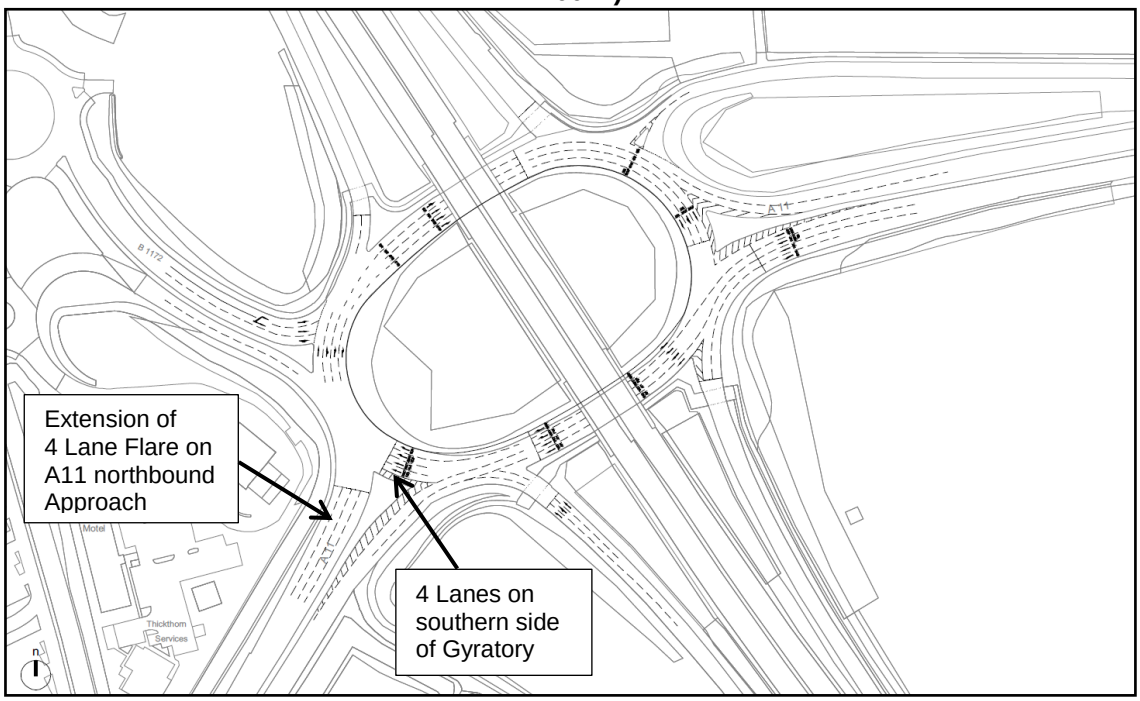
Hethersett North

5.2.8 This development of 1,196 dwellings was granted outline planning permission in June 2013.

5.2.9 The planning conditions include a requirement for the construction of the highway mitigation scheme shown in drawing SR36900006-TR0021 prior to occupation of the 250th dwelling. An excerpt from this drawing is included in Figure 5-3 overleaf.

5.2.10 The committed mitigation scheme will provide four lanes on the southern side of the Thickthorn gyratory, as well as extending the four lane flare on the A11 northbound approach to the gyratory.

Figure 5-3 Excerpt from Hethersett North Mitigation Scheme (Drawing No. SR36900006-TR0021)

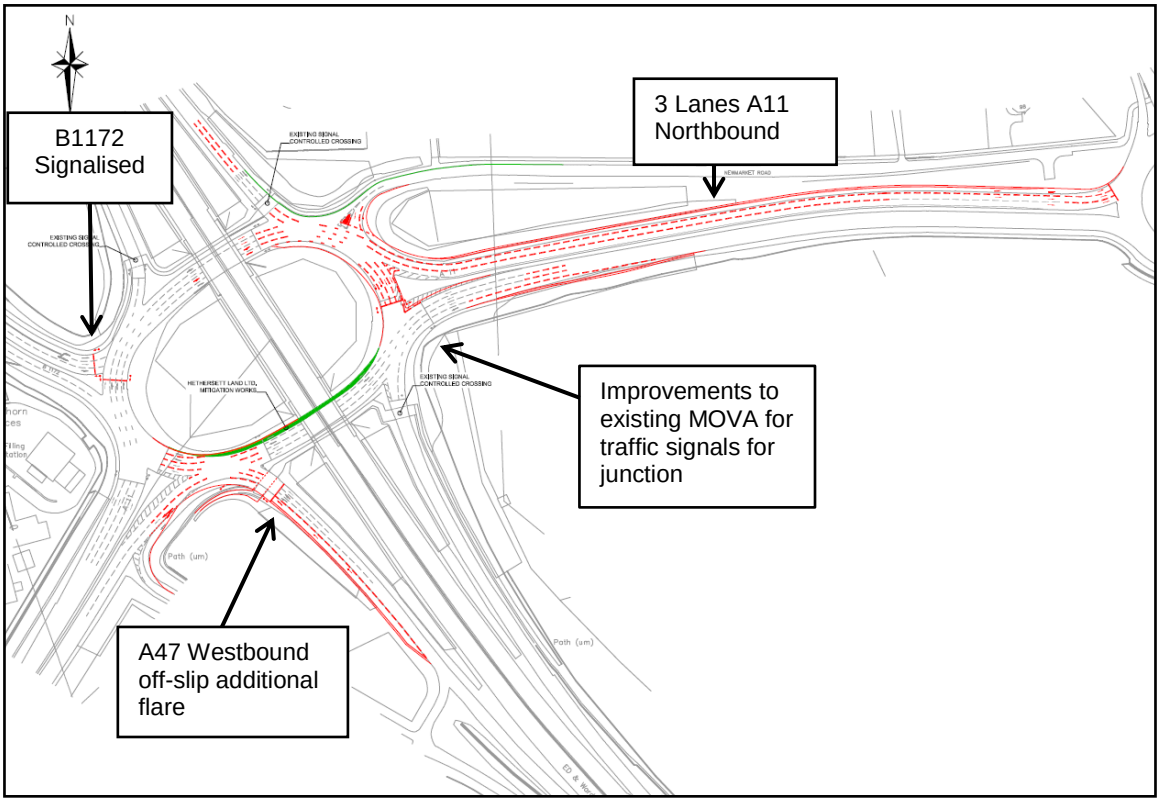


Land West of Cringleford

5.2.11 This development of 650 dwellings was granted outline planning permission at appeal in January 2016.

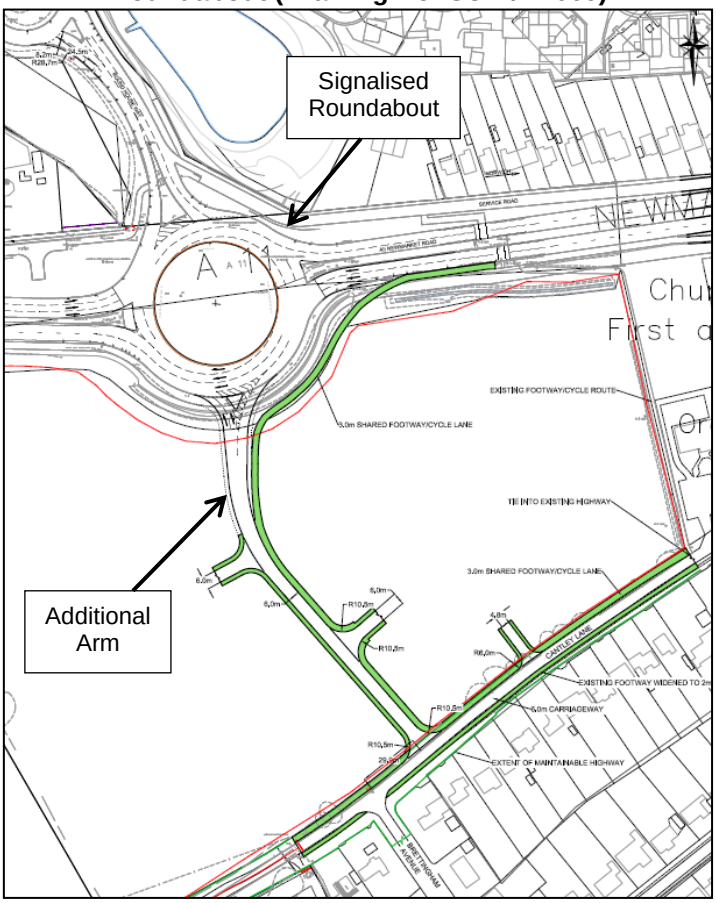
5.2.12 The planning conditions include a requirement for the construction of a scheme substantially close to that shown on drawing G871/014 prior to occupation of the 100th dwelling. An excerpt from this drawing is included in Figure 5-4 below. This includes 3 lanes on the A11 northbound approach to the Round House Roundabout, an additional flare on the westbound A47 off-slip approach, improvements to the existing MOVA at the Thickthorn Junction and signalisation of the B1172 approach to the gyratory.

Figure 5-4 Excerpt from Land West of Cringleford Mitigation Scheme (Drawing No. G871/014)



5.2.13 In addition, construction of a scheme substantially close to that shown in drawing G871/TA009 is required prior to land being occupied south of the A11. An excerpt from this drawing is included in Figure 5-5 overleaf. This includes signalisation of the A11 approaches to Round House Roundabout and the construction of a new arm on the southern side of the roundabout to provide access to the development.

Figure 5-5 Excerpt from Land West of Cringleford Mitigation Scheme at Round House Roundabout (Drawing No. G871/TA009)



Land at Newfound Farm

5.2.14 This development of up to 800 dwellings has been granted outline planning permission, with a decision notice yet to be published.

5.2.15 It is understood that conditions are yet to be formally agreed for this development. However, it is expected that a scheme substantially close to that shown in drawings 60163960-THK-001 and 60163960-THK-002 will be required prior to occupation of the 100th dwelling. Excerpts from these drawing are included in Figures 5-6 and 5-7 overleaf. The committed mitigation shown on these drawings includes many of the same mitigation measures as those which are to be provided for the Hethersett North development as shown on drawing TR0021 (Refer to Figure 5-3) and the West of Cringleford development shown in drawing G871/014 (Refer to Figure 5-4).

5.2.16 These planning conditions would therefore require either the Newfound Farm development, the West of Cringleford development, or the Hethersett North development to provide the scheme, depending on which development reaches its threshold first. This has the potential for a delay in the delivery of these improvements as developers seek to reduce their costs.

Figure 5-6 Excerpt from Land at Newfound Farm Mitigation Scheme (Drawing No. 60163960-THK-001)

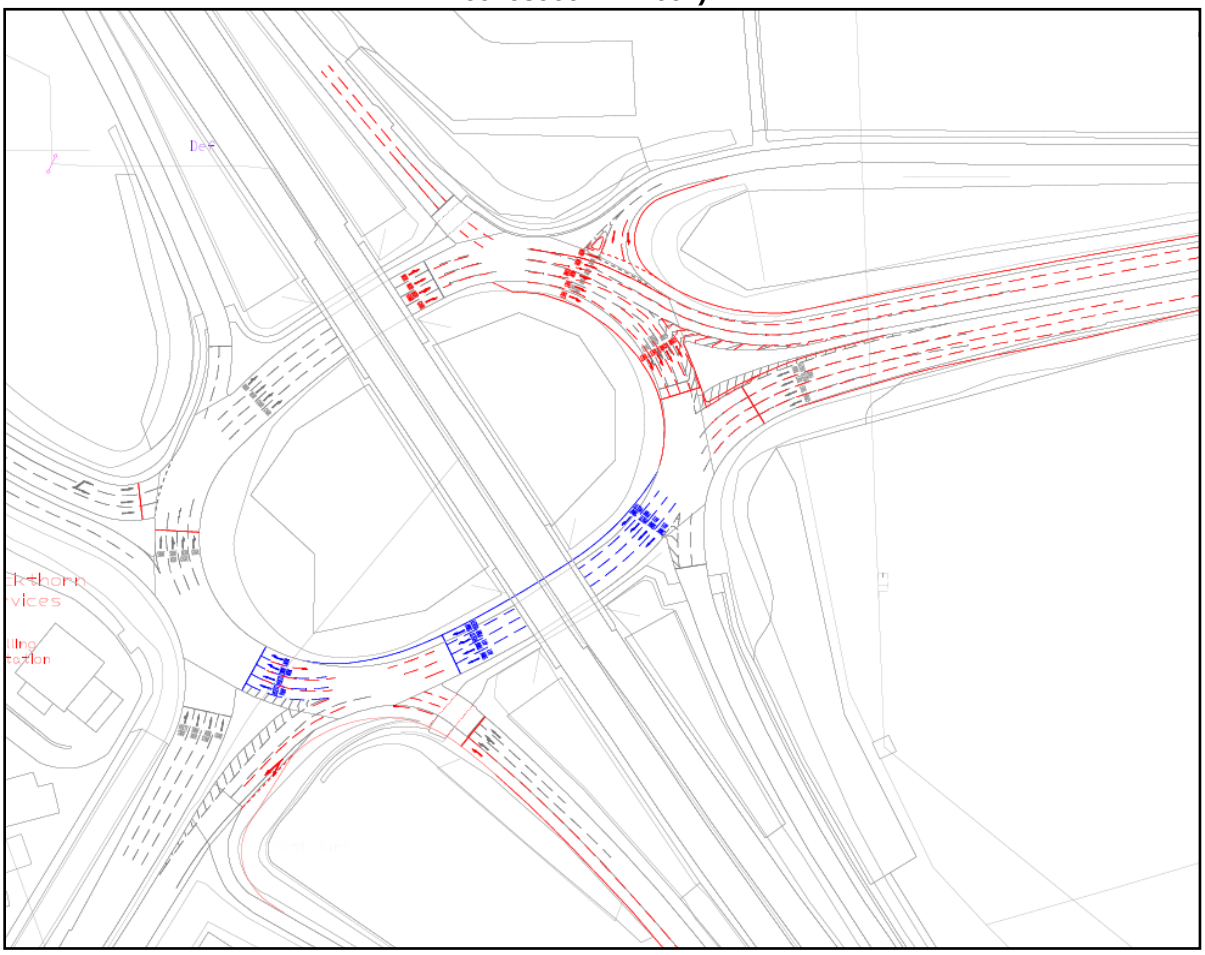
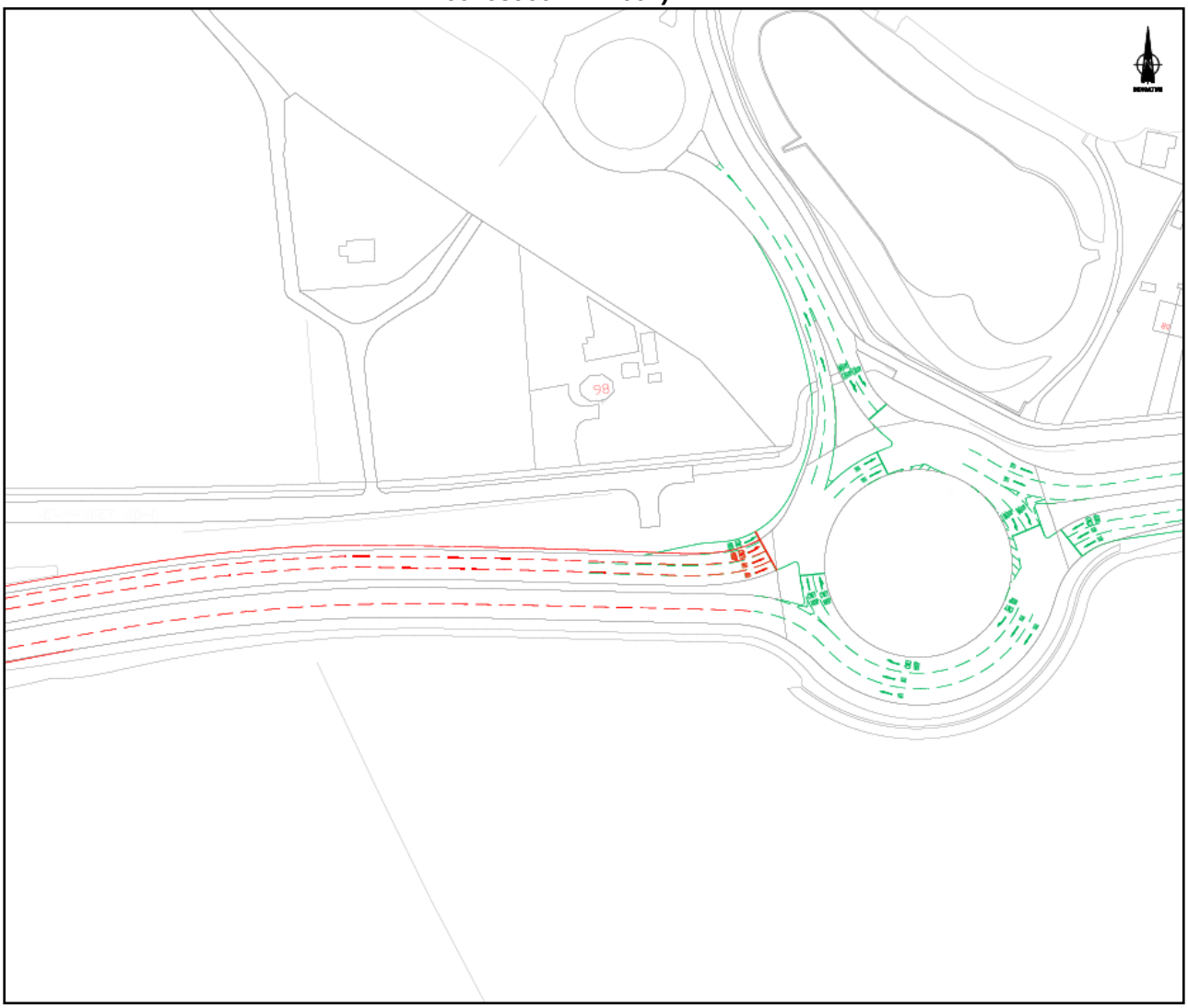
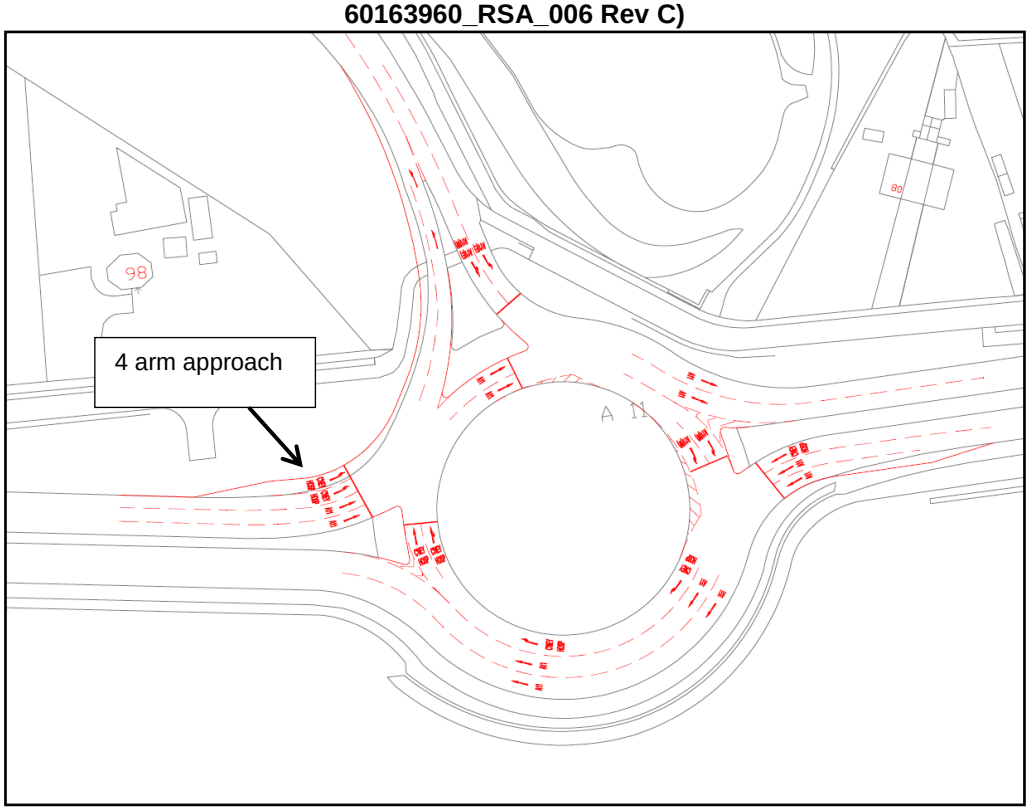


Figure 5-7 Excerpt from Land at Newfound Farm Mitigation Scheme (Drawing No. 60163960-THK-002)



5.2.17 It is expected that a scheme substantially close to that shown in drawing 60163960_RSA_006 Rev C will be required prior to occupation of the 500th dwelling. An excerpt from this drawing is included in Figure 5-8 below. This drawing shows provision of a short 4-lane flare on the A11 northbound approach to the fully signalised Round House Roundabout.

Figure 5-8 Excerpt from Land at Newfound Farm Mitigation Scheme (Drawing No. 60163960_RSA_006 Rev C)



5.2.18 The committed mitigation measures at Thickthorn Junction of local developments, if implemented, are relatively low-cost improvements but could affect the operation of the junction significantly. Committed mitigation for these three developments is conditioned relative to the occupation of each development. The rate of build-out and occupation of development will depend on the strategy adopted by each developer to maximise its return on investment.

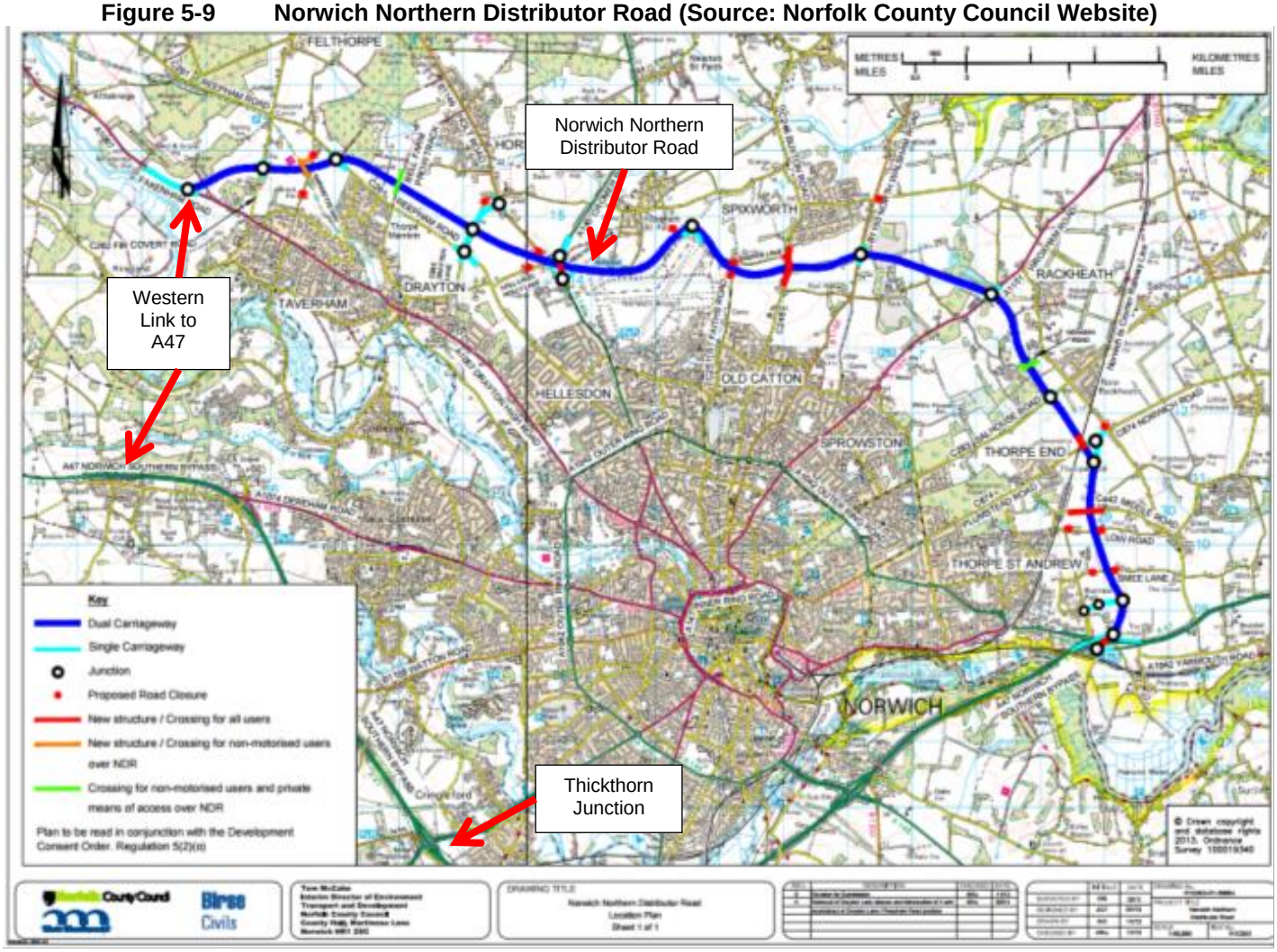
Current Status

5.2.19 A meeting was held with Norfolk County Council and Norwich City Council planning officers, a consortium of developers representing local future development sites and Highways England on the 13th April 2016. At this meeting it was agreed that the developers would prepare detailed proposals for the highway improvements identified in the previous sections and estimate the value of these improvements. Subject to agreement of the value of the works identified, it was agreed that, if the Thickthorn Junction Improvements scheme were to be implemented by Highways England, the developers would make a financial contribution to Highways England to the value of the improvements identified. It was further agreed that should Highways England not implement an improvement scheme for Thickthorn Junction, the developers would provide the improvements identified in accordance with the conditions of their respective planning consents. As the scheme evolves there will be continued dialogue with the developers.

5.3 Committed Infrastructure

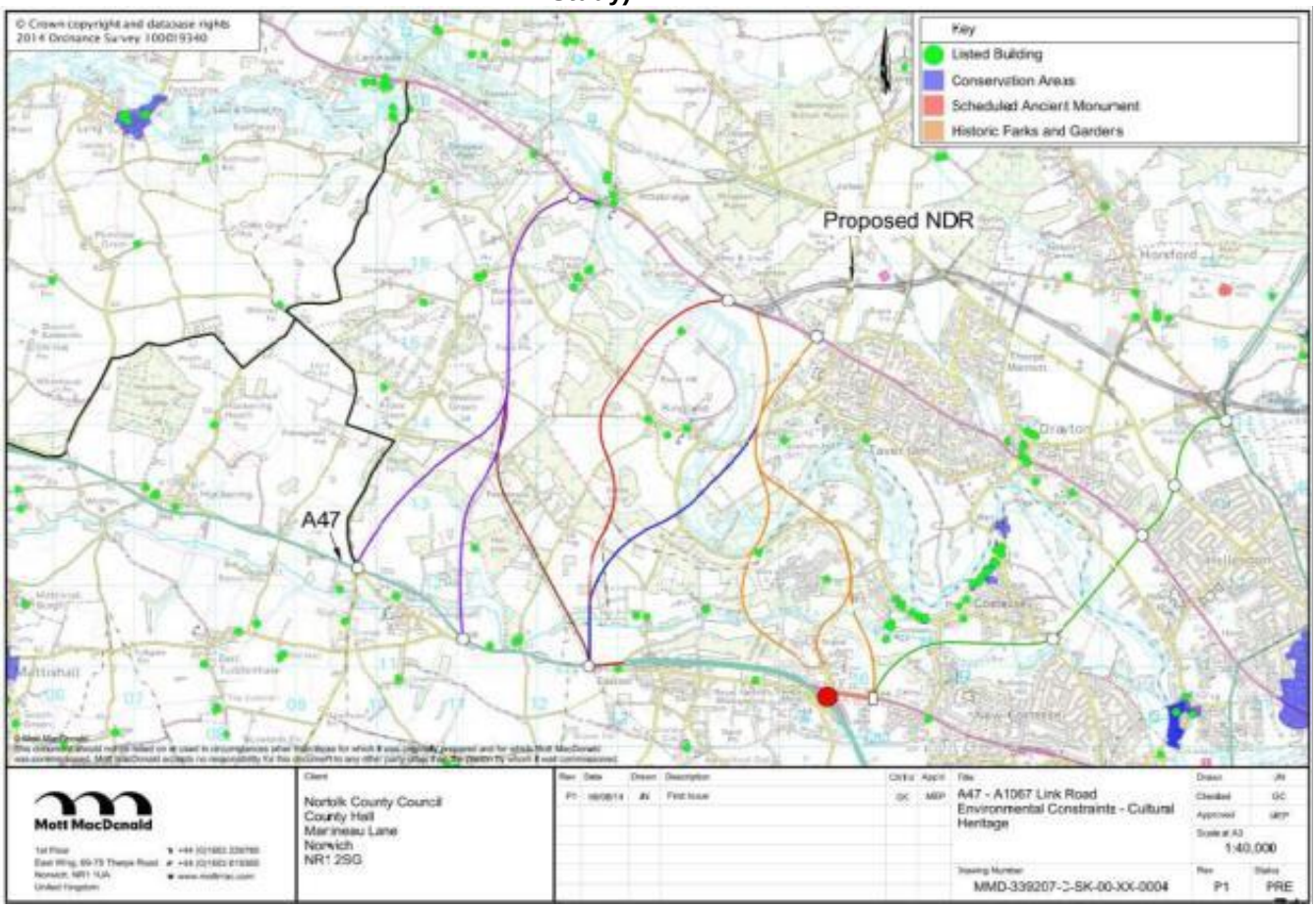
5.3.1 In June 2015, Norfolk County Council obtained approval through the DCO process for the Norwich Northern Distributor Road (NDR). The NDR is a 20km dual carriageway road planned to run from the A47 at Postwick, east of Norwich, to the A1067 north of Taverham, as shown in Figure 5-9. This provides a link road around the north and east sides of Norwich linking to the A47 at the east of Norwich. Construction on various sections of the NDR is currently ongoing with construction due to be completed in 2018.

Figure 5-9 Norwich Northern Distributor Road (Source: Norfolk County Council Website)



5.3.2 There is also a scheme being developed by Norwich Country Council (NCC), which is in the options feasibility stage, to provide a link to potentially complete the north western section of the distributor road. The western link would potentially join to the A47 within the Tuddenham to Easton scheme or close to the limits of the scheme, see Figure 5-10.

Figure 5-10 Location Plan A1067 to A47 Route Options (source: 2014 Scoping Study)



5.3.3 The Norwich Western Link Project was taken to the Environment Development and Transport Committee of Norfolk County Council on the 8th July 2016 following a report undertaken by Mouchel to appraise the potential solutions to the transport issues in the western quadrant of Norwich.

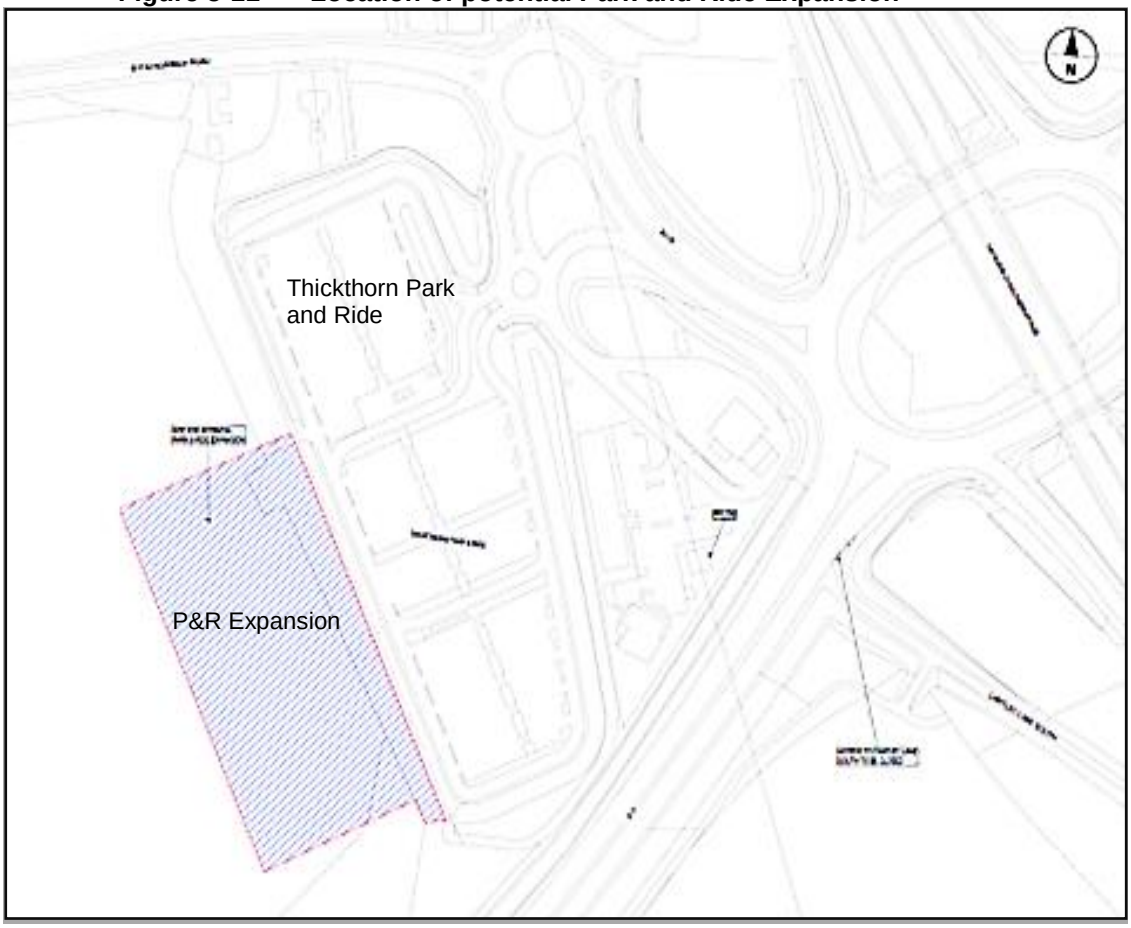
5.3.4 "A tentative programme envisages some preliminary work prior to the opening of the NDR and work required after the NDR is opened and following a period of monitoring. This would also need to take regard of A47 improvements being progressed by Highways England (with construction currently suggested to start in 2020), the Food Hub proposal, and the update of the Greater Norwich Local Plan (GNLP). This report therefore recommends options to be progressed in the short-term over the next 18 months, in 6 month phases, with appropriate "review gateways" before further work is progressed."

5.4 Potential Development

5.4.1 According to the Greater Norwich Infrastructure Plan (GNIP), growth in Wymondham, Hethersett and Cringleford is considered to be dependent on the junction improvements at Thickthorn Junction.

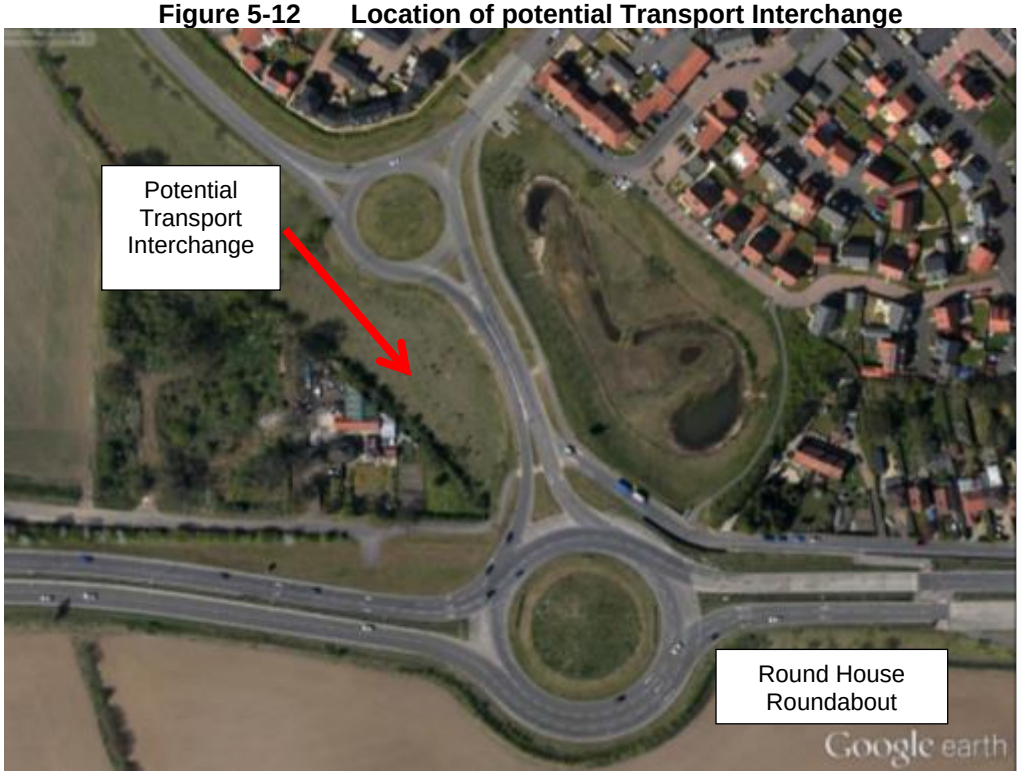
5.4.2 The GNIP includes expansion of the Park and Ride at Thickthorn Junction using land secured from a S106 agreement. The location of the potential Park and Ride expansion is shown in Figure 5-11 below.

Figure 5-11 Location of potential Park and Ride Expansion



5.4.3 The Cringleford NDP (refer to Section 2.4.23) sets out proposals for a new transport interchange to the northwest of Round House Roundabout. This would be situated on the western side of Round House Way as shown in Figure 5-12 below. This is being considered as a method of connecting the Bus Rapid Transit system to the employment hub consisting of the Norfolk and Norwich University Hospital, the University of East Anglia and the Norwich Research Park.

Figure 5-12 Location of potential Transport Interchange



5.5 Options Investigated

5.5.1 The TAR Addendum (Document reference HE551492-ACM-GEN-TJ-RP-ZM-00019) recommended that only the Single Option be presented to the public at the Public Information Exhibitions (PIEs).

5.6 Single Option Constraints

5.6.1 The Single Option was assessed not to have a negative impact on any of the plans described in Chapter 2 of the original TAR ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032, and complies with the policies described in the same chapter, with the exception of the GNIP and the Cringleford NDP.

5.6.2 The GNIP (2015) sets out development sites in the south-west sector of Norwich which have been identified for early delivery. The Cringleford NDP includes all proposed and committed developments that would access the A11 via the Round House Roundabout, east of Thickthorn Junction. These plans include a development for 650 dwellings on land north and south of the A11 Newmarket Road, Cringleford, which is expected to start in 2017/18.

5.6.3 The Single Option requires land which has been attributed to the development. Land is needed for both the Strategic Road Network (SRN) and may also be required for the Local Road Network (LRN) components of the scheme.

5.6.4 The local road component of the scheme, which aims to reconnect Cantley Lane South to Cantley Lane, requires some additional development land, and routes local traffic through part of the development.

6 Summary of Do-Nothing Consequences

6.1 Traffic and Economics

6.1.1 Details of likely Do Minimum (DM) network improvements have been established from local authority planning and transportation officers.

6.1.2 The trip matrices prior to variable demand modelling are the same for the Do Minimum and Do Something scenarios. Comparisons have been carried out to check the trip end totals between the 2015 base year and the future years for all time periods to ensure the expected, overall growth between the base year and the future years is in line with that estimated by TEMPRO and NTM. Overall trip growth is around 6% in the peaks to 2021 and 23% to 2036. Growth in the inter-peak is forecast to be higher at around 8% to 2021 and 30% to 2036.

6.1.3 Table 6-1 shows the predicted Annual Average Daily Traffic (AADT) flow for the base year (2015) and the core scenario at opening year (2021). These are for the A11 south of Thickthorn and the A47 east of Thickthorn and are the road sections that are mostly affected by the proposed scheme. The forecast traffic increases without the scheme are between 18% and 28% between 2015 and 2021.

Table 6-1 : AADT comparisons between 2015 and 2021 DM at Thickthorn

Road Section		2015	2021 DM	Diff (abs)	Diff (%)
A11	Northbound Approach	20978	24689	3710	18%
A11	Southbound Exit	21239	25435	4196	20%
A47	Westbound Off-Slip	12775	16312	3537	28%
A47	Eastbound On-Slip	11711	14143	2432	21%

6.1.4 Table 6-2 shows the Annual Average Daily Traffic (AADT) flow for the base year (2015) and those predicted for the core scenario at design year (2036). Increases in traffic between 34% and 59% are predicted to occur around Thickthorn with the larger proportional increases occurring on the A47 slip roads.

Table 6-2 : AADT comparisons between 2015 and 2036 DM at Thickthorn

Road Section		2015	2036 DM	Diff (abs)	Diff (%)
A11	Northbound Approach	20978	28123	7144	34%
A11	Southbound Exit	21239	30978	9739	46%
A47	Westbound Off-Slip	12775	20322	7547	59%
A47	Eastbound On-Slip	11711	17235	5524	47%

6.1.5 Figure 6-1 shows modelled travel times from Station Lane on the A11 to the A47 junction east of Thickthorn in the AM peak. This shows that there is significant delay on the northbound approach to Thickthorn junction of around 4 minutes per vehicle in the 2015 base year increasing by a further 2 minutes by 2036.

6.1.6 Figure 6-2 shows modelled travel times for the opposite direction in the AM peak. This shows that although the delay is less than that in the south to east direction there is notable delay at Thickthorn of around 1 minute per vehicle in the 2015 base year increasing by a further minute by 2036.

Figure 6-1 : Base Year and Forecast Year Travel Times – AM Peak – A11 to A47

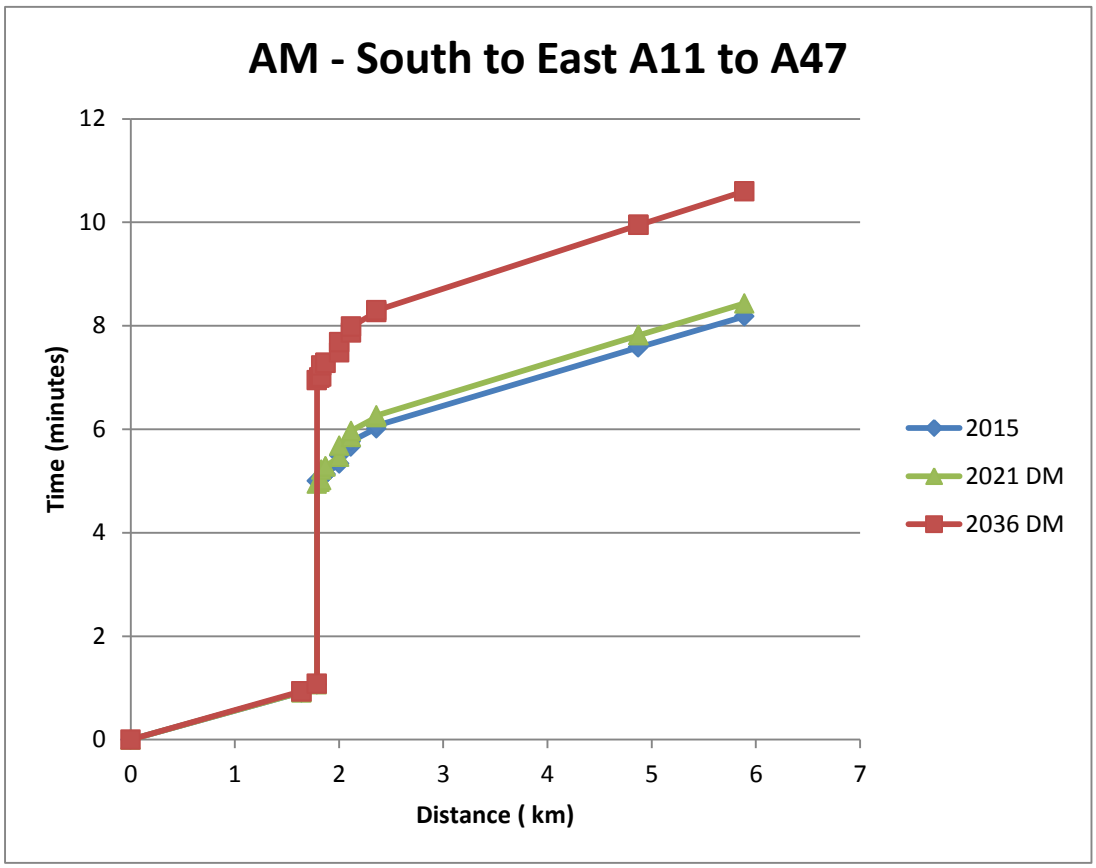
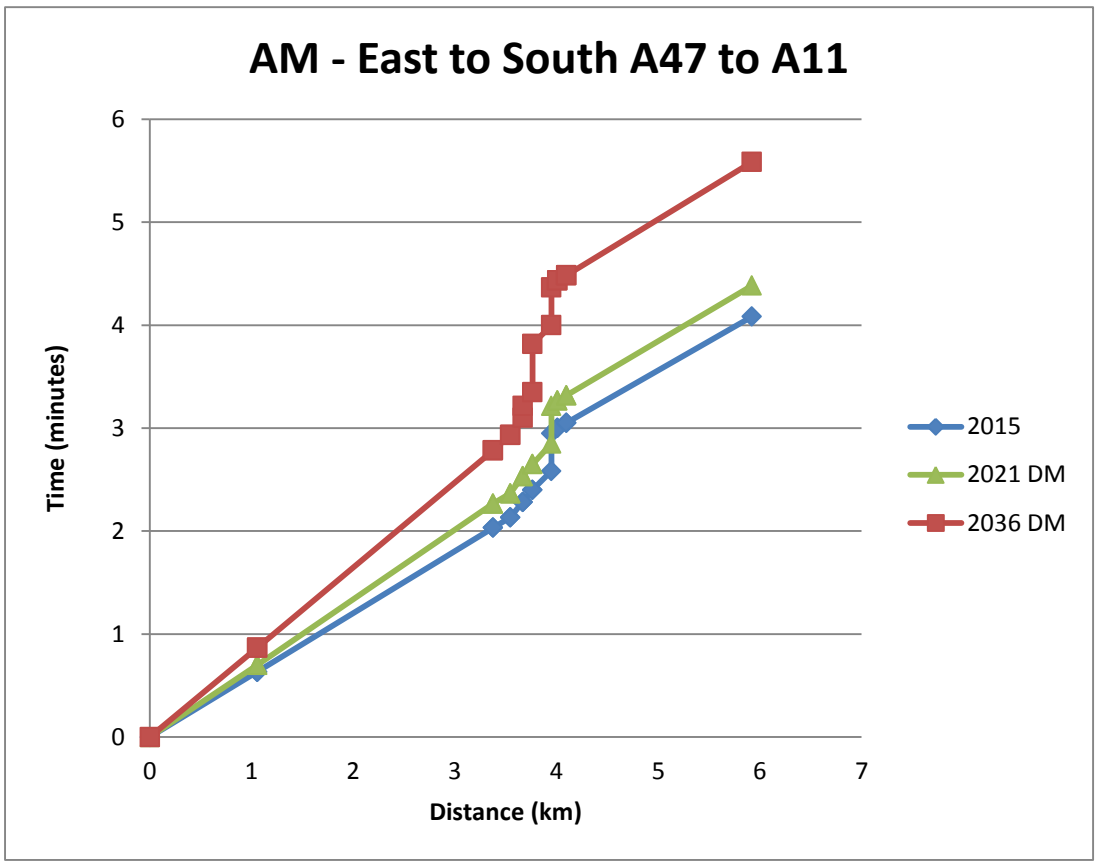


Figure 6-2 : Base Year and Forecast Year Travel Times – AM Peak – A11 to A47



7 Summary of the originally proposed Single Option

7.1 Background

7.1.1 Following the completion of PCF Stage 1, an attempt was made to identify an AVFM solution prior to the next IDC review. This exercise, which was informally referred to as the 'Deep Dive' resulted in a Single Option.

7.1.2 Details of the development of the originally proposed Single Option are documented in the TAR Addendum, ref. HE551492-ACM-GEN-TJ-RP-ZM-00019.

7.2 Originally proposed Single Option

7.2.1 The originally proposed Single Option (initially referred to as Option 23), which was shown at the Public Information Exhibition (PIE) incorporates the A11 south to A47 east bi-directional interchange link roads, as shown on Figure 7-1, and Drawing HE551492-ACM-HML-TJ-DR-HE-01060 Rev I3, included in Appendix G.

7.2.2 Owing to the headroom constraint caused by the existing high voltage overhead power lines, the proposed A11 northbound to A47 eastbound interchange link is in cutting, and passes beneath the A11 to the south of Thickthorn Junction, the A47 westbound off-slip, and the A47 to the east of Thickthorn Junction, via three consecutive underbridges.

7.2.3 There are two consecutive merges on to the A47 eastbound carriageway. The upstream merge is for the existing A47 eastbound on-slip from the Thickthorn Junction gyratory. The downstream merge is for the on-slip for the new A11 northbound to A47 eastbound interchange link.

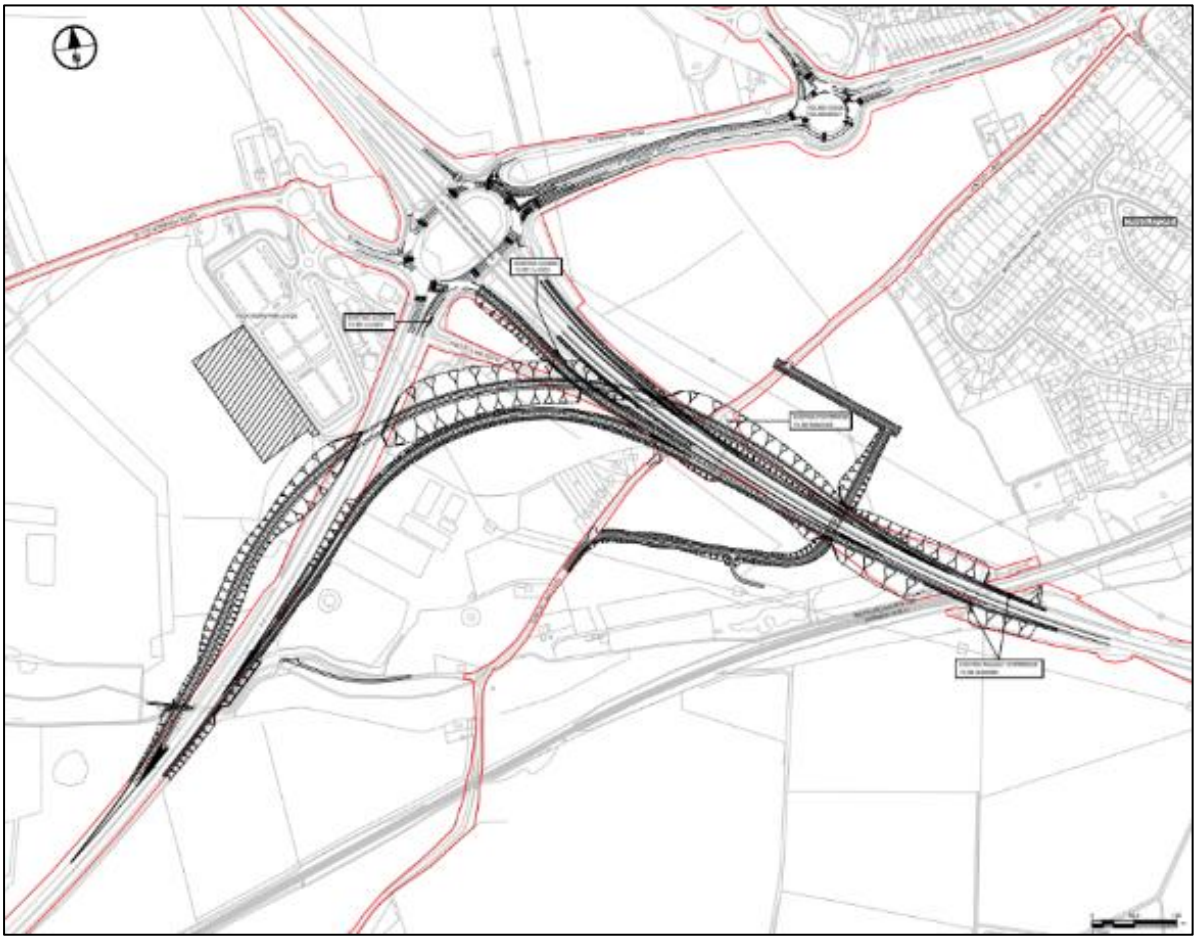
7.2.4 There is a single diverge from the A47 mainline westbound carriageway. This is then followed by a subsequent downstream diverge from the A47 westbound off-slip, for the new A47 westbound to A11 southbound interchange link.

7.2.5 For the early versions of the Single Option, it was envisaged that the new merge / diverge tapers could be introduced to the west of the Breckland Railway Bridge. However, for the reasons explained the Engineering Assessment below, it became necessary to widen on both sides of the railway bridge.

7.2.6 The existing left-turn connections for Cantley Lane South onto the A47 westbound off-slip and from A11 south could not be retained on grounds of highway safety owing to the proposed consecutive A47 westbound diverges, and because it will be severed by the proposed A11 south to A47 east bi-directional interchange links. It was therefore necessary to provide an alternative local route for the residences which currently access Cantley Lane South.

7.2.7 The proposed route for local traffic is provided by reconnecting Cantley Lane South to Cantley Lane. Owing to the headroom constraint, which is imposed by the overhead power lines, the proposed connection is in cutting, and passes beneath the A47 to the east of Thickthorn Junction via an underbridge.

Figure 7-1 Single Option: Based on Value Engineered Rationalisation of Option 22, incorporating A11 south to A47 east Bi-Directional Link Roads



7.3 Preliminary Engineering Assessment

7.3.1 Preliminary engineering assessment was undertaken with regards to the following design aspects:

- Highways and Alignment
- Departures from standards
- NMU provisions
- Land take and impact on property
- Highways drainage and flooding
- Geology
- Public utilities
- Structures
- Buildability
- Accommodation works
- Severance
- Lay bys

7.4 Highways and Alignment

Interchange Links

7.4.1 The Single Option solution, (refer to Figure 7-1) and Drawing HE551492-ACM-HML-TJ-DR-HE-01060 Rev I3, included in Appendix G, provides relief to the Thickthorn Junction gyratory by the provision of bi-directional free flowing interchange links between the A11 south and the A47 east.

7.4.2 Owing to their length, both the interchange link roads have two lanes with hardstrips (type DG2E as per Table 3/1a of TD 22/06) to enable the passing of slow moving vehicles. These are reduced to a single lane in advance of the merge tapers.

7.4.3 The design speed for the interchange links is 85kph, but the alignment of the southbound link is horizontally constrained by:

- a Scheduled Monument, which is the site of two tumuli (round barrows) dating back to the bronze age; and
- the houses adjacent to Cantley Lane South.

7.4.4 For this reason, and to minimise land-take, the horizontal radius of the southbound link has been relaxed, by just over one design speed step, to 340m with a superelevation of 7%.

7.4.5 The eastbound link has a desirable minimum radius of 510m with a superelevation of 5%.

7.4.6 Owing to the presence of high voltage overhead cables, the vertical alignment of the eastbound interchange link is constrained to pass under the A11 to the south of Thickthorn Junction, the A47 westbound off-slip, and the A47 to the east of Thickthorn Junction, via three consecutive underbridges.

7.4.7 The A47 eastbound carriageway has successive merges. The first merge is for the eastbound off-slip from the Thickthorn Junction Gyratory, and the subsequent merge is for the A11 northbound to A47 eastbound interchange link.

7.4.8 There is a diverge from the A47 westbound carriageway for the off-slip to the Thickthorn Junction Gyratory, and a successive diverge from the off-slip to the southbound A11 interchange link.

7.4.9 The proposed merge and diverge types are summarised in Table 7-1. The merge/ diverge assessments in accordance with TD 22/06 are included in Appendix H. This assessment was based on preliminary traffic flows and will have to be carried out again in PCF Stage 3. This could affect the number of Departures from Standards required for proposed merges and diverges.

Table 7-1 Proposed Merge and Diverge Types

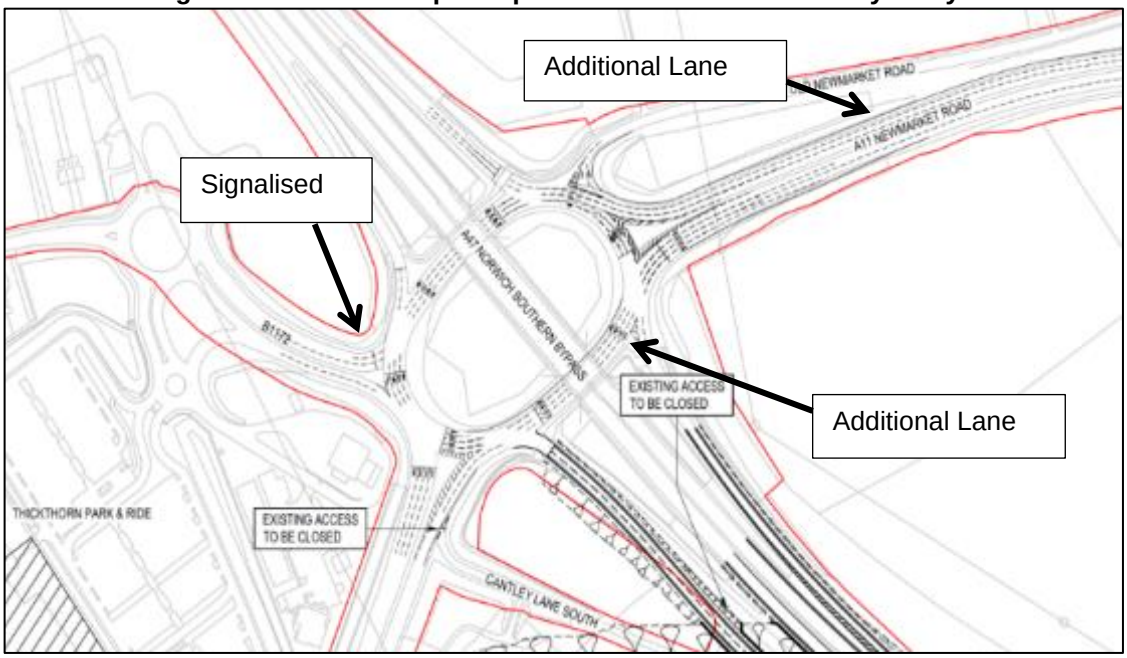
Description	Type	Comments
A11 northbound diverge to the A11 northbound to A47 eastbound interchange link	Type A – Taper diverge	
A11 southbound merge from the A47 westbound to A11 southbound interchange link	Type A – Taper merge	Requires a departure from standards [Ref. 3-G]. Refer to Section 7.5.
A47 eastbound upstream merge from the A47 eastbound on-slip from the Thickthorn Junction gyratory	Type A – Taper merge	
A47 eastbound downstream merge from the A11 northbound to A47 eastbound interchange link	Type A – Taper merge	Requires a departure from standards [Ref. 4-G]. Refer to Section 7.5.
A47 westbound upstream diverge to the A47 westbound off-slip to the Thickthorn Junction gyratory.	Type B – Parallel diverge	Requires a departure from standards [Ref.5-G]. Refer to Section 7.5.
A47 westbound downstream diverge from the A47 westbound off-slip to Thickthorn Junction gyratory to the A47 eastbound to A11 southbound interchange link.	Type A – Taper diverge	

7.4.10 In order to accommodate the geometrical requirements for the proposed successive merges and diverges, and to provide the required desirable minimum stopping sight distances, it became necessary to widen the existing Breckland Railway Bridge on both sides of the A47.

7.4.11 The design of the Single Option incorporates the improvements which must be provided by developers as part of their planning requirements.

7.4.12 Improvements to the Thickthorn Junction gyratory include signalisation of the B1172 approach, the addition of an extra circulatory lane on the east side of the gyratory, and the addition of a lane to the A11 northbound between the Thickthorn Junction gyratory and Round House Roundabout. These improvements are shown in Figure 7-2.

Figure 7-2 Developer Improvements to Thickthorn Gyratory

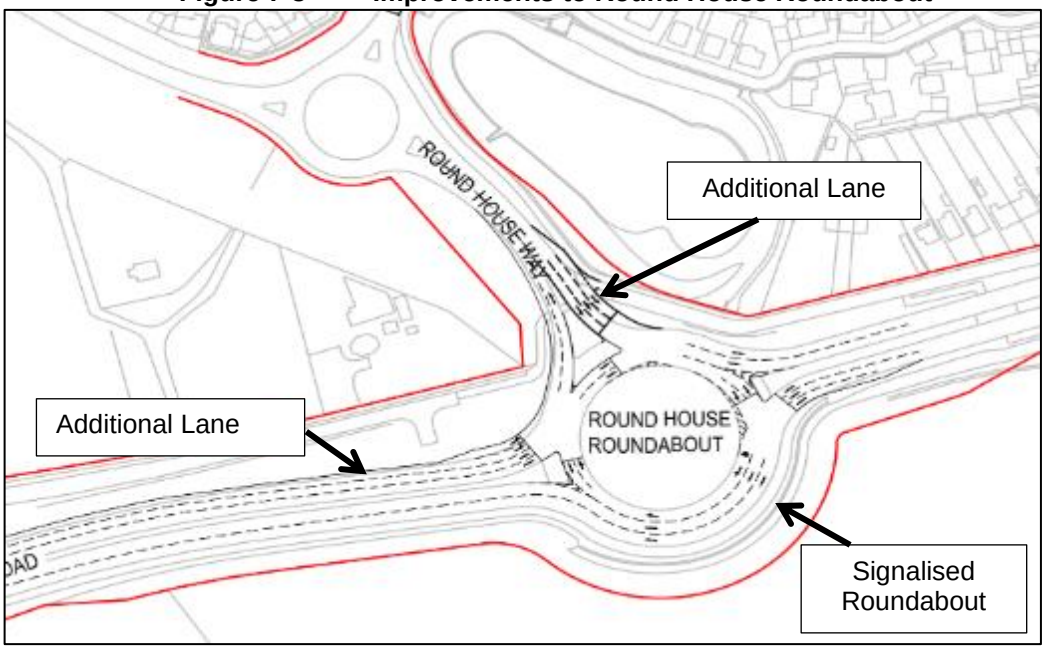


7.4.13 The developer's improvements to the Round House Roundabout include an additional lane on the A11 northbound entry, and signalisation of the roundabout.

7.4.14 However, VISSIM modelling has identified the need for an additional lane for the Round House Way approach, owing to queuing that is predicted to occur during the PM peak.

7.4.15 The improvements to the roundabout are shown in Figure 7-3.

Figure 7-3 Improvements to Round House Roundabout



Potential reconnection of Cantley Lane South to Cantley Lane

7.4.16 Currently there is a left turn only entry from Cantley Lane South onto the existing A47 westbound off-slip, and a left turn only exit from the A11 southbound.

7.4.17 The existing exit to Cantley Lane South from the A11 southbound will be severed by the new interchange links, and the entry could not be retained for reasons of highway safety, owing to the proposed provision of the A47 westbound successive diverges. Therefore, it became necessary to provide alternative means of access for Cantley Lane South, so it was proposed to reconnect Cantley Lane South to Cantley Lane.

7.4.18 The proposed new link between Cantley Lane South and Cantley Lane is constrained to pass beneath the A47 owing to the headroom constraint from the high voltage overhead cables, which are routed alongside the A47, adjacent to the northern highway boundary.

7.4.19 The location of the underpass, which is constrained by the vertical alignment of the existing A47, is located at the transition between the cutting and embankment.

7.4.20 Based on an early version of the developer's plans, the new link forms a 'T' junction with a future estate road. However, this layout could change following negotiations with the developer, to accommodate changes to the development plans.

7.4.21 It is envisaged that the new link would be subjected to a 30mph speed limit, subject to agreement with Norfolk County Council and the Police.

7.4.22 Subject to agreement with Norfolk County Council, it is proposed that the Manual for Streets (MfS 1 and 2) is an appropriate standard for the design of this link for the following reasons:

- The high number of constraints that exist make it unfeasible to provide a geometrical alignment in accordance with the DMRB;
- It is commensurate with the standard of the existing Cantley Lane South, which has very tight bends, down to approximately 20m in radius;

- It uses geometrical parameters and stopping sight distances, which are designed to ensure that traffic does not exceed the speed limit, there-by reducing the need for speed enforcement; and

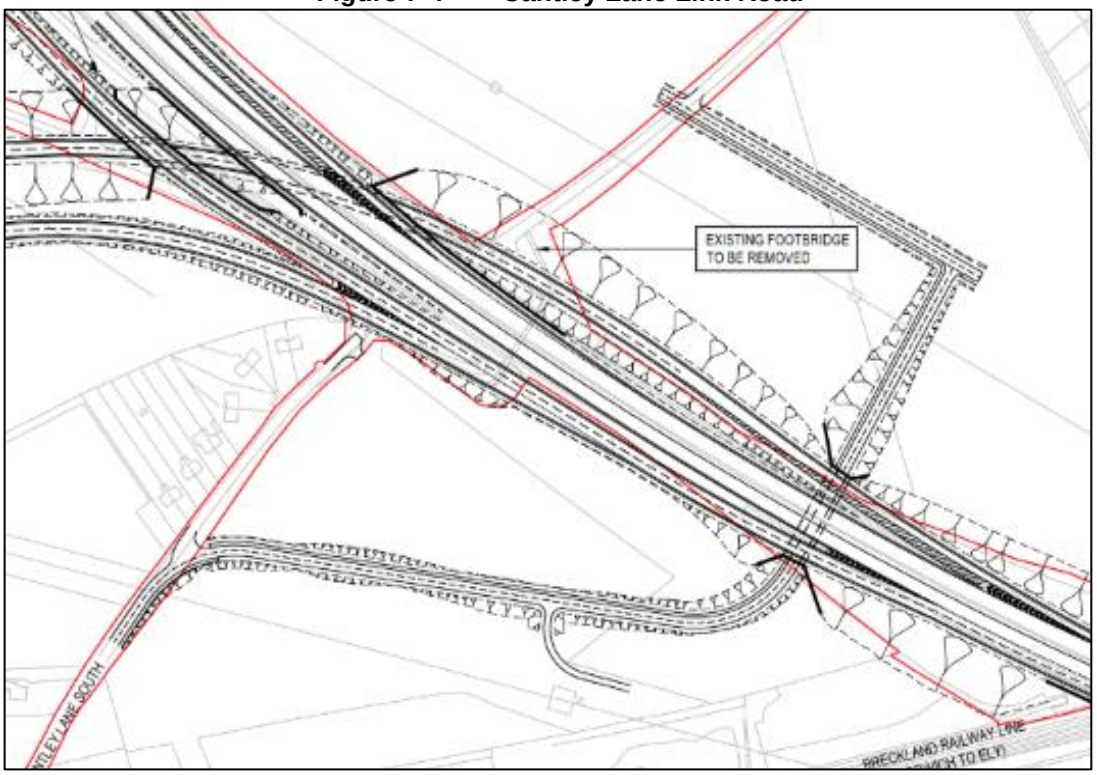
- Traffic using the link will be conditioned to the lower traffic speeds for the new development.

7.4.23 In accordance with the MfS guidance, the design speed for the link is proposed to be 60kph, which is often used for roads subjected to a 30mph speed limit.

7.4.24 Cantley Lane South is currently connected to Cantley Lane, via a bridge designed for pedestrians and cyclists, which is to be removed. Owing to the close proximity of the new underpass to the existing footbridge, it is proposed that the new link will provide a suitable alternative route for NMUs. This issue is discussed further in Section 7.6.

7.4.25 The Cantley Lane link (Figure 7-4) has therefore been designed as a two-way single carriageway, with 3m lane widths. The verge on one side has been widened to 4.5m to accommodate a shared facility for NMUs, which could also be used by equestrians. In accordance with MfS2, para. 8.2.2, the horizontal radius of the bends is 64m.

Figure 7-4 Cantley Lane Link Road



7.5 Departures from Standards

7.5.1 The need for five Departures from Standards has been identified. The locations of these have been illustrated in Appendix I and are detailed below:

Weaving Length Requirements

7.5.2 TD 22/06 Para. 4.38 requires that the desirable minimum weaving length between a grade separated junction and an at-grade junction for Rural All-Purpose Roads must be 1 km.

Departure Ref. 1-G: Reduction in Weaving Length on the A11 Northbound Carriageway

7.5.3 On the A11 northbound carriageway, there is a 'left-in, left-out' junction for Station Lane, located approximately 1.8km south-west of Thickthorn Junction. The weaving length between Station Lane Junction and the A11 northbound diverge taper for the A47 eastbound interchange link, will be approximately 750m.

Departure Ref. 2-G: Reduction in Weaving Length on the A11 Southbound Carriageway

7.5.4 The weaving length between the A11 southbound merge for the A47 westbound interchange link, and the Station Lane Junction southbound diverge will be approximately 965m.

Merge and Diverge Geometric Requirements

7.5.5 An assessment of the geometrical Merge/ Diverge requirements in accordance with TD 22/06 is included in Appendix H.

Departure Ref. 3-G: A11 Southbound Merge for the A47 Westbound Interchange Link

7.5.6 The assessment in accordance with TD 22/06 indicates that a Type B parallel merge is required, which includes an auxiliary lane. However, a Type A Merge is proposed owing to reduction in weaving length to the existing Station Lane Junction diverge taper (refer to departure reference 2-G).

Departure Ref. 4-G: A47 Eastbound Downstream Merge for the A11 Northbound Interchange Link

7.5.7 The assessment in accordance with TD 22/06 indicated that a Type E Lane Gain is required, which requires the A47 to be widened to three lanes. However, a Type A Merge is proposed since widening of the existing A47 is outside the project's scope.

Departure Ref. 5-G: A47 Westbound Upstream Diverge for the Off-slip to the Thickthorn Junction Gyratory.

7.5.8 The assessment in accordance with TD 22/06 indicated that a Type D Ghost Island Diverge for Lane Drop is required, which requires the A47 to be widened to three lanes. However, a Type B Parallel Diverge is proposed since widening of the existing A47 is outside the project's scope.

Departure Approvals

7.5.9 No departures from standards have yet been formally submitted for approval. However, During PCF Stage 2, the Highways England Safer Roads Team were consulted with regards to the proposed departures from standards. Records of this meeting including feedback that needs to be addressed during PCF Stage 3 are included in the Departures from Standards Checklist Product Ref: HE551492-ACM-HAC-TJ-DS-HE-00001. This assessment was based on preliminary traffic flows and will have to be carried out again in PCF Stage 3. This could affect the number of Departures from Standards required for proposed merges and diverges.

7.6 NMU Provision

7.6.1 Local non-motorised users' routes were analysed with reference to Norfolk County Council's definitive maps. Appendix J contains the existing and proposed NMU routes for the Single Option.

7.6.2 The design references that were referred to within the DMRB were:

- TA 90/05 – The Geometric Design of Pedestrian, Cycle and Equestrian Routes,
- TA 91/05 – Provision for Non-Motorised Users, and
- IAN 195/16 – Cycle Traffic and the Strategic Road Network.

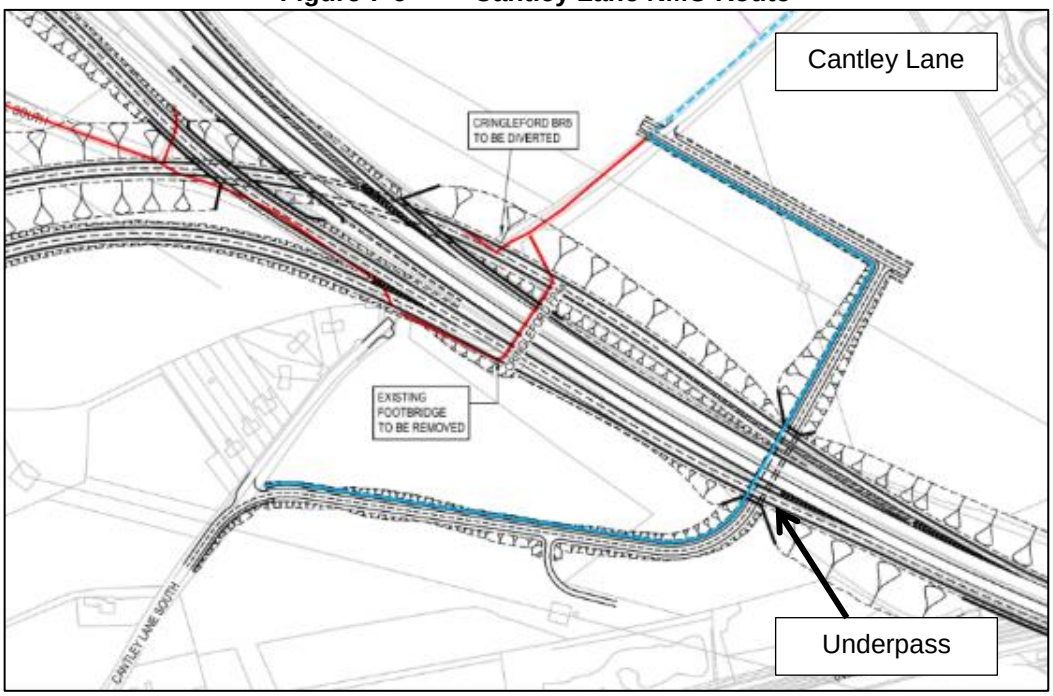
7.6.3 A NMU Context Report ref. HE551492-ACM-GEN-TJ-PR-TR-00002 has been produced to inform and develop the design of NMU routes and crossing provisions.

Cantley Lane NMU Route

7.6.4 The provision of the A11 to A47 bi-directional interchange links provides an opportunity to rationalise the existing NMU routes in the vicinity of Cantley Lane. The original routing of the A47 severed Cantley Lane as a through route. In order to mitigate this severance, a footbridge with a facility to wheel dismounted bicycles, was provided across the A47 for NMU use (refer to Figure 7-5). This footbridge is not compliant with the Equality Act 2010 as it contains steps, and is not suitable for equestrian use owing to the low parapets. The footbridge will have to be demolished to accommodate the A11 south to A47 east bi-directional interchange links, so an alternative improved NMU route was proposed along the new potential Cantley Lane link as shown in Figure 7-6. This will be an unsegregated shared use facility which is 3m wide to allow pedestrians, cyclists and equestrians to cross beneath the A47 via the new underpass.

Figure 7-5 Existing Cantley Lane Footbridge

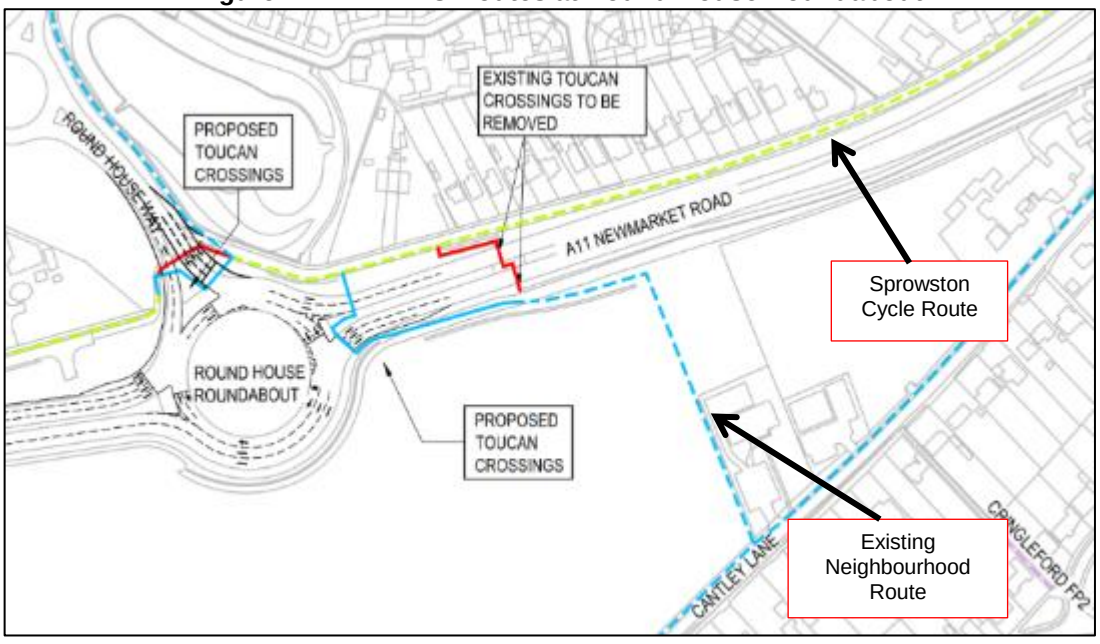
Figure 7-6 Cantley Lane NMU Route



Cringleford to Sprowston Cycle Route

7.6.4 As the footprint of the Cringleford to Sprowston Cycle Route is not being changed, it would be unaffected by the proposals along the B1172, Thickthorn Junction gyratory and the Old Newmarket Road. However, as Round House Roundabout is being upgraded with traffic signals, a toucan crossing will need to be provided on the Round House Way arm for pedestrians and cyclists. The existing toucan crossings on the northern arm of the A11 Newmarket Road will have to be moved closer to the roundabout, and all of the proposed crossings would be coordinated with the roundabout signals. The revised layout can be seen in Figure 7-7.

Figure 7-7 NMU Routes at Round House Roundabout



Existing Pegasus Crossings

7.6.6 There are existing Pegasus crossings on the A47 westbound off-slip and the A47 eastbound on-slip. Since the bridleway route is heavily overgrown, and appears to be disused it is proposed to remove the Pegasus crossings and stop up the bridleway, subject to further consultation in future stages.

7.7 Land-take and Impact on Property

7.7.1 Information obtained from the Land Registry was used by AECOM to assess the land take required for the Single Option. Details of the land take identified and ownership details are contained in Appendix K.

7.7.2 For the originally proposed Single Option, it has been estimated that a total of 12.4 hectares of land is required outside of the existing highway boundary.

7.7.3 Approximately 2.2 hectares of this land is located to the east of the A47 and south of the A11. This land has been granted planning consent for residential development and is known as 'Land West of Cringleford'. The A11 northbound to A47 eastbound interchange link crosses the mainline via an underbridge to the south of this site within an area between existing overhead electricity pylons and the A47. This land is allocated as public open space in the current development proposals. The slip road will be in cutting to limit the visual impact on the proposed residential development. Landscaping bunds could be provided in this area to further reduce the visual impact of the scheme on the new development.

7.7.4 The proposed potential Cantley Lane link road would connect to the development roads, which would re-route local traffic through part of the development, and along Cantley Lane.

7.7.5 Land to the south of the A47 and east of the A11 is a mix of farmland and woodland interspersed by existing residential properties. The scheme affects all of these elements. The bi-directional interchange link roads between the A11 south and A47 east, which pass behind the properties on Cantley Lane South, are highly likely to result in objections from the local residents due to proximity and traffic noise. The proposed potential Cantley Lane link road severs farmland, and could create a 'rat-run' for vehicles crossing the A47, so it could also become a source of objections from local landowners and residents.

7.7.6 The proposed A47 westbound to A11 southbound interchange link is routed behind the two ancient burial mounds or tumuli, which are classified as ancient monuments, which may result in objections being received on environmental grounds.

7.7.7 There is an existing watercourse, Cantley Stream, to the south of the proposed road improvements. This watercourse has an associated flood plain, and the land required for the originally proposed Single Option impinges on the designated flood zone. This would require land to be provided for flood compensation, which has been included in the land take assessment.

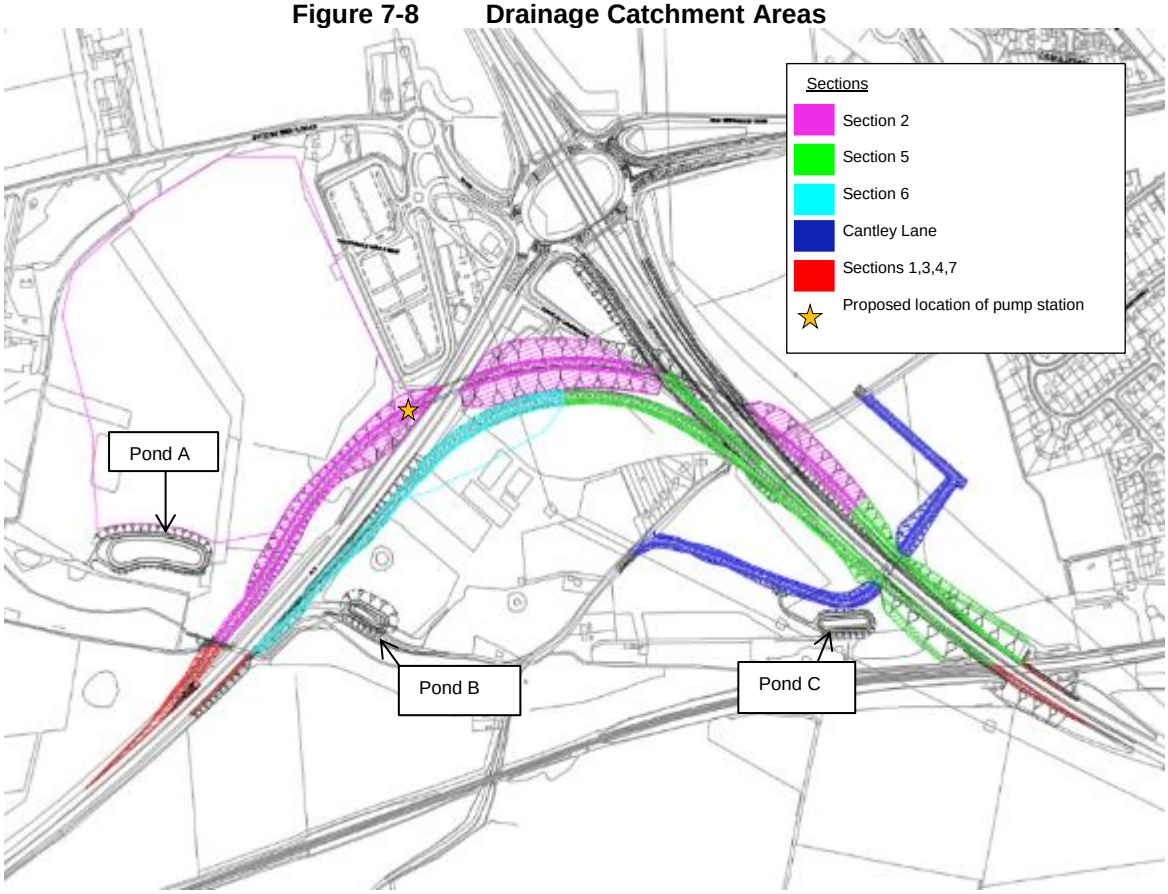
7.7.8 Land to the west of the A11 is a mix of farmland and woodland, both of which are affected by the proposals.

7.8 Highway Drainage and Flooding

7.8.1 The originally proposed Single Option includes a total additional impermeable area of approximately 2.0ha, with associated earthworks. This additional area results in increased surface water run-off, and therefore a strategy has been proposed to store, treat and discharge this additional runoff.

7.8.2 The additional impermeable area and extents of earthworks were split into 3 main catchments (section 2, section 5 and section 6), see Figure 7-8. The increased runoff from these three sections will be stored, treated and the discharge rate limited by three ponds.

Figure 7-8 Drainage Catchment Areas



7.8.3 For each section, the additional impermeable area, verge, earthworks and greenfield area that would be intercepted by the proposed road, were analysed to calculate greenfield runoff rates for each area using the Interim Code of Practice Sustainable Drainage Systems (ICP SuDS) method. These greenfield rates were then used to estimate the storage volume required.

7.8.4 All ponds will act as storage basins designed with a 0.3m freeboard and 1:4 side slopes. A worst case scenario of a 0.0m/hr infiltration rate has been used for the design of the storage ponds.

7.8.5 Appropriate silt and oil protection devices, and pollution prevention measures such as penstocks or flap valves, are recommended where ponds have infiltration. This will minimise the risk of groundwater pollution from potential highway spillages.

7.8.6 Pond A is proposed to store run off from section 2, with an additional 23 ha of greenfield run-off. The greenfield area is proposed to be intercepted by a ditch located at the top of the cutting and routed into Pond A. Surface water from the lowest levels in section 2 will be pumped from a pumping station located near the A11 northbound to A47 eastbound interchange link underbridge (see Figure 7-8) to a high level gravity system that outfalls into Pond A. Pond maintenance access is proposed from an existing track. Pond A has been designed with a depth of 1.2m, which gives an approximate storage volume of 5,350m^3. The pond will outfall into Cantley Stream, and the discharge rate will be limited to 235.5l/s.

7.8.7 Pond B has been designed to collect the additional run off from section 6, via a gravity system. The access to the pond is proposed to link to the track running to the south of the

location. Pond B has been designed with a depth of 1.0m, which gives an approximate storage volume of 550m^3. The pond will outfall into Cantley Stream, and the discharge rate will be limited to 19.1l/s.

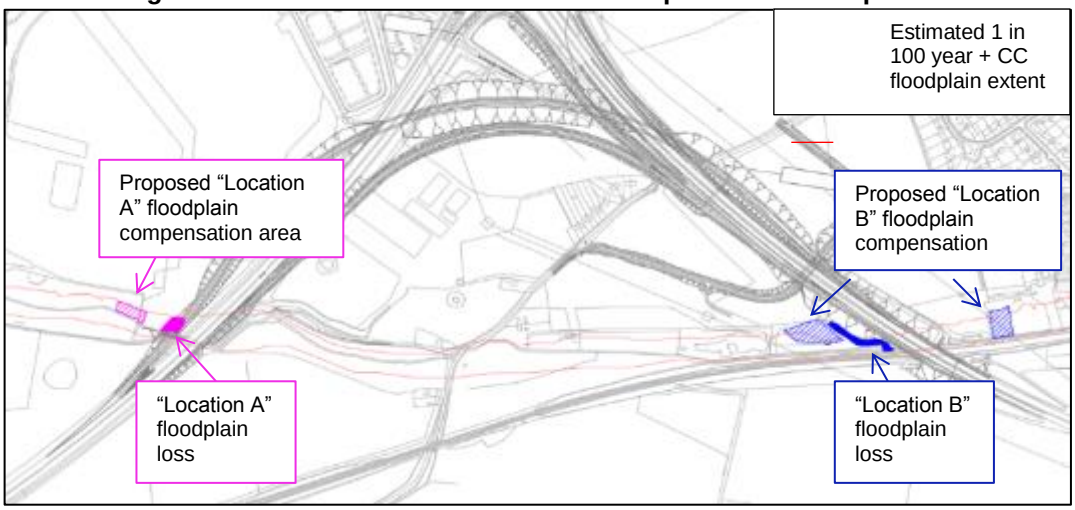
7.8.8 Pond C will collect the additional run off from section 5, via a gravity system. The access to the pond is proposed via the new Cantley Lane link road. Pond C has been designed with a depth of 1.0m, which gives an approximate storage volume of 850m^3. The pond will outfall into Cantley Stream, and the discharge rate will be limited to 23.2l/s.

7.8.9 For the additional run-off generated by the Cantley Lane South to Cantley Lane link road and underpass, it is proposed a system of soakaways is used.

7.8.10 It is proposed that the drainage systems south of the A11 culvert and south of the A47 railway crossing (catchments 1, 3, 4 and 7) are upgraded to incorporate oversized pipes in order to provide the required additional storage.

7.8.11 The proposed mainline link roads encroach into the 100 year flood plain, which includes an allowance for Climate Change (CC), resulting in the need to design flood plain compensation areas.

Figure 7-9 Notional locations for floodplain loss / compensation



7.8.12 Figure 7-9 shows the areas of floodplain loss, and potential locations for floodplain compensation. The volume of floodplain lost to the west of the A11 culvert (Location A) is estimated to be 300m^3, and the estimated volume of floodplain loss to the west of the A47 culvert (Location B) is 875m^3.

7.8.13 The proposed floodplain compensation areas have been located as close as is practical to the areas where floodplain is lost, and where possible upstream of the lost floodplain. The compensation areas have been located where it is anticipated a level for level compensation will be most viable.

7.8.14 The extents of floodplain have been estimated from HADDMS flood zone 3 maps, so the volume of floodplain loss and indicative compensation areas are an estimate. Detailed modelling of the flood extents and an in depth level for level assessment of the compensation areas will be required during the next stage of the design.

7.8.15 It is proposed to have drainage ditches at the toes of embankments and the top of cuttings to intercept overland flows, and land drains which have been severed by the proposed works. Where overland flows cannot be rerouted, the volume of ponds will need to accommodate the additional greenfield area.

7.8.16 There are no proposed attenuation requirements for the A47 westbound off-slip to Thickthorn Junction gyratory to the south side of the junction. While there are proposed alterations to the alignment, the impermeable area will remain the same. Similarly, there is no increase to the impermeable area for the eastbound A47 on-slip from the Thickthorn Junction gyratory.

7.9 Geology

General Geotechnical Risks in the vicinity of Thickthorn Junction

7.9.1 The following sections highlight the geological and geotechnical risks associated with the proposed junction improvements at Thickthorn Junction. The geological and geotechnical risks identified within this section refer to risks pertinent to the Single Option.

7.9.2 The primary geological risk anticipated at this stage is a lack of ground investigation information specific to the proposed option.

7.9.3 Whilst the basic geological make up beneath the site is understood and some borehole information is available along the existing road corridors, there is limited detailed information available along the proposed new roads. A project specific ground investigation will be required to assess the potential impact of geological features in detail.

7.9.4 A broad level assessment of the currently available information has identified the following potential geological risks that would require further assessment:

- The superficial geology beneath the Thickthorn Junction generally comprises clay till of the Lowestoft Formation underlain by glacial sands and gravels (Sheringham Cliffs Formation). The composition of the till is variable and includes bands of sand and gravel with a potential for perched groundwater being encountered in excavations leading to slope instability;
- Narrow strips of alluvium are present along Cantley Stream, which crosses both the A11 and A47 within the scheme extents. The primary risks associated with the alluvial deposits will be presence of highly compressible organic material and potential settlement;
- The solid geology of the site predominantly comprises Chalk of the White Sub-Group which includes the Lewes Nodular Chalk Formation. These deposits are formed of soluble rocks below a variable thickness of superficial deposits and are believed to outcrop in places along the lower valley slopes. The chalk has potential for the formation of subsurface voids. Although the risks associated with this are considered to be low, a specific ground investigation is required to assess the risks for this project; and
- An historic landfill is present along Cantley Lane adjacent to the A11, which may be encountered during construction with associated issues of potential contamination of soil and water and ground gas.

Other General Geotechnical Considerations

7.9.5 The geology map included in Appendix D illustrates the anticipated geology within the scheme locality.

7.9.6 The majority of the earthworks will be within the superficial deposits of Glacial Till of the Lowestoft Formation or Glacial Sand and Gravel of the Sheringham Cliffs Formation. These deposits may exhibit significant local variation in composition both laterally and vertically. Generally the excavated materials will be suitable as general fill and side slopes of 1(v) to 2.5(h) are recommended for preliminary design of cuttings and embankments. Provision for slope drainage may be required where perched water tables are present in cutting slopes.

7.9.7 Where the proposed roads cross the Cantley Stream, alluvial deposits will be encountered. These include soft highly compressible organic clay and peat which will need to be removed below embankments or ground improvement carried out. The limited borehole information suggests these deposits are fairly thin (1.0m to 2.5m in thickness) and removal may be the most practical solution. Detailed ground investigation is required to confirm the extent of removal or treatment required.

7.9.8 Existing culverts carrying Cantley Stream and minor watercourses below the new earthworks will need to be extended or reconstructed. Localised removal of the alluvial deposits will be required. It may be possible to found lightly loaded structures including culverts and headwalls on glacial deposits or Chalk, if present in an acceptable condition.

7.9.9 The depth to chalk is highly variable and is deeply weathered so piled foundations are likely to be required for moderately and heavily loaded structures, including bridge foundations. Retaining walls for underbridges will need to penetrate the glacial deposits into the chalk and contiguous piled walls would be appropriate. CFA piles may provide a suitable foundation option for these structures.

Additional Specific Geotechnical Considerations relating to the originally proposed Single Option

7.9.10 Additional geological and geotechnical considerations for the originally proposed Single Option are provided below:

7.9.11 The originally proposed Single Option (Drawing HE551492-ACM-HML-TJ-DR-HE-01060 Rev I3 included in Appendix G) shows that the A11 northbound to A47 eastbound interchange link diverges from the A11 south of Cantley Stream, passes beneath the A11 and the A47 carriageways and merges onto the A47 westbound across the railway overbridge.

7.9.12 The A11 northbound to A47 westbound interchange link would require an overbridge over Cantley Stream, skewed underbridges beneath both the A11 and A47 and an overbridge over the diverted Cantley Lane South. The A47 railway overbridge would also require widening.

7.9.13 At the divergence from the A11, the interchange link would be constructed on a relatively low embankment (maximum height approximately 3m) before switching into a cutting approximately 70 metres north of Cantley Stream. The depth of the cutting increases as the link passes under the A11 and A47 to a maximum of approximately 13.5m. East of the proposed bridge for the reconnection of Cantley Lane, earthworks become an embankment west of the A47 (east) and the Norwich-Ely Breckland railway line; the height of the embankment next to the bridge reaches a maximum of approximately 11.5m.

7.9.14 The originally proposed Single Option drawing (HE551492-ACM-HML-TJ-DR-HE-01060 Rev I3) also shows the A47 westbound to A11 southbound interchange link. The link road begins to diverge from the A47 east of the railway overbridge and fully merges onto the A11 south of Cantley Stream.

7.9.15 The A47 westbound to A11 southbound interchange link would require widening of the existing railway overbridge and the eastern side of the existing A11 overbridge over Cantley Stream. The link road would also be carried over the diverted Cantley Lane South on a new underbridge.

7.9.16 The A47 westbound to A11 southbound interchange link will be predominantly constructed on relatively low height embankments and shallow cuttings, locally almost at grade, with the exception of the approximately 11 to 13m high embankment sections proposed to the east and west of Norwich-Ely Breckland railway line.

7.9.17 The Single Option drawing (HE551492-ACM-HML-TJ-DR-HE-01060 Rev I3) further shows a reconnection road for Cantley Lane, which will be predominantly constructed on relatively low

height embankments and shallow cuttings, locally at grade, with the deepest cutting section shown north of the A47 (approximately 6.5m deep).

7.9.18 In addition, widening of the A47 eastbound and westbound into relatively shallow cuttings east of the Thickthorn Junction gyratory would also be required. These cuttings would be formed predominantly in soils of the Lowestoft Till Formation.

7.9.19 Wingwalls are shown retaining the existing carriageways on all sides of the proposed A11 and A47 underbridges. The south-east wingwall to the A47 underbridge, however, extends for approximately 90m parallel to the A47 eastbound carriageway due to the depth and proximity of the link road at this location.

7.9.20 Shallow foundations would be possible for lightly loaded structures founded in the Lowestoft Till. However the depth to Chalk is variable and the Chalk is highly weathered in this area so piled foundations will be required for the bridges. CFA piles would be a suitable option.

7.9.21 The new crossings under the A11 and A47 would require retaining walls up to 11m height which could comprise propped contiguous piled walls formed by “top down” construction.

Cuttings

7.9.22 Cuttings will be formed primarily in Glacial Sand and Gravel although Lowestoft Till may be encountered in the upper parts of the cuttings. The maximum depth of cutting is around 13.5m, between the A11 and the A47. Perched groundwater may be encountered in sand and gravel bands within the Lowestoft Till. Cutting side slope of 1 (v) to 2.5 (h) are recommended for preliminary design with provision of localised slope drainage where necessary. Additional drainage may be required if the cuttings extend below the groundwater table. Top-down construction using propped contiguous piled walls with CFA piles could also be appropriate for deep cuttings.

7.9.23 Between the reciprocal interchange link roads, care should be taken during design and construction, as a low embankment for the A47 westbound to A11 southbound interchange link (~1.5m high) is shown at the crest of the deep cutting.

7.9.24 The southbound interchange link to the A11 passes close to the old landfill site at Cantley Lane. The depth and condition of the fill is not known and will need to be investigated. Localised ground treatment may be required in this area.

Embankments

7.9.25 The majority of the embankments will be primarily founded on Glacial Sand and Gravel and less on Lowestoft Till, although Chalk may outcrop in the lower part of the valley and Alluvium is present in the vicinity of the railway crossings and Cantley Stream. The alluvial deposits are believed to be of limited depth (less than 2.5m) so removal below the embankments and the extension to the existing culvert may be practical option. Ground investigation is required to confirm the required depth of excavation and feasibility or alternative ground treatment if required. However it should be noted that sheet piling and surcharging was used for the A47 railway bridge construction to limit excavation close to the railway.

7.9.26 The excavated material from the cuttings should be suitable as general fill to form the embankments and embankment side slopes of 1 (v) to 2.5 (h) are recommended.

7.10 Public Utilities

7.10.1 C2 and C3 enquiries have been submitted, and currently all eight C3 estimates have been obtained for the area around Thickthorn Junction. These are included the Statutory Undertakers Estimate PCF product ref. HE551492-ACM-VUT-TJ-RP-ZM-00001.

7.10.2 There are 400kV and 132kV overhead cables mounted on pylons traversing the site, which run roughly parallel with the A47 mainline:

- The 400kV power lines run south of the A47. These cross the A11 south to A47 east reciprocal interchange links, and the A11 to the south of Thickthorn Junction gyratory; and
- The 132kV power lines run north of the A47, and cross the A11 to the north of Thickthorn Junction gyratory.

7.10.3 There are 11kV overhead cables to the north of the A47. These cross the A47 to the west of Cantley Lane, and then run to the south of the A47, and cross the A11 south to A47 east reciprocal interchange links, and the A11 to the south of Thickthorn Junction gyratory.

7.10.4 Based on the C2 / C3 responses, a composite drawing of existing utilities has been produced. Refer to Drawing HE551492-ACM-VUT-TJ-DR-HE-01060 in Appendix E.

7.10.5 The vertical alignment of the Single Option has been designed so that the 400kV and 132kV overhead powerlines are unaffected.

7.10.6 Consultations are required with National Grid with regards to whether maintenance facilities for the power lines are required for the proposed interchange links, such as sky cradle lay-bys.

7.10.7 Construction of the A11 south to A47 east bi-directional interchange links, with associated structures; and the works at the Thickthorn Junction gyratory and Round House Roundabout will affect the following utilities:

- Potable water pipeline, (TBC);
- 11kV overhead electricity lines;
- Surface and foul water pipes, (TBC);
- Virgin media cables; and
- Underground electricity cables.

7.10.8 Furthermore, the potential reconnection of the existing Cantley Lane South will impact on the low pressure gas pipeline, BT cables, existing potable water pipes and underground electricity cables.

7.10.9 Further Statutory Undertakers requests will be required in later PCF stages to check for detailed positions of utilities. Proposed changes to accommodate the Single Option developing design will also need to be considered during later PCF stages.

7.11 Structures

7.11.1 The construction of the infrastructure for the originally proposed Single Option requires the construction of five new structures, demolition of the A47 Cantley Lane Footbridge, which presently connects Cantley Lane South to Cantley Lane, modification works to Cantley Stream Underpass on the A11, and widening of Breckland Railway Bridge and the potential modification of the outlets of its adjacent culverts. The locations of these structures can be found in Drawing HE551492-ACM-SBR-TJ-DR-SE-00201-PO2 in Appendix L.

7.11.2 The Single Option was formally referred to as Option 23, so the prefix of the structure identification numbers for the Single Option is 23 (e.g. Structure 23-S1).

7.11.3 When the design constraints are finalised (such as finished road levels and traffic phasing during construction), other structure options should be considered as they may be more economical and practical.

The new underpass for the A11 northbound to A47 eastbound interchange link for an accommodation track and Cantley Stream, and modifications to the adjacent existing A11 Cantley Stream Underpass (Structure 23-S1)

7.11.1 The Single Option requires a new structure to the west of the existing A11 Cantley Stream Underpass to carry the proposed two lane A11 northbound to A47 eastbound interchange link over Cantley Stream and a private track. Refer to Drawing HE551492-ACM-SBR-TJ-DR-SE-00201-PO2 in Appendix L.

7.11.2 The new bridge will be approximately 18.3m wide to accommodate two 3.65m traffic lanes, two 1m hard strips, and one 2.5m wide verge. It will be a reinforced concrete box structure, either cast in-situ or of precast concrete construction.

7.11.3 Modifications will also be required to the east end of the existing A11 Cantley Stream Underpass to allow for the merge taper for the A47 eastbound to A11 southbound interchange link.

7.11.4 The A11 southbound merge taper can be accommodated within the width of the existing verge of the A11 without eastward lengthening of the underpass. Modification works to the east headwall and wingwalls however will be required in order to accommodate the increase in retained height (approximately 720mm) to suit the proposed alignment of the merge taper.

7.11.5 Lengthening the underpass to the east could be considered as an alternative to raising the headwalls and wingwalls.

7.11.6 Strengthening of the underpass might be required to accommodate the proposed road layout. Structural assessment will be needed to confirm the need for strengthening.

7.11.7 Assuming that strengthening of the existing structure would not be required, the proposed construction sequence would comprise removal of existing guardrails from the top of the east headwall and wingwalls, drilling and fixing of post-installed reinforcement bars to be used as starter bars and raising the existing headwall and wingwalls by constructing the new cast in-situ reinforced concrete parts. Finally the guardrails previously removed (or new guardrails if needed) will be fixed to the newly constructed parts of the headwall and wingwalls. Stiffening of the guardrails or provision of a structure parapet might be required due to the reduced working width available.

7.11.8 The modifications to the eastern side of the existing A11 Cantley Stream Underpass could result in the need to relocate an adjacent pollution control ditch, in which case the Environment Agency should be consulted.

7.11.9 Consultation with the Environment Agency and other stakeholders is advised in relation to the temporary or permanent realignment of water bodies, and the implications on the design of the modifications to this bridge and its construction methodology. Special care shall be taken when working over a watercourse to avoid spillages and other potential environmental hazards. It is recommended that the Cantley Stream will be protected by channelising or simple covering for the duration of works.

7.11.10 Record drawings indicate the use of 'Expandite Asbestumin (or similar approved)' for the sealing of the waterproof membrane at the edges of the existing A11 Cantley Stream Underpass (from Detail Y of drawing 81305/S103/1). The manufacturer's product name for this material suggests the presence of Asbestos-Containing Materials (ACM). The procedure for management of asbestos is set out in DMRB IAN 63/05r3, including carrying out a refurbishment survey prior to any work being undertaken and an intrusive survey as required. These surveys should confirm the location, presence and extent of ACMs.

7.11.11 Consideration shall be given to health and safety principles. Special care must be taken when planning or undertaking tasks within confined working room caused by the narrow underpass.

7.11.12 Total closure of the private farm track will be required for the duration of works. Suitable diversion routes will need to be proposed.

7.11.13 As the new bridge will be constructed on the west side of the existing bridge, and assuming that modification works to the existing Cantley Stream Underpass will only be undertaken to the eastern end (subject to no strengthening works will be required), no major disruption to the traffic on the A11 is envisaged.

A11 Underpass (Structure 23-S2)

7.11.14 A structure is required under the A11 main trunk (Structure 23-S2) in order to accommodate the proposed A11 northbound to the A47 eastbound interchange link. Refer to Drawing HE551492-ACM-SBR-TJ-DR-SE-00202 P02 in Appendix L.

7.11.15 The clear square span between abutments will be 15.3m to fit the two 3.65m traffic lanes, two 1m hard strips and two raised verges, 2.5m and 3.6m in width respectively. The proposed cross section also accommodates the required visibility splay for the 85kph design speed for the alignment.

7.11.16 Due to the geometries of the road layouts, the interchange link will be significantly skewed (approximately 35°) to the A11 above, which would normally require a skew deck span of approximately 27m. In order to reduce the skew span, and to improve constructability, the abutments will be extended so that a square deck span of 15.3m is formed. Top-down construction method is proposed as it considered to be most practical for this project and would significantly reduce disruption to traffic compared to conventional construction methods. The solution proposed consists of an approximately 78.6m wide solid slab deck made of in-situ reinforced concrete. Precast deck construction could also be considered to accelerate construction. The deck must be designed to accommodate the carriageway and verges of the A11. The soffit level must be sufficient to provide the minimum headroom of 5.3m as required by TD 27/05.

7.11.17 The proposed construction for the abutments is contiguous or secant pile walls made of reinforced concrete bored piles cast to an adequate bearing level to be determined at a later stage. The proposed deck is connected to the substructure with reinforcement designed to achieve an integral structure. Wingwalls would be of the same construction as the abutments with pile depth and/or diameter decreasing as their height reduces. This top-down construction provides support to the A11 embankments during the underbridge construction works, avoiding the use of any temporary retaining structures. An in-situ aesthetic concrete facing to the exposed abutment and wingwall piling is highly recommended in order to achieve an improved appearance.

7.11.18 Significant disruption is anticipated to the A11 traffic and appropriate traffic management and enabling works planning must be implemented in order to mitigate any delays and traffic congestion arising from the construction of the underpass. The structure would be constructed in two stages; one stage for the east part of the structure and one for the west part. Traffic on A11 from both directions will be accommodated in a single carriageway by using narrow lanes and/or contra-flow. Constructing the structure over-long at one end could be considered to provide space for improved temporary routing of traffic if required.

7.11.19 Road drainage of the A11 northbound to A47 eastbound interchange link under the structure should be considered at following design stages. Pumping of surface water may be required to prevent accumulation within the structure (refer to Section 7.8).

A47 Westbound Off-slip Underpass (Structure 23-S3) and A47 main trunk Underpass (Structure 23-S4)

7.11.20 A structure is required under the realigned A47 westbound off-slip to the Thickthorn Junction gyratory (Structure 23-S3) in order to accommodate the proposed A11 northbound to the A47 eastbound interchange link. Refer to Drawing HE551492-ACM-SBR-TJ-DR-SE-00203-P02 in Appendix L.

7.11.21 The structure has an approximate length of 45.3m. The clear square span between abutments above the slip road will be 15.3m to accommodate the slip road with its two 3.6m traffic lanes, two 1m hard strips and two raised verges, 2.5m and 3.6m in width respectively. The proposed cross section also accommodates the required visibility splay at the proposed design.

7.11.22 An additional structure is required under the A47 main trunk (Structure 23-S4) in order to accommodate the proposed A11 northbound to the A47 eastbound interchange link. Refer to Drawing HE551492-ACM-SBR-TJ-DR-SE-00204-P02 in Appendix L.

7.11.23 The structure has an approximate length of 128m. The clear square span requirements for this structure are identical as those of Structure 23-S3, described above.

7.11.24 The proposed construction is similar to that for Structure 23-S2 (refer to text above). The possibility of using a voided slab deck for these two structures should be explored in order to reduce loading. Precast deck construction could also be considered to accelerate construction.

7.11.25 The combined length, and the proximity of structures 23-S3 and 23-S4 to one another may result in a tunnel effect, which is undesirable for drivers at times of accidents or breakdown. Consideration should therefore be given to including a stairway, to be used as an emergency exit, located between these structures.

7.11.26 According to drawings provided by the Statutory Undertakers, there is a Virgin Media trench/duct in the area between Structures 23-S3 and 23-S4 running along the side of the A47 westbound off-slip to the gyratory. Temporary diversion of the service could be required during construction. Any potential relocation would be accommodated either on top of the new deck or below the proposed road level.

7.11.27 Structure 23-S3 encroaches on the existing A47 westbound off-slip to the Thickthorn Junction gyratory. Significant disruption to the traffic on this slip road is anticipated, and appropriate traffic management and enabling works planning must be implemented in order to mitigate any delays and traffic congestion arising from the construction of the underpass. Temporary widening of the existing slip road carriageway to the north-west of the proposed structure could be considered to accommodate all the traffic of the A47 off-slip while construction is taking place. During closure periods, traffic into and out of Norwich could be diverted via the adjacent A140 Ipswich Road Junction.

7.11.28 With regards to construction staging and traffic considerations, construction of Structure 23-S4 will be very similar to Structure 23-S2. Temporary widening of the A47 carriageways may be required to accommodate the traffic during construction.

Cantley Lane Footbridge

7.11.29 The Single Option also requires the demolition of the A47 Cantley Lane Footbridge to allow for the construction of the new A11 south to A47 east bi-directional interchange links.

7.11.30 The originally proposed Single Option makes provision for an alternative route for NMUs via the potential new link between Cantley Lane South and Cantley Lane beneath Structure 23-S5.

7.11.31 Full closure of the A47 is anticipated during demolition works. Such operations should be limited to off-peak hours to minimise the disruption to traffic. Adequate temporary traffic management needs to be planned and implemented to mitigate any disruption or traffic congestion.

7.11.32 The existing footbridge has an approximate dead load of 2000kN, which was estimated using a cross-section taken from near to the abutments multiplied by the length of the bridge, thus giving a conservative estimation.

7.11.33 The demolition of the footbridge would require the removal of the 6mm Hyflor stainless steel floorplate over the joint between the bridge deck and abutment (see record drawing No. 81303/2152). The 'knuckle pins' from the bearings would then be removed/cut whilst the bridge is temporarily propped, which would allow for the bridge to be lifted.

7.11.34 It is recommended to demolish the abutments to foundation level after the removal of the bridge for aesthetic reasons.

7.11.35 Further details are included in Section 11.

A47 Cantley Lane Underpass (Structure 23-S5)

7.11.36 A structure is required under the A47 mainline (Structure 23-S5) in order to accommodate the proposed potential local road link reconnecting Cantley Lane South and Cantley Lane. Refer to Drawing HE551492-ACM-SBR-TJ-DR-SE-00205-P02 in Appendix L.

7.11.37 The minimum clear square span between abutments will be 13.1m to accommodate the two 3m traffic lanes, two raised verges, 4.5m and 2.6m in width on the west and east side respectively, with a 3m wide shared NMU route in the west verge. The proposed cross section also accommodates the required visibility splay for the proposed 60 kph design speed for the alignment.

7.11.38 The solution proposed consists of an approximately 58m wide solid slab deck made of in-situ reinforced concrete (or precast concrete to accelerate construction as discussed above). The deck must be designed to accommodate the carriageway and verges of the A47. The soffit level must be sufficient to provide the minimum headroom of 5.3m as required by TD 27/05.

7.11.39 The top-down construction method is considered to be most suitable as for the other new structures in the scheme. As described for Structure 23-S2, the structure will comprise contiguous or secant bored pile abutments integral with the deck slab. Wingwalls would be of the same construction. Similar staging and traffic considerations apply as in the case of Structures 23-S2, 23-S3 and 23-S4.

Existing A47 Breckland Railway Bridge (Structure 23-S6)

7.11.40 The existing Breckland Railway Bridge carries the A47 mainline over a dual non-electrified railway line. It is a single span prestressed beam and in-situ reinforced concrete composite deck bridge. This bridge has a skew span of 23.65m and is skewed at 54 degrees. The bridge deck is 25.41m wide and consists of 22 No. precast M8 inner beams and 2No. precast UM8 edge beams. The deck is divided into two independent halves by a longitudinal deck expansion joint. There is a separation joint (approximately below the longitudinal deck expansion joint) to each of the abutments and their foundations, which also divides the substructure into independent parts.

7.11.41 Widening of the existing Breckland Railway Bridge is required to accommodate the proposed merge for the A11 northbound and A47 eastbound interchange link, and the diverge for the A47 westbound off-slip to the Thickthorn Junction gyratory. The existing bridge will be widened on the north side by approximately 3m, and on the south side by

approximately 8m. Refer to Drawing HE551492-ACM-SBR-TJ-DR-SE-00206-P02 in Appendix L.

7.11.42 A similar form of construction will most likely be used for the new widened parts of the bridge. Both of the existing parapets will be removed and the cast insitu part of the deck supporting the parapets will be demolished. Additional prestressed beams will be placed on either side, and the cast insitu deck slab will be extended. The deck will have to be resurfaced as a result of the widening, and the road crossfalls may have to be modified to suit the new arrangement of the lanes over the bridge. The existing abutments and foundations will also need to be widened. The abutment extensions will be founded on bored piles and will be dowelled to the existing abutments to minimize differential settlements between the old and new parts of the abutments.

7.11.43 The available record drawing No. 81303/2160 describes the parapets as P5/113kph aluminium parapet 1500mm high with solid Infill on front face. The former P5 containment level is now referred to as N2 according to TD 19/06. According to TD19/06 higher containment level of H4a would be required for parapets on new bridges over or adjacent to railways hence the current parapets are unsuitable for the widened bridge. The proposed option allows for replacement of the existing parapets with new H4a parapets suitable for bridges over railways.

7.11.44 Existing structure's records include inconsistencies which cause uncertainty of the load carrying capacity of the existing structure. At present it has been assumed that the widening will be effected without strengthening of the existing structure, although the adequacy of the structure has not been confirmed. Under the scheme, elements of the existing structure that currently support a hardened verge will support a carriageway, and there is potential that these retained elements may not have capacity to support the revised loadings to which they will be subjected. Should retained parts of the existing bridge not be able to support the loadings applied then they would either need to be strengthened or replaced. If this is required, noting that the bridge is over a railway, it could add significantly to scheme cost, programme and risk, as well as impacting the traffic disruption during the period of the work.

7.11.45 The available record drawings show that the approaches to the structure had been surcharged and abutment settlements were monitored prior to construction of the deck. This indicates that considerable settlement could occur in the vicinity of the existing abutments and approach embankments due to the widening of the highway embankments. Strengthening of the existing abutments and foundations could be required. Special technical solutions might need to be considered (e.g. lightweight fill, pile load transfer platforms, etc.) to reduce the effect of the new parts of the embankments on the existing and new parts of the substructure.

7.11.46 For the reasons stated above a quantitative structural assessment of the structure including its foundations is recommended at the earliest opportunity.

7.11.47 In the most recent Principal Inspection undertaken in 2016 certain areas of the diaphragm beams were found cracked and delaminated and the defects were classified as "Severe: Defect is clearly causing damage to element or structure". The defects to the existing structure will need to be investigated and repairs could be required. However, the risk associated with these defects is the same regardless of the widening works.

7.11.48 Construction of the deck would most likely be completed in two phases; one separate phase for each side of the deck. Significant disruption to the traffic on the A47 is anticipated involving total closure of at least one lane of traffic per phase while the modification works are being carried out. Necessary traffic planning and management will be required to mitigate any delays or traffic congestion. Rail possessions will also be required.

7.11.49 Temporary retaining measures will be required along the sides of the existing carriageway to protect existing traffic while excavations will be taking place to expose the existing foundations. Complex construction works will need to be carried out over and near the

railway. Demolition of the existing cribwalls (or part of them) will also be required. A considerable amount of post-installed reinforcement bars (i.e. resin fixed bars) will be required in order to construct the new parts of the abutments and foundations in order to make them structurally continuous with the existing parts. Hydrodemolition of the edges of the existing deck and diaphragm beams is envisaged above the railway. The deck will have to be encapsulated during hydrodemolition and settlement tanks will be required to contain water prior to offsite disposal.

7.11.50 If the Single Option is ultimately pursued then a Departure from Standard is proposed to allow for abutment galleries not to be provided (DMRB BD57/01). The departure is justified as the proposed new parts are extensions to the existing and of the same construction and they do not add a new maintenance liability.

7.11.51 Due to the extent of the works required that are associated with widening of the structure, consideration should be given at future stages of the project to whether the A47 could be realigned such that widening of the bridge is required on one side only.

Existing A47 Cringleford Culvert (Structure 23-S7) and Cantley Culvert (Structure 23-S8)

7.11.52 The available record drawings indicate that the culverts outlets extend out from the existing carriageway edges by approximately 13.5m on either side. Consideration should therefore be given to widening the A47 and the adjacent bridge without widening the existing culverts. This might be possible with careful selection of the type and geometry of the new bridge wingwalls and retaining walls, although extension of the outlet headwalls and wingwalls might be required at some locations.

7.11.53 Consultation with the Environment Agency and other stakeholders is advised in relation to the temporary or permanent realignment of water bodies and its implication on the design of these culverts.

7.12 Buildability

7.12.1 In order to establish the potential issues regarding buildability and temporary works associated with the construction sequence of the Single Option, Highways England have procured the ECI advice of a Lot 3b Framework contractor.

7.12.2 The Single Option contains a high proportion of ‘on-line’ works requiring the contractor to work in areas where space is limited and traffic flows are high. Careful consideration is therefore required for the phasing of the works in order to minimise network disruption.

7.12.3 In order to maintain the programme, the underbridges will need to be constructed concurrently. Therefore the Traffic Management schemes on the A11 and A47 will affect each other, which will therefore need to be considered.

7.12.4 For the underbridges beneath the A47 and A11 mainline, temporary closures would not be acceptable due to the high traffic volumes. Consideration would therefore be needed to incorporate narrow lanes and/or contraflow and a full time speed limit, which would increase the indirect economic costs for the scheme associated with delays and disruption during construction.

7.12.5 At the proposed location of the underbridge beneath the A11, there is already a permanent 40mph speed limit. A temporary 40mph speed limit should also be considered on the A47 mainline. This will significantly enhance work place safety during the works, and also allow the use of delineators within the traffic management phases, and remove the requirement for long stretches of varioguard, which would be more expensive, and would extend the construction programme.

7.12.6 The construction of the underbridges for the A11 north to A47 east interchange link, beneath the A47 westbound off-slip and the A47 mainline, will require closures and diversions of the A47 east-facing on and off slip roads. During the closure periods, traffic into and out of Norwich will be diverted via the adjacent A140 Ipswich Road Junction. This would also increase the indirect economic cost associated with delays and disruption during construction.

7.12.7 The existing footbridge crossing the A47 mainline east of Thickthorn Junction would be removed under the proposals for this option. The demolition of this footbridge would require the A47 mainline to be closed in both directions for one weekend. Strategic diversion of traffic would be as described in Section 6.4 of the original TAR ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032. The temporary closure of the A47 is likely to cause significant network disruption.

7.12.8 The existing Breckland Railway Bridge would need to be widened on both sides of the A47 in order to accommodate the proposed slip road connections. These works would require 'possession' of the rail track to be arranged with Network Rail to facilitate the positioning of the deck beams.

7.12.9 The construction of the roadworks for the A47 and A11 slip road connections to both carriageways should be feasible using a number of overnight lane closures of lane 1. This would minimise network disruption.

7.12.10 In order to meet the programme, the earthworks will need to be completed within one earthworks season (1st April to 31st October). Early ecology mitigation would therefore be advisable prior to the ecological seasons with respect to vegetation and site clearance work required for the scheme. In order to avoid the disturbance of nesting birds, tree clearance must be completed by 20 February. Early mitigation is also advisable for the existing areas of archaeological significance.

7.12.11 Since there is a surplus of excavated material from the cuttings, opportunities should be sought to reutilise the material on site for earthwork bunds for environmental screening. This would avoid the need to haul the surplus earthworks material for disposal off site.

7.12.12 Separate haul routes will be needed to access the various sections of the site, which are on opposite sides of the A11 and A47.

7.12.13 The advanced diversion of utilities should be considered, as the encroachment of the diversion work on the construction activities is likely to affect the overall programme duration.

7.13 Accommodation Works

7.13.1 The accommodation works have been considered throughout the development of the originally proposed Single Option, with particular attention to how the landowners will be affected.

7.13.2 Access to the drainage ponds have been shown on the land take drawings included in Appendix K.

7.13.3 The existing section of Cantley Lane South that runs parallel to the A47 will be stopped up. This is because this part of Cantley Lane will be severed by the new interchange links, and the entry could not be retained for reasons of highway safety, owing to the provision of the A47 westbound successive diverges. The section of Cantley Lane South, adjacent to the row of properties will be retained as a cul-de-sac with a turning head at the northern end.

7.13.4 The existing underpass for the track and Cantley Stream, approximately 700m to the south of Thickthorn Junction, will need to be extended beneath the proposed A11 south to A47 east bi-directional interchange links.

7.13.5 Refer also to para. 7.14.3.

7.14 Severance

7.14.1 This section considers the potential severance caused by the originally proposed Single Option. The new scheme may affect social groups or amenities by bisecting existing communities or creating a barrier between existing communities.

7.14.2 Cantley Lane South will be severed by the proposed Thickthorn Junction Improvements scheme, and the existing NMU bridge to the east of Cantley Lane will be removed. It is therefore proposed to provide a new link to connect Cantley Lane South to Roundhouse Roundabout via an underpass beneath the A47. This would reconnect Cantley Lane South to the wider network for local traffic and NMUs.

7.14.3 The proposed Option 3 local road link between Cantley Lane South and Roundhouse Roundabout severs a small pocket of land between Cantley Lane South, the A47 and the Breckland Railway Line. This is a single carriageway, and accesses from it can be provided.

7.15 Lay-Bys

7.15.1 A number of existing lay-bys are affected by the Single Option. A review of lay-by provision in the area should be assessed in PCF Stage 3.

7.15.2 There are two maintenance lay-bys in the immediate vicinity of Thickthorn Junction. One is located in the central island of the junction opposite the A47 westbound off-slip road. This lay-by provides maintenance access to two electrical 'Lucy' cabinets in the centre island. The second is located adjacent to the A11 southbound carriageway approximately 120m beyond the junction. It is a maintenance hardstanding that has been positioned immediately below the 400kv overhead electricity cables that cross the A11 at this point. This is presumed to be for National Grid to access the cables using a sky cradle.

7.15.3 The requirements for maintenance hardstandings should be reviewed during PCF Stage 3.

7.15.4 The existing lay-by on the A11 northbound carriageway approximately 275m south of Thickthorn Junction is also affected by this option due to weaving issues and would need to be closed.

7.15.5 The existing lay-by on the A47 eastbound carriageway approximately 240m east of the Breckland Railway Bridge is also affected by this option as it clashes with the location of the proposed A47 eastbound merge and would need to be closed.

7.15.6 The existing lay-by on the A47 westbound carriageway approximately 1.4km east of the Breckland Railway Bridge may also affected by this option due to the reduction in weaving length, and may need to be closed or subject to a Departure from Standards.

8 Operational Technology and Maintenance Assessment

8.1 Operational Assessment

8.1.1 The results of the operational assessment for the existing Thickthorn Junction (refer to Section 3.3 of the original TAR Ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032) show that the current traffic flows for the east-facing slip roads (A47 westbound diverge and eastbound merge) at the existing junction already exceed the recommended traffic flows.

8.1.2 As a result of these predictions, the problems with the capacity of the east-facing slip roads were taken into consideration when designing the Single Option.

8.1.3 For the A47 mainline two-lane dual carriageway, the predicted 2036 design year peak hour traffic flow for the westbound and eastbound carriageways is predicted to be 3800 and 3550 vehicles per hour (vph) respectively. Therefore, these traffic lanes will be over the theoretical capacity of 3200 vph for a D2AP, as defined in Cl 3.3 of TD 22/06.

8.1.4 Since widening of the A47 to three lanes is beyond the scope of this project, it is not feasible to incorporate merges or diverges with lane gains or lane drops. For this reason, the options are still not fully compliant with the standards and a number of Departures from Standards have been identified, as discussed in Section 7.5.

8.1.5 The restriction in capacity of the west-facing slip roads is far less acute than for the east-facing slip roads, since they are adequate for the current traffic flows and have capacity to spare. Furthermore, the transport problem identified in Stage 0 did not identify these slip roads as a cause of congestion at the junction and improvements have therefore been excluded from the current proposals. However, it is likely that improvements will be required in order to accommodate the future traffic levels for the design year. Improvements to these slip roads could be considered in future design stages.

Operational Assessment of the Proposed Slip Roads

8.1.6 The operational assessment of the merges and diverges was carried out in accordance with TD 22/06 and the results can be seen in Appendix H. The Single Option has two consecutive A47 eastbound merges, and the new A11 northbound to A47 eastbound interchange link road provides relief to the traffic that uses the existing eastbound on-slip from the Thickthorn Junction gyratory. For this reason, the capacity of the existing eastbound on-slip from the gyratory is adequate for the design year, and it will not need to be upgraded.

8.1.7 The A47 eastbound downstream merge, for the new A11 northbound to A47 eastbound interchange link, is proposed to be a Type A merge instead of the required Type E for Lane Gain, since increasing the A47 to three lanes is outside the scope of the project.

8.1.8 The A47 westbound diverge, for the new A47 westbound to A11 southbound interchange link, is proposed to be a Type B Parallel diverge in place of a Type D Ghost Island diverge for Lane Drop, since the provision of an additional lane on the A47 is not within the scope of the scheme.

8.1.9 The downstream diverge from the A47 westbound off-slip for the A47 westbound to A11 southbound interchange link road requires a Type A diverge for the design year traffic.

8.1.10 The A11 northbound diverge for the A11 northbound to A47 eastbound interchange link road requires a Type A diverge for the design year traffic.

8.1.11 For the A11 southbound merge a Type B Parallel Merge is required. However, a Type A Merge taper is proposed to maximise the distance to the subsequent diverge taper for Station Lane Junction to the south, owing to the substandard weaving length.

8.2 Technology Assessment

8.2.1 This section provides an overview of how the proposed options may affect the existing technology in the vicinity of Thickthorn Junction (refer to section 3.12 of the original TAR). The proposed options may require this equipment to be removed, replaced or relocated. An initial summary of potential impacts has been compiled in the section below.

Vehicle Detectors

8.2.2 The Single Option will not alter the MOVA loops on the Thickthorn Junction A47 eastbound off-slip. However, the alterations to the A47 westbound off-slip will require relocation of the MOVA loops.

8.2.3 With the developer Do-Minimum improvements, Round House Roundabout will be upgraded to MOVA controlled signals to increase the capacity. Therefore, in addition to upgrading the roundabout to include signal control, new MOVA detectors will be required at each of the three signal controlled approaches.

Lighting

8.2.4 This option introduces two free flowing bi-directional interchange links between the A11 south and the A47 east. There are alterations to the A47 eastbound merge and A47 westbound diverge layouts. The scheme also includes alterations to Thickthorn Junction gyratory, Round House Roundabout, and the connecting A11 link. The originally proposed Single Option provided a new local road link, reconnecting Cantley Lane South to Cantley Lane north of the A47.

8.2.5 The lighting on the existing Thickthorn Junction slip roads already extends to a distance of 100m from the gyratory, which is further than the recommended minimum lit conflict area suggested by the Institution of Lighting Professionals Application of Conflict Areas on the Highway for a road with a 40 mph speed limit. However, the A47 westbound exit slip is being realigned, so new lighting will have to be provided for the last 89m approach to the gyratory. This lighting should utilise 10m columns with high pressure sodium lanterns to match the existing.

8.2.6 The lighting on the Round House Roundabout will require minor alterations/additions to the existing lighting to accommodate alterations to the carriageway width at Round House Way and A11 link to the Thickthorn Junction gyratory.

8.2.7 The new free flowing A11 northbound to A47 eastbound interchange link passes under three roads. The new underbridge structure beneath the A11 mainline is on a curved horizontal alignment, and the combination of its overall length and width, results in a Look Through Percentage (LLTP) of approximately 46%. BS 5489 Part 2 – Lighting of Tunnels recommends where 20% < LLTP < 80% daytime lighting of the tunnel should be considered and if an object, representing a cyclist, cannot be seen by more than 30% against the exit portal then lighting should be provided, which will be the case for this underbridge.

8.2.8 Where the new A11 northbound to A47 eastbound interchange link passes under the A47 there are two new underbridge structures. The first carries traffic under the realigned A47 westbound off-slip. This structure is 45m long, and daytime lighting is required.

8.2.9 The third underbridge carries traffic under the existing A47 dual carriageway, and is also on a curved horizontal alignment, which together with its length and width results in a LLTP of

10%. BS 5489 – 2 recommends where LLTP < 20% daytime lighting should be provided, which is the case for this underbridge.

8.2.10 As both the A11 and A47 in this area are presently unlit, there would normally be no requirement to provide lighting for the new interchange link roads. However, by having to provide daytime lighting to the three underbridges, night-time lighting must also be in place through the tunnels and to assist driver's visual adaption on entering and leaving two lit features in close proximity to one another. The entrance and exit zones should therefore be lit, which results in continuous lighting being provided from a point 120m in advance of the A11 underbridge, through the two new underbridges at the A47 to a point 120m beyond the exit of the last underbridge.

8.2.11 The new lighting should comprise 10m high columns with post top mounted LED lanterns set at 0 degrees to the horizontal, which will minimise any upward light, and not provide a glare source to drivers on the A11 or A47.

8.2.12 As included within the originally proposed Single Option, Cantley Lane is being diverted under the A47 through a new underbridge, which is straight, and has a LLTP of 69%. BS 5489 -2 recommends where 20% < LLTP < 80% daytime lighting of the underbridge should be considered and if an object, representing a cyclist, cannot be seen by more than 30% against the exit portal then lighting should be provided. In this instance due to the straightness of the underbridge and the relatively high LLTP, approximately 60% of the object is visible and therefore there is no requirement to provide daytime, and consequently night-time, lighting through this underbridge.

8.2.13 Cantley Lane and Cantley Lane South are presently lit by the Parish Council with ad hoc 5m lighting columns in areas where there are residential properties. There is no intention to provide any additional lighting as a consequence of linking the two roads back together although the Parish Council may wish to provide some form of beacon lighting at strategic points.

8.2.14 The electrical services to all new lighting columns and underbridge lighting will utilise a private cable network, which will require a new three phase Distribution Network Operator electrical connection into a new feeder pillar located in the vicinity of the old Cantley Lane South near the Thickthorn Junction gyratory.

8.2.15 The decision whether to provide lighting to the roads proposed within either Option 3 or 4 will need to be taken as part of subsequent PCF stages.

Other Considerations

8.2.16 The known ANPR camera on the A11 northbound will not be affected by the Single Option.

8.2.17 The lay-by on the A47 eastbound which accommodates an Emergency Roadside Telephone (ERT) will need to be closed to allow for the construction of the Single Option. The provision and location of a replacement lay-by with ERT will require further consultation.

8.2.18 Some of the existing traffic signals and signalised crossings at Thickthorn Junction can be incorporated into the Single Option. The Pegasus crossing at the end of the A47 westbound off-slip could be affected, owing to the realignment of the slip road, however, as discussed in section 3.2.33 of the original TAR, it is proposed to remove this crossing as it is not used.

8.2.19 If the developer Do-Minimum improvements are made to Thickthorn Junction gyratory, the B1172 will become signalised and extra traffic signals will be needed at this location. An extra lane will also be added to the eastern side of the gyratory and an extra lane will be added to the A11 Newmarket Road towards Round House Roundabout.

8.3 Maintenance Assessment

8.3.1 Consideration has been given to the ease of maintenance of the Single Option at a strategic level during its development and a separate PCF product, the Maintenance Repair Strategy Statement (MRSS), has been produced within PCF Stage 2 (Ref. HE551492-ACM-GEN-TJ-RP-ZM-00022).

8.3.2 The MRSS is guided by Interim Advice Note 69/14 and addresses issues concerned with the safety of road workers with respect to maintenance and repairs for the infrastructure being provided for new highway schemes. The expected outcomes of IAN 69/14 are:

- reduced exposure to risk by operatives;
- reduced level of site accident rates and ill-health arising from maintenance activities;
- more efficient and cost effective maintenance; and
- reduced congestion and delay.

8.3.3 The objective of the MRSS is to generate scope for improvements in safety within the design phase, before physical work occurs on site and to ensure compliance with CDM Regulations 2015 with regards to designing for maintenance. It is also used to ensure that appropriate liaison has taken place with maintenance teams within Highways England. The scope of this document includes:

- anticipated maintenance task;
- assumed means of safe access;
- traffic management measures;
- assumed safe methods of working;
- provision of welfare facilities;
- specific safety measures; and
- risks.

8.3.4 The existing maintenance access facilities are described in Section 3.13 of the original TAR.

8.3.5 The following high level issues associated with maintenance of the options have been identified at this stage, and should be considered during the development of the MRSS in the following stages.

Key Maintenance Considerations relating to the Single Option

8.3.6 The Single Option provides an offline bypass for Thickthorn Junction, thus allowing an alternative route for A47 east to A11 south traffic in both directions, should there be maintenance or emergency access requirements to the existing gyratory, which improves network resilience compared to the existing junction. Thickthorn Junction can also remain open even if the A47 east to A11 south interchange links are closed in both directions.

8.3.7 The construction of the Single Option will require the closure of an existing maintenance lay-by on the A11 southbound, and an existing public lay-by on the A47 eastbound. The current Cantley Lane South access to Thickthorn Junction will be made redundant but maintenance vehicles will have access from Cantley Lane to the north of the A47 via the new underpass.

8.3.8 The Single Option may require the closure of an existing public lay-by on the A47 westbound. Alternatively this may be the subject to a departure submission for a reduction in weaving length from that required by section 4.36 of TD 22/06.

9 Safety Assessment

9.1 Introduction

9.1.1 An assessment of the available collision data for five years from 2011 to 2015 has been undertaken as described in Section 3.4 of the original TAR Ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032. This was used as the basis for a high level evaluation of the predicted effects of each option on collision risk.

9.2 Summary of Safety Assessment

9.2.1 The safety of the road user has been considered to a level appropriate at this stage in the design process. At present a Road Safety Audit (RSA) has not been undertaken but these will be conducted at later PCF stages to ascertain the requirement for an NMU Audit and to inform and develop the design.

9.2.2 User safety will be further addressed at later PCF stages, when designs are prepared for traffic signs, road marking and vehicle restraint systems.

Specific Key Safety Considerations relating to the Single Option

9.2.3 For the Single Option, which introduces a grade-separated junction on the A11 south of Thickthorn Junction, there might be an increase in the risk of side swipe and rear end shunt type collisions due to the weaving manoeuvres caused by the introduction of a merge and diverge. Some of the proposed merges / diverges require a Departure from Standards as described in Section 7.5, and consultations will be undertaken with Highways England over their design.

9.2.4 The provision of successive merges on to the A47 eastbound increases the potential for increased side swipe and rear end shunt type collision risk on the A47 mainline carriageway due to an increase in weaving manoeuvres. However, this would be offset by a significant reduction in congestion, since the traffic would be shared between the successive merge facilities. Therefore, it is likely that there would be an overall reduction in this type of collision risk compared to the existing situation.

9.2.5 The provision of a diverge from the A47 westbound followed by a successive diverge for the A47 westbound to A11 southbound interchange link road from the A47 westbound off-slip would introduce the risk of side impact and rear end shunt type collisions on A47 upstream approach and within the upstream diverge taper due to an increase in weaving manoeuvres. Liaison will be undertaken with Highways England to ensure that the signing and road marking strategy ensures that vehicles are in the correct lane, and that weaving is minimised between the upstream and downstream diverges.

9.2.6 The closure of the sub-standard Cantley Lane South connections to the A47 westbound diverge and the A11 southbound carriageway would reduce the risk of side impact and rear end shunt type collisions at the intersection with the slip road caused by merging slow moving vehicles. For the current layout, the risk of rear end shunt type collisions on the A11 south mainline carriageway is caused by traffic decelerating in close proximity to the A11 southbound exit from the gyratory. These closures would also reduce the amount of strategic traffic using the local road network to access Thickthorn Junction, thereby reducing the risk of rear end shunt type collisions on the junction approaches.

9.2.7 The introduction of an alternative bi-directional route between A11 south and A47 east, and the subsequent reduction in the number of vehicles passing through the currently congested Thickthorn Junction would reduce the risk of side swipe and rear end shunt type collisions on and approaching the gyratory, where most of the collisions currently occur.

9.3 Impact on Road Users – Strategic Safety Action Plan

9.3.1 This section discusses how the key safety aspects of the design for the options align with the Highway's England RIS and Delivery Plan.

Highways England Delivery Plan 2015-2020: A safe and serviceable network

9.3.2 The Highways England Delivery Plan 2015-2020 sets out the following measures to benefit safety that will result in noticeable improvements for customers, and will contribute significantly towards achieving the Killed or Seriously Injured (KSI) for a 40% reduction in accidents. The commentary below summarises how the Single Option aligns with these measures.

Upgrades to junctions and removing some of the worst bottlenecks

9.3.3 The Single Option seeks to upgrade Thickthorn Junction and address the capacity issues and bottlenecks at the site.

Developing higher standard A roads, to be known as 'Expressways'

9.3.4 RIS sets out its 2040 vision to improve parts of the strategic road network to Expressway standards, which are portrayed as "A-roads that can be relied upon as to be as well designed as motorways, and which are able to offer the same standard of journey to users". An Expressway Technical Note was formally issued by Highways England SES that summarises the core requirements for an Expressway, which was endorsed by the Highways England executive committee on 17th February 2016.

9.3.5 Thickthorn Junction is not identified in the "current, planned and potential Expressways" category, although there is an aspiration to upgrade the A47 route to 'Expressway Standards'.

9.3.6 Should the Expressway network be expanded to include Thickthorn Junction, the key relevant criteria to these schemes are "Junctions which are largely or entirely grade separated, so traffic on the main road can pass over or under roundabouts without stopping." The Single Option for the Thickthorn Junction fits this criterion.

Upgrading central barriers

9.3.7 The existing highway layouts on the A47 and A11 include a central reserve safety barrier system. Minimising vehicle conflicts and providing appropriate segregation will be a factor as the scheme develops so these central barriers will need to be analysed to determine if they need to be upgraded to reduce the risk of crossover accidents.

Providing safer verges with improved run off protection

9.3.8 Providing safer verges with improved run off protection and safer street furniture is a detailed consideration which will be incorporated during the subsequent PCF stages.

Improved road signing and markings

9.3.9 Consultation will be required with Highways England SES when developing the signing and road marking strategy for the consecutive diverges for the A47 westbound off-slip, and the A47 westbound to A11 southbound interchange link road.

9.3.10 Providing improved road signing and markings is a detailed consideration which will be incorporated during subsequent PCF stages.

Upgrading lay-bys

9.3.11 As all the options require one or more of the lay-by's on the A47 mainline to be removed, discussions will be required with the Area 6 Asset Support Contractor relating to alternative provision.

Developing and deploying technology to prevent, detect and monitor incidents

9.3.12 For the Single Option, which includes junction bypasses, there may be an opportunity to install Variable Message Signs (VMS) to route traffic on to the interchange links in the event of an incident or for maintenance of the gyratory, or to switch traffic to the gyratory if an incident occurs.

9.3.13 There are no existing CCTV cameras at the site.

Using designated safety funding to deliver targeted safety improvements

9.3.14 Opportunities for the use of designated safety funding to deliver targeted safety improvements will be explored in the Value Management Workshop to be held with the Buildability Contractors and detailed in the Value Management Workshop Report (Ref. HE551492-ACM-GEN-TJ-RP-ZM-00005). The measures identified will be developed in future PCF stages.

9.4 Impact Relating to Construction and Operations – Construction (Design and Management) Regulations 2015

9.4.1 The Construction (Design and Management Regulations) 2015 requires the Client to formally appoint a Principal Designer (where it is reasonably foreseeable that more than one contractor will be working on a project at any one time), who has responsibility to plan, manage and monitor the pre-construction phase, and to co-ordinate matters relating to health and safety during the pre-construction phase.

9.4.2 AECOM has been appointed as Principal Designer on the A47 Programme and promotes co-operation, co-ordination and communication between designers and other project partners through a combination of formal and informal processes, such as:

- design team meetings;
- design reviews;
- face-to-face discussions with designers;
- exchange and sharing of information; and
- other communication as required.

9.4.3 AECOM will ensure, so far as is reasonably practicable, that the design addresses health & safety issues. This will include risks that, by virtue of the design, may affect the health & safety of any person carrying out construction, maintenance or demolition work on the project, or using the finished facility as a workplace. The elimination and / or mitigation measures should commence at the earliest stages of a project design (as has been done during PCF Stage 1). Significant understanding is required and this will be enhanced by consultation with those who will maintain the road and, through design and engineering, risks will be mitigated where practicable following the general principles of prevention.

9.4.4 The flow of information between the team members will be encouraged, particularly the communication and the sharing of designer's considerations of relevant health & safety information. The subject will be reviewed regularly, including at project design meetings, to ensure that this information is collected and distributed. The pre-construction information document (Ref HE551492-ACM-GHS-TJ-RP-ZS-00002) is based on information provided by others and their own considerations, based on their knowledge of the project. Draft pre-

construction information documents will be issued during the design phase to provide information to inform the design and to prompt contributions from all parties for the tendering stage.

9.4.5 An integral part of the design process for AECOM is that designers are required to follow mandatory safety in design guidance, which is introduced within their Integrated Management Systems. Forms to record identification of hazards, risk elimination and/or reduction measures, information to be conveyed, actions, and ownership are included within the standard documentation.

9.4.6 An initial Health & Safety File (HE551492-ACM-GHS-TJ-RP-ZS-00003) was prepared by the Principal Designer in PCF Stage 2. As for the pre-construction information document, the file was based on information provided by others and AECOM design teams.

10 Summary of Public Consultation

10.1 Consultation Arrangements

10.1.1 The Non Statutory Public Consultation planning process was undertaken in accordance with the requirements of the Planning Act 2008 and associated guidance. Early consultations took place with Norfolk County Council and Suffolk County Council in their role as highway authority for the local road network within the locality of the A47/A11 Thickthorn Junction.

10.1.2 Highways England's best practice is to arrange a non-statutory consultation in the early stages of scheme development, to ensure that public opinion is integrated into the scheme design at an early stage.

10.1.3 The aim was to provide a suitable avenue for the general public, Statutory Consultees (including local authorities), and other interest bodies to express their views on the outline proposals for the A47/A11 Thickthorn Junction Improvements scheme.

10.1.4 The event arrangements involved the various communications channels such as;

- Scheme brochure
- Questionnaire (provided in hard copy and also available online)
- Advertisement
- Public Information Exhibitions
- Illustrative Design Drawings and Display Material
- Static Panel
- Meeting with affected parties
- Press releases and media coverage

10.1.5 The consultation period was from 13 March 2017 to 21 April 2017.

10.2 Advertising

10.2.1 Advertising for the Public Information Exhibition (PIE) was done in the following ways:

- Highways England website for the A47 Improvement:

  http://www.highways.gov.uk/a47Improvement

- Highways England press notice (published on 15 March 2017):

  https://www.gov.uk/government/news/have-your-say-on-plans-to-dual-and-improve-junctions-on-the-a47

- Invitation to local MPs, local councillors and other key stakeholders to attend a preview of the Exhibition (before it opened to the public), sent on 02 March 2017;

- Advertisements in local newspapers ('EDP', 'Norwich Evening News', 'Diss Wymondham & Attleborough Mercury', 'Norwich Extra') on 16 March 2017;
- Interviews on local television news and radio;
- Notices posted at strategic locations around the Cringleford and Hethersett area before the Exhibition;
- Leaflet drops in Cringleford and Hethersett;
- Notices posted at the exhibition venues on the days of the exhibition;
- A 'static' advertisement set up at the Norwich City library (refer to Section 3.6 of the A47 Thickthorn Junction Consultation Report for further details).

10.3 Public Information Exhibition

10.3.1 Public Information Exhibitions (PIEs) were held on 25, 27 and 28 March 2017. Details including the number of visitors that attended are shown in Table 10-1. The exhibition was attended by Highways England staff, its consulting engineers (AECOM) and officers from Norfolk County Council.

10.3.2 The venues for the exhibitions were selected with locality and suitability in mind. The aim was to provide the optimum opportunity for members of the public across the area to attend. Details of the venue locations can be found in the Public Consultation Leaflet (refer to document number HE551492-ACM-GEN-TJ-RP-ZM-00007, Appendix M).

10.3.3 The PIEs presented the scheme proposals on display boards, with a combination of drawings and descriptive text.

10.3.4 Copies of the brochure and questionnaire were available at the exhibitions. Members of the public were invited to provide feedback on the event by completing a hard copy of the consultation questionnaire or via an online version.

Table 10-1: Public Information Exhibitions Details

Venue	Date	Opening Times	Number of Visitors
The Forum Millennium Plain Norwich NR2 1TF	Tue 14 March 2017	1pm – 3pm MPs, Councillors and stakeholders Preview	Not recorded
Willow Centre 1-13 Willowcroft Way Cringleford Norwich NR4 7JY	Sat 25 March 2017	10am to 2pm	71
Jubilee Youth Club Back Lane Hethersett Norwich NR9 3JJ	Mon 27 March 2017	3pm to 8pm	117

Venue	Date	Opening Times	Number of Visitors
Willow Centre 1-13 Willowcroft Way Cringleford Norwich NR4 7JY	Tue 28 Mar 2017	3pm to 8pm	69

10.4 Brochure and Questionnaire

10.4.1 The Public Consultation brochure included:

- Information on the scheme proposals;
- Details of the exhibition dates; and
- Contact details to enable comments to be made to Highways England.

10.4.2 A separate questionnaire was also given to respondents in order to gain feedback.

10.4.3 Copies of the brochure and questionnaire are included in the Public Consultation Report (refer to document number HE551492-ACM-GEN-TJ-RP-ZM-00007).

10.5 Overall consultation Responses

10.5.1 185 responses to the consultation were received via the following channels shown in Table 10-2.

Table 10-2: Number of responses by type

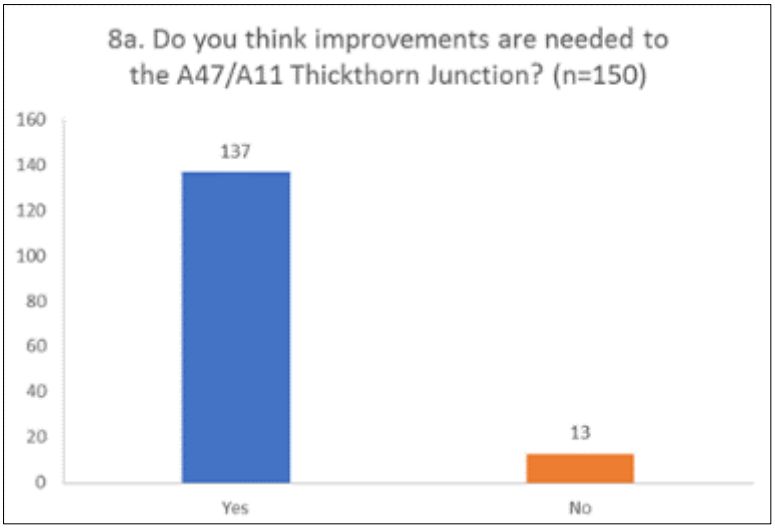
Type of response	Count
Online response form	78
Response form hardcopy	74
Emails/letters	33
Total	**185**

10.5.2 The responses were handled differently according to the format in which they were received. These were assigned a unique reference number based on their distinct channels and imported into Dialogue by Design's bespoke consultation database for analysis.

10.5.3 The key findings were;

- There is generally good support for the scheme from both the local residents/stakeholders and the travelling public (Figure 10-1);
- Disapproval of Cantley Lane South being reconnected to Canley Lane north of the A47; and
- Concerns about the impact during the construction period in terms of noise pollution and traffic disruption.

Figure 10-1: Response to Question 8a

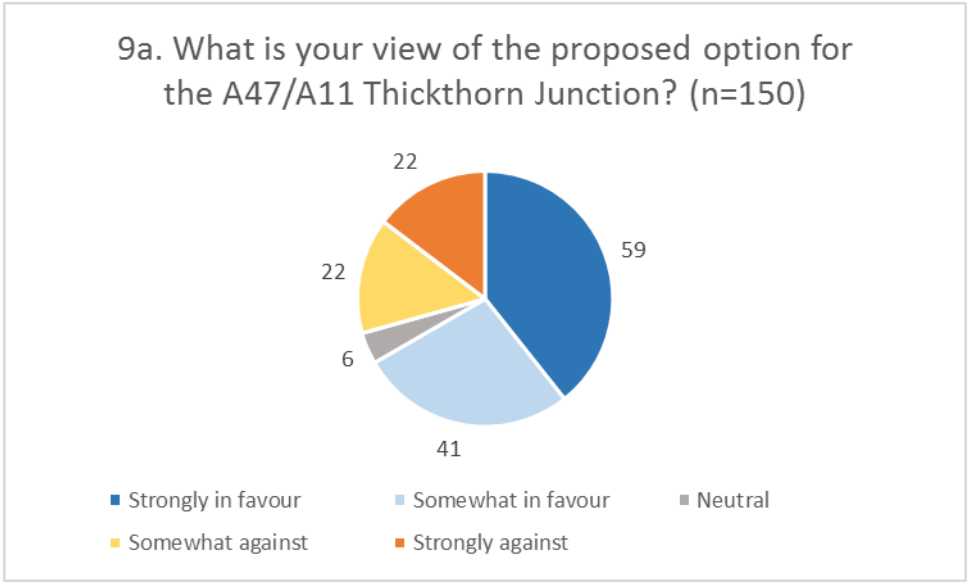


10.5.4 More than 90% of the 150 respondents agreed that improvements are needed at the A47/A11 Thickthorn Junction. Respondents made comments on the need for the scheme, identifying current problems with congestion, safety, and design of the Thickthorn Junction that they believe justifies the need for improvement. Less than 10% argued that the junction does not require any improvement at all.

10.6 Single option Responses and Results

10.6.1 Question 9a provided in the consultation questionnaire to assess views on the proposed option had a total of 150 responses. The responses relative to the level of support for the proposed option are shown in Figure 10-2.

Figure 10-2: Responses on the proposed option for the A47/A11 Thickthorn Junction



10.6.2 A total of 100 respondents are either strongly or somewhat in favour whilst 44 indicated they are either strongly or somewhat against. Six respondents chose to remain neutral on this question.

10.6.3 The comments from 122 respondents on Question 9b (refers to reasons for response given to Question 9a) provided in the questionnaire were summarised and analysed to ascertain their views for the proposed option.

10.6.4 The respondents who supported the proposed option believe it will alleviate congestion problems around the Thickthorn Junction, improve the local environment and socio-economic climate, protect the safety of users, and represents the best design and construction process. In their comments, respondents also added caveats to their support and, whilst supporting the proposal in general, they expressed concern about the Cantley Lane link road and underpass.

10.6.5 Respondents who opposed the scheme believe it will increase congestion issues, harm the environment and the socio-economic climate, pose a hazard to users, be complicated and difficult to construct, and route vehicles far out of their way. They particularly oppose the Cantley Lane Underpass which they think would severely impact the local residents, whilst approving of the implementation of slip road interchanges. Respondents did suggest methods of mitigating these impacts as well as a number of alternative suggestions to the design.

10.7 Consultation Responses Outside Current Scope

10.7.1 During the consultation period, Highways England also received some responses that were considered to be outside the current scope of the scheme. As most of these responses related to issues on the local road network, the comments were forwarded to the local highway authorities – Norfolk County Council and Suffolk County Council.

10.7.2 Other responses outside the scope of the proposed option included;

- Provisions for Non-motorised users (NMUs);
- The Consultation Process itself.

10.7.3 Respondents commented on the provision for NMUs in the proposals, identifying that provisions should be made for cyclists and pedestrians. Respondents commented that the issue of safety is most important when discussing NMUs and is the primary reason they should be provided for. Other respondents argued that provision for NMUs is not required, due to safety issues and the current provision available to them.

10.7.4 Respondents finished by discussing the consultation process itself, raising concerns about the depth of communication shown by Highways England. They discussed the public exhibitions and the competency levels of the staff who presented them, as well as the information available in the brochure, being critical of missing or vague information as well as the accuracy of much of the material. Respondents finally requested more information be provided by Highways England, as well as requesting further engagement as the proposals develop.

10.8 Alternative Options put Forward at Public Consultation

10.8.1 As part of the supporting information for the consultation, a Non-Technical Summary Report was prepared and made available to the general public on the Highways England's scheme website. This document provided background information on the scheme development prior to the consultation, and included details of the alternative options considered along with the reasoning for their rejection.

10.9 Ongoing Consultation and Engagement

10.9.1 Consultation has continued with the local authorities and residents following completion of the formal non statutory Consultation Period. This was undertaken specifically to address concerns raised during the Public Information Exhibition as a result of the originally proposed Single Option.

10.9.2 Local residents/communities were strongly opposed to the scheme design specifically as a result of the proposal for Cantley Lane South. The concerns raised were:

- Routing of traffic from Cantley Lane South onto Cantley Lane (North) which is considered to be too narrow;
- 'Rat Running' to the A11 at Station Lane;
- Impact on private land;
- Proximity of the proposed road to properties adjacent to the A47;
- Impact of noise from the A47;
- The existing footbridge bridge should be retained or replaced with a new one;
- Impact on key cycle path and walking route;
- Environmental impact on vegetation and wildlife.

10.9.3 Various options for the reconnection of Cantley Lane South including Cringleford Parish Council's proposal (referred to as Cantley Lane Option 7) were developed to address the above concerns. These options are described in Section 11.

10.10 Next Steps

10.10.1 Any announcement on the scheme Preferred Route should clearly state that the design of the Cantley Lane link will be refined and finalised in the next stage of the scheme development and the public will have the opportunity to comment on this at the next consultation.

10.10.2 As the preliminary design of the junction improvements are developed, the traffic and economic benefits of the proposals should be continually assessed to confirm the viability of the scheme against Highways England's objectives.

10.10.3 The environmental impacts of the proposals should be fully assessed at the next stage of the scheme development and the findings of this and details of required environmental mitigation should be presented at the next consultation.

10.10.4 Further assessment of the required provision for non-motorised users shall be undertaken at the junction and surrounding area to ensure that adequate and appropriate facilities are provided. Again the details of this assessment and any proposals for new and improved NMU facilities should be presented at the next consultation.

11 Options to Compensate for the Severance of Cantley Lane South

11.1 Introduction

11.1.1 Public Information Exhibitions were undertaken on 25th, 27th and 28th March 2017 to inform the public of the proposed Single Option and gather feedback to identify issues prior to a final decision on the Preferred Route Announcement.

11.1.2 Following negative feedback from members of the public relating to the proposed reconnection of Cantley Lane South to Cantley Lane, this section considers and gives recommendations with regards to potential options which could be provided to compensate for the severance of Cantley Lane South.

11.2 Feedback Examples from the Public Information Exhibitions

11.2.1 Many of the concerns from the public that arose during the PIEs, and the follow-up meetings, were associated with the proposal for the local road link to reconnect Cantley Lane South to Cantley Lane. These varied depending on the impacts that would be experienced by the affected parties, and some examples of these concerns - which are not exhaustive - are as follows:

- Since the A11 Station Lane Junction was converted from an 'at-grade' full movement junction to a 'left-in, left-out' junction, there has been an increase in traffic which now uses Cantley Lane South for their return trip from the recycling centre at Station Lane;
- The reconnection of Cantley Lane South to Cantley Lane would increase traffic 'Rat Running' to the A11 via Station Lane. Cantley Lane (north), which is currently a gated 'no through route' is considered by many to be too narrow, and that parked cars often make it difficult for buses to pass;
- There would be environmental impacts on trees and wildlife along the existing Cantley Lane (north);
- There was strong opposition to the development West of Cringleford, which was won on appeal. Some suggested that connection of the development to Cantley Lane (north) was excluded from the detailed proposals;
- The proposed local road link crosses the amenity land / LPZ adjacent to the new development;
- A number of people claimed to use the existing footbridge;
- One resident on Cantley Lane (north), who operates a business at Station Lane (north side of the A11) was surprised that Cantley Lane South was being reconnected to Cantley Lane. He claimed that when the Station Lane Junction was converted to 'left-in, left-out', he had been told to detour via Wymondham when entering his premises;
- A number of people suggested that an underpass at Station Lane should be provided instead of the proposed reconnection of Cantley Lane South to Cantley Lane. This would re-introduce a right hand turn onto the A11 to Thickthorn Junction, for people using the recycling centre;

- The owner of the corner of land between Cantley Lane South, the A47, and the Breckland Railway Line (Plot 52A on the originally proposed Single Option land plans with the originally proposed local road link), complained that the proposed link caused severe severance to his land; and

- Owners of a property on Cantley Lane South, who wish to move, claim that the sale of their house has fallen through as a result of the proposed scheme.

11.2.2 As a consequence of this and other similar feedback, it became necessary to consider further options to compensate for the reduced connectivity of Cantley Lane South to the main highway network, which was caused by the originally proposed Single Option.

11.2.3 A total of six options developed by AECOM and one suggested by a member of the public have been assessed.

11.3 Options 1 and 2 – Connection of Cantley Lane South to Round House Roundabout via an Overbridge across the A47

Background

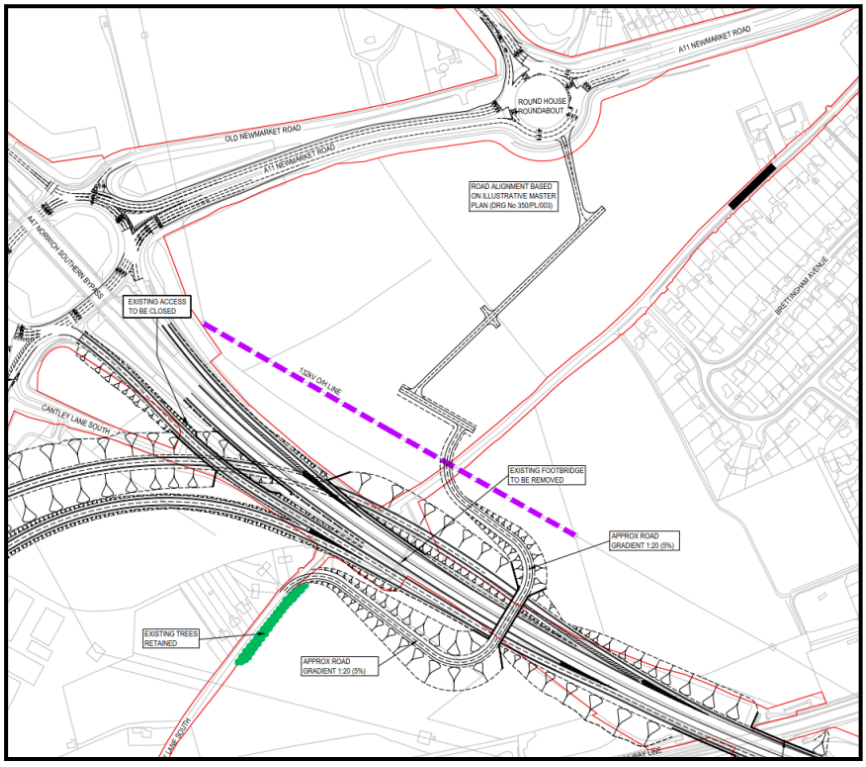
11.3.1 The owners of the property on Cantley Lane South, who claim to be having difficulty selling their property, asked for the following issues relating to the proposed local road link to be given consideration.

- Whether Cantley Lane underpass could be replaced with an overbridge;
- Whether a Cantley Lane overbridge could pass south-east of the trees in front of their properties, and thus cross the A47 closer to the site of the existing footbridge.

11.3.2 In order to investigate these proposals, Options 1 and 2 were developed.

Option 1 – Connection of Cantley Lane South to Round House Roundabout via an Overbridge across the A47

Figure 11-2 Option 1 – Connection of Cantley Lane South to Round House Roundabout via an Overbridge across the A47



Engineering Assessment

Highway Alignment

11.3.3 The alignment of Option 1 follows the A47 southern boundary as closely as possible in order to reduce severance of the land between Cantley Lane South, the A47, and the Breckland Railway Line.

11.3.4 The preliminary layout of Option 1 is shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01062, included in Appendix N. This drawing is for illustrative purposes only, and is subject to design development.

11.3.5 The presence of the overhead high voltage cables was the main constraint to the alignment to the north of the A47.

11.3.6 The local road link is then routed through the development West of Cringleford, via the estate roads, before connecting to Round House Roundabout. The indicative route through the development is based on Developer Layout Drg. No. 350/PL/003, which may be subject to change. This route avoids the need to route vehicles along Cantley Lane (north), which was a common cause of concern for many respondents.

11.3.7 Subject to agreement with Norfolk County Council, it is proposed that MfS1 and 2 are the appropriate standards for the design of this link for the following reasons:

- The high number of constraints that exist make it unfeasible to provide a geometrical alignment in accordance with the DMRB;
- It is commensurate with the standard of the existing Cantley Lane South, which has very tight bends, with the smallest approximately 20m in radius;
- It uses geometrical parameters and stopping sight distances which are designed to ensure that traffic does not exceed the speed limit, thereby reducing the need for speed enforcement; and
- Traffic using the link will be conditioned to the lower traffic speeds commensurate with the new development.

11.3.8 In order for the geometrical alignment to fit within the existing constraints, a 50kph design speed is needed. A 30mph speed limit would be required, which is subject to agreement with Norfolk County Council and the Police.

11.3.9 The resulting alignment, shown in Figure 11-2, requires bends with 44m inner radii, which is in accordance with MfS2 Table 8.1 for a 50kph design speed.

11.3.10 However, the originally proposed design for the link adopted a 60kph design speed, and used bends with 64m inner radius. This is better practice considering the semi-rural location, since it makes some allowance for vehicles travelling at higher speeds, as recommended by MfS2 para. 8.2.2.

11.3.11 The alignment has been designed such that the gradient of the bridge approaches is 1 in 20 (5%), which is desirable for pedestrians in accordance with MfS2 para. 8.4.1.

11.3.12 Whilst the alignment meets the requirements of MfS2 for a 50kph design speed, the lack of flexibility for faster vehicles is a cause of concern, particularly in view of the steep approach gradients and the close proximity of overhead high voltage cables on the northern side of the A47.

11.3.13 Owing to the high embankments, up to approximately 7m, this option increases the footprint of the scheme compared to the originally proposed alignment.

11.3.14 The location of the overbridge is approximately 140m east of the existing footbridge, which is only 60m closer than the underpass for the originally proposed option.

11.3.15 Earthworks associated with this option are designed to a 1 in 2.5 side slope.

Structures

11.3.16 The overbridge will span 68m across the A47 mainline and bi-directional interchange links. The structure will accommodate 2no. 3m traffic lanes, a 4.5m wide raised west verge and 2.5m wide raised east verge. The widened verge is needed to accommodate a combined NMU route and the visibility envelope for the stopping sight distance for the approach radii. The overall width of the structure would therefore be 13m excluding the parapet upstands, and may require being wider if the lane widths need to be increased following a swept path analysis.

11.3.17 The structure could be divided into three spans, with two abutments and two piers, one each side of the A47 main trunk road. This arrangement would result in indicative span lengths of 18m, 25m and 25m from south to north span, respectively.

11.3.18 Assuming that prestressed beams are used, which would match the existing adjacent structures, the required structural depth would be approximately 1.5m. It is therefore estimated that a finished road level approximately 7m above existing would be needed, which allows for the minimum headroom of 5.35m plus sag curve compensation as set out in TD27/05.

11.3.19 The bridge and its high approach embankments would therefore have a far greater visual impact compared to the existing 1.8m wide slender arch footbridge, which varies in depth from 2m at the bank seats to 0.65m at mid-span.

11.3.20 Piled foundations are likely to be required due to differential settlements and the high embankment approaches. The embankments may need to be constructed first or the ground preloaded to minimise post-construction settlements of the abutments.

11.3.21 Positioning the abutments away from the A47 main trunk road and adding an additional span each side of the main road would result in more economical bank seat type abutments and minimal retained heights. However, this is unlikely to be feasible owing to the constraints to the horizontal alignment of the road on the approaches to the bridge.

Drainage

11.3.22 It is assumed that there is existing highway drainage within the A11 Newmarket Road / Round House Roundabout to which the link road north of Cantley Lane could connect. It is likely that this would require additional piped attenuation before discharging to the drainage system. The section of link road south of Cantley Lane, and the whole of the section west of the A47 is proposed to drain via soakaways adjacent to Cantley Stream / Breckland Railway Line. The new alignment would also require realignment of the access road to the balancing pond in the same location, as for the originally proposed Single Option.

Geotechnical

11.3.23 There could be differential settlement between the proposed abutment and the embankments on the approaches to the overbridge.

Traffic

11.3.24 Reconnection of Cantley Lane South to Round House Roundabout could increase the traffic by encouraging ‘rat running’ to the A11 via Station Lane.

11.3.25 This option would result in additional trips through the development West of Cringleford by vehicles returning from the Station Lane recycling centre.

11.3.26 The access distance from Cantley Lane South to Thickthorn Junction would be extended by up to approximately 1.1km, compared to the current route. This is shorter than for the original Single Option for which the additional distance of the trip was 2.2km.

Environment

11.3.27 Cantley Lane South in this option is much closer to the residential properties than in the originally proposed scheme, so more adverse air quality impact is likely.

11.3.28 With regards to cultural heritage, there is potential for greater adverse effects on the setting of listed buildings from the overbridge.

11.3.29 Introduction of an overbridge structure and associated embankments will result in greater landscape and visual effects compared with the originally proposed scheme.

11.3.30 There is potential for greater propagation of traffic noise from Cantley Lane South due to overbridge and traffic being much closer to the residential properties than the originally proposed scheme.

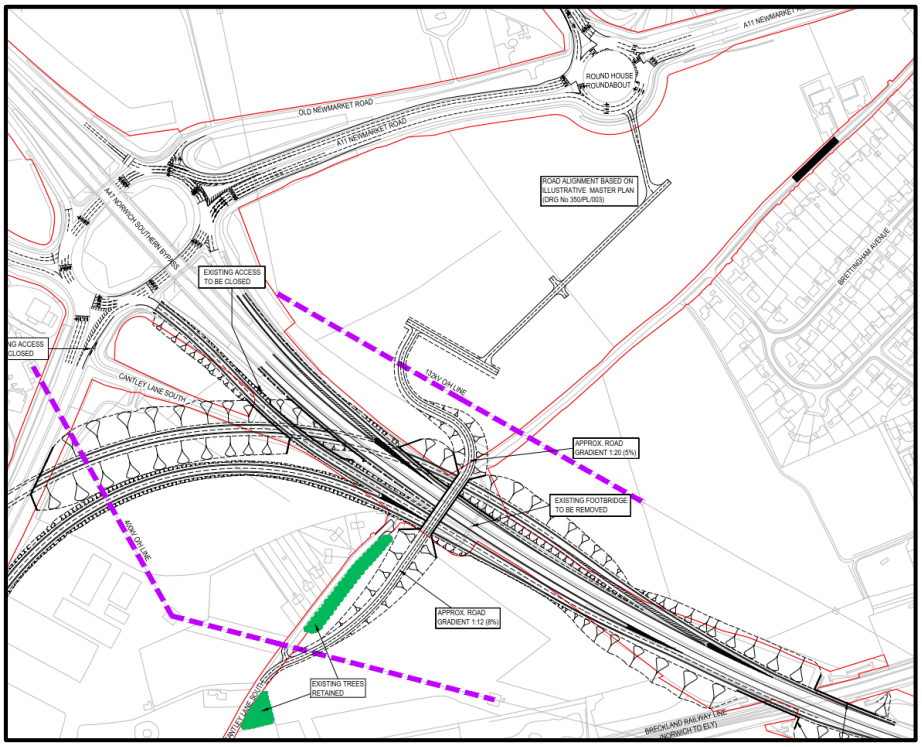
Recommendations

11.3.31 Option 1 is not recommended for the following main reasons:

- The overbridge would not be much closer to the location of the existing footbridge than the originally proposed location of the underbridge, so the NMU route would not be much shorter than the originally proposed NMU route;
- The overbridge, and its high approach embankments, would be far more visually intrusive to the residents of Cantley Lane South than the originally proposed underbridge;
- There are highway safety concerns with regards to providing a highway alignment with tight bends and steep gradients so close to live elevated high voltage electricity cables to the north of the A47.
- There is potential for greater propagation of traffic noise from Cantley Lane South due to the overbridge and traffic being much closer to the residential properties than the originally proposed scheme; and
- The option will result in local trips through the development West of Cringleford by vehicles returning from the recycling centre, and a potential increase in traffic through the development and along Cantley Lane South due to ‘rat running’ to the A11 via Station Lane.

Option 2 – Connection of Cantley Lane South to Round House Roundabout via an Overbridge across the A47

Figure 11-2 Option 2 – Connection of Cantley Lane South to Round House Roundabout via Overbridge across the A47



Engineering Assessment

Highway Alignment

11.3.32 Option 2 was also developed in response to the request to investigate the feasibility of providing the link from Cantley Lane South via an overbridge closer to the location of the existing footbridge as detailed in para. 11.3.1.

11.3.33 The preliminary layout of Option 2 is shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01063, included in Appendix N. This drawing is for illustrative purposes only, and is subject to design development.

11.3.34 The horizontal alignment of Option 2 to the south of the A47 passes through an existing thinning in the vegetation adjacent to Cantley Lane South, beneath the overhead high voltage electricity cables, and is therefore screened to some extent from the properties along Cantley Lane South by an established row of mature trees and shrubs.

11.3.35 The alignment, which is close to the tree screen, minimises the severance to the land between Cantley Lane South, the A47, and the Breckland Railway Line.

11.3.36 As for Option 1, the main constraint to the alignment to the north of the A47 is the presence of the overhead high voltage cables.

11.3.37 The local link road is then routed through the West of Cringleford development land via the estate roads before connecting with Round House Roundabout. This indicative route is based on Developer Layout Drg. No. 350/PL/003, which may be subject to change. This route

avoids the need to route vehicles along Cantley Lane (north), which was a common cause of concern for many respondents.

11.3.38 Subject to agreement with Norfolk County Council, for the reasons explained in para. 11.3.6, it is proposed that MfS1 and 2 are the appropriate standards for the design of this link.

11.3.39 In order for the geometrical alignment to fit within the existing constraints, a 50kph design speed is needed. A 30mph speed limit would be required, which is subject to agreement with Norfolk County Council and the Police.

11.3.40 The resulting alignment, shown in Figure 11-2, requires bends with 44m inner radii in accordance with MfS2 Table 8.1 for a 50kph design speed.

11.3.41 However, the originally proposed design for the link adopted a 60kph design speed, and used bends with 64m inner radii. This is better practice considering the semi-rural location, since it makes some allowance for vehicles travelling at higher speeds, as recommended by MfS2 para. 8.2.2.

11.3.42 The vertical alignment to the south of the A47 is constrained by the overhead power cables, resulting in a gradient of 1 in 12 (8%), which is considered a maximum gradient for wheelchair users - but not desirable / recommended – in accordance with MfS2 para 8.4.2.

11.3.43 The alignment north of the A47 has been designed such that the gradient of the bridge approach is 1 in 20 (5%), which is desirable for pedestrians in accordance with MfS2, para. 8.4.1.

11.3.44 Whilst the alignment meets the requirements of MfS2 for a 50kph design speed, the lack of flexibility for faster vehicles is a cause of concern, particularly in view of the steep approach gradients and the close proximity of overhead high voltage cables on the northern side of the A47.

11.3.45 Earthworks associated with this option are designed to a 1 in 2.5 side slope.

Structures

11.3.46 The overbridge for Option 2 is similar to the overbridge for Option 1.

11.3.47 As discussed in para. 11.3.16, the overall width of the structure would be 13m excluding the parapet upstands, and may require widening if the lane widths need to be increased following a swept path analysis.

11.3.48 The structure could be divided into three spans, with two abutments and two piers, one each side of the A47 main trunk road. This arrangement would result in indicative span lengths of 30m, 30m and 20m from south to north span, respectively creating a structure approximately 80m in length.

11.3.49 Assuming that prestressed beams are used, which would match the existing adjacent structures, the required structural depth would be approximately 1.8m It is therefore estimated that a finished road level approximately 7m above existing would be needed, which allows for the minimum headroom of 5.35m plus sag curve compensation as set out in TD27/05.

11.3.50 The bridge and its high approach embankments, which are closer to the properties on Cantley Lane South than the existing footbridge, would have a much greater visual impact than the existing 1.8m wide slender arch footbridge, which varies in depth from 2m at the bank seats to 0.65m at mid-span.

11.3.51 Piled foundations are likely to be required due to differential settlements and the high embankment approaches.

Drainage

11.3.52 As with Option 1, it is assumed that there is existing highway drainage within the A11 Newmarket Road / Round House Roundabout to which the link road north of Cantley Lane could connect. It is likely that this would require additional piped attenuation before discharging to this drainage system. The section of link road south of Cantley Lane, and the whole of the section west of the A47 is proposed to drain via soakaways adjacent to Cantley Stream / Breckland Railway Line. The new alignment would also require realignment of the access road to the balancing pond in the same location, as proposed for the Single Option.

Geotechnical

11.3.53 There could be differential settlement between the proposed abutment and the embankments on the approaches to the overbridge.

Traffic

11.3.54 The proposed link in Option 2 takes traffic from Cantley Lane South to Round House Roundabout via the West of Cringleford development land. It could encourage 'rat running' to the A11 via Station Lane.

11.3.55 This option would result in additional trips through the development West of Cringleford by vehicles returning from the Station Lane recycling centre.

11.3.56 The access distance from Cantley Lane South to Thickthorn Junction would be extended by up to approximately 1.3km, compared to the current route. This is shorter than for the original Single Option for which the additional distance of the trip was 2.2km.

Environment

11.3.57 For this option, Cantley Lane South is much closer to the residential properties than in the originally proposed scheme, so more traffic noise and adverse air quality impact is likely.

11.3.58 The introduction of the proposed overbridge structure and associated embankments would result in greater landscape and visual effects compared with the originally proposed scheme.

Recommendations

11.3.59 Option 2 is not recommended for the following main reasons:

- The overbridge, and its high approach embankments, would be far more visually intrusive to the residents of Cantley Lane South than the originally proposed underbridge;
- The steep approach gradient on the southern side of the A47 is on the limit of acceptability for mobility users, and may cause high traffic speeds;
- There are highway safety concerns with regards providing a highway alignment with tight bends and steep gradients so close to live elevated high voltage electricity cables on the northern side of the A47;
- There is potential for greater propagation of traffic noise from Cantley Lane South due to the overbridge and traffic being much closer to the residential properties than the originally proposed scheme; and
- The option will result in local trips through the development West of Cringleford by vehicles returning from the recycling centre, and a potential increase in traffic through the development and along Cantley Lane South caused by rat running' to the A11 via Station Lane.

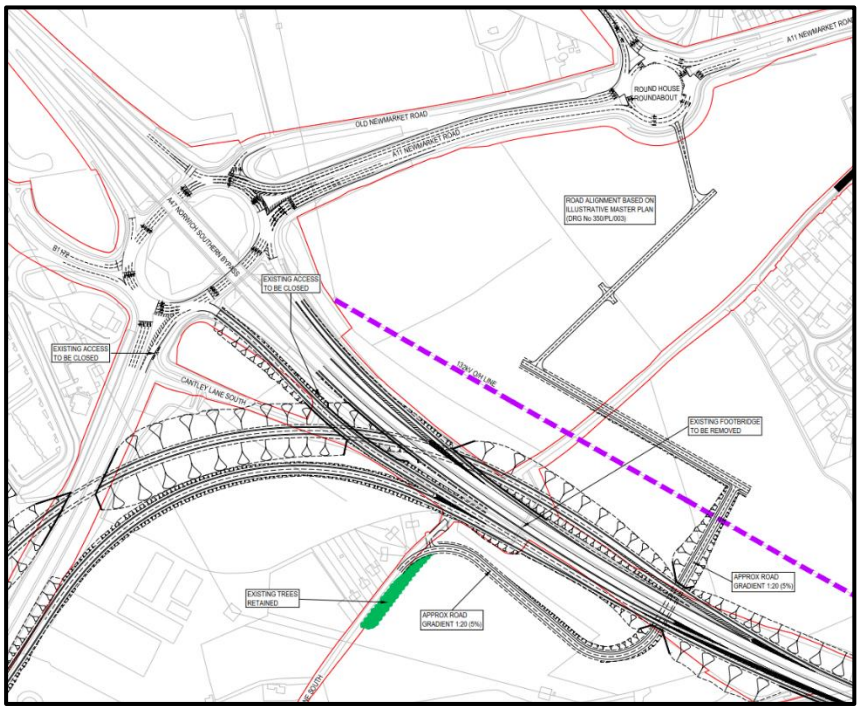
11.4 Option 3 – Connection of Cantley Lane South to Round House Roundabout via an A47 Underbridge

Background

11.4.1 Option 3 was developed in response to concerns that were raised by the owner of the corner of land between Cantley Lane South, the A47, and the Breckland Railway Line (Plot 52A on the originally proposed Single Option land plans with the originally proposed local road link), that the proposed link caused severe severance to his land.

11.4.2 The preliminary layout of Option 3 is shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01064, included in Appendix N. This drawing is for illustrative purposes only, and is subject to design development.

Figure 11-3 Option 3 – Connection of Cantley Lane South to Round House Roundabout via an A47 Underbridge



Engineering Assessment

Highway Alignment

11.4.3 Option 3 connects Cantley Lane South to Round House Roundabout beneath the A47 via an underbridge. It is similar to the originally proposed option, except that the local road to the South of the A47 has been diverted along the edge of the existing trees in order to reduce the severance of the land between Cantley Lane South, the A47, and the Breckland Railway Line.

11.4.4 The local link road is then routed through the West of Cringleford development land via the estate roads before connecting with Round House Roundabout. This indicative route is based on Developer Layout Drg. No. 350/PL/003, which may be subject to change. This route avoids the need to route vehicles along Cantley Lane (north), which was a common cause of concern for many respondents.

11.4.5 Subject to agreement with Norfolk County Council, for the reasons explained in para. 11.3.6, it is proposed that MfS1 and 2 are the appropriate standards for the design of this link.

11.4.6 As for the originally proposed option, and subject to agreement with Norfolk County Council, a 60kph design speed has been adopted, which makes some allowance for vehicles travelling at higher speeds, as recommended by MfS2, para. 8.2.2.

11.4.7 A 30mph speed limit would be required, which is subject to agreement with Norfolk County Council and the Police.

11.4.8 The resulting alignment, shown in Figure 11-3, requires bends with 64m inner radii in accordance with MfS2 Table 8.1.

11.4.9 The alignment has been designed such that the gradient of the bridge approaches is not greater than 1 in 20 (5%), which is desirable for pedestrians in accordance with MfS2 para. 8.4.1.

11.4.10 Earthworks associated with this option have been designed to a 1 in 2.5 side slope.

Structures

11.4.11 A structure is required under the A47 mainline in order to accommodate the proposed local road link reconnecting Cantley Lane South and Round House Roundabout. This structure would be similar to structure reference 23-S5 for the originally proposed Single Option. Refer to the Scheme Assessment Report ref. HE5551492-ACM-GEN-TJ-RP-ZM-00006 section 7.11 for details.

Drainage

11.4.12 As with the previous options, it is assumed that there is existing highway drainage within the A11 Newmarket Road / Round House Roundabout to which the link road north of Cantley Lane could connect. It is likely that this would require additional piped attenuation before discharging to the drainage system. The section of link road south of Cantley Lane, and the whole of the section west of the A47 is proposed to drain via soakaways adjacent to Cantley Stream / Breckland Railway Line. The new alignment would also require realignment of the access road to the balancing pond in the same location, as for the originally proposed Single Option.

Geotechnical

11.4.13 Since there are only minor modifications to the originally proposed Single Option, there are no major changes to the geotechnical information.

Traffic

11.4.14 The proposed link in Option 3 takes traffic from Cantley Lane South to Round House Roundabout via the West of Cringleford development land, and could encourage ‘rat running’ to the A11 via Station Lane.

11.4.15 This option would result in additional trips through the development West of Cringleford by vehicles returning from the Station Lane recycling centre.

11.4.16 The access distance from Cantley Lane South to Thickthorn Junction would be extended by up to approximately 1.3km, compared to the current route. This is shorter than for the original Single Option for which the additional distance of the trip was 2.2km.

Environment

11.4.17 Cantley Lane South in this option is much closer to the residential properties than in the originally proposed scheme, more adverse noise and vibration, and air quality impact is likely.

11.4.18 Landscape and visual effects are similar to the originally proposed scheme. However, alignment of the local road link is immediately in front of the properties on Cantley Lane South and will result in greater visual effects.

11.4.19 There is increased land take of primarily arable habitat (with field margins that may meet NERC Act and LBAP criteria) in comparison to the originally proposed scheme.

11.4.20 With this option, there is a potential increase in the impermeable area.

Recommendations

11.4.21 Option 3 is an option that presents several constraints, the main one is:

- The option will result in local trips through the development West of Cringleford by vehicles returning from the recycling centre, and a potential increase in traffic through the development and along Cantley Lane South due to 'rat running' to the A11 via Station Lane.

- Despite the constraints, Option 3 cannot be withdrawn at this moment until the other options have been assessed further.

11.5 Option 4 – Connection of Cantley Lane South to B1172 Norwich Road

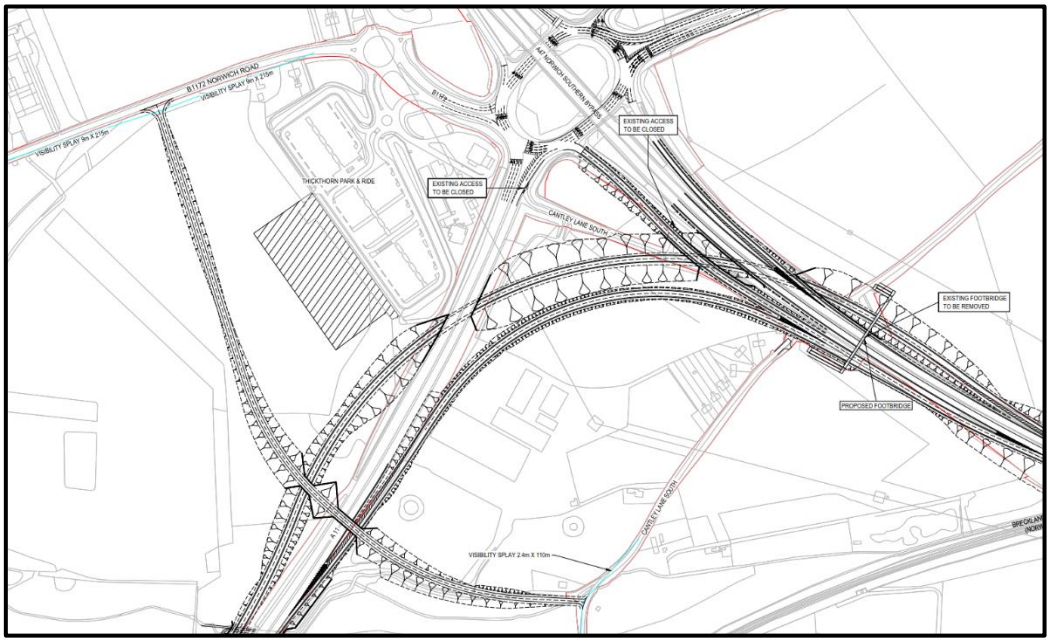
Background

11.5.1 Owing to the concerns that were raised by the public at, and following, the PIE, regarding the traffic flows along Cantley Lane (north) (following the re-connection of Cantley Lane South to Cantley Lane); the option of connecting Cantley Lane South to the B1172 Norwich Road was investigated.

11.5.2 This option is located to the north of the existing low bridge where the Breckland Railway Bridge crosses Cantley Lane South, which has headroom of 13' 6'' (4.11m).

11.5.3 This option restores access to the main highway network for the properties along Cantley Lane South, who otherwise would have their access restricted by this low bridge, when the Cantley Lane (South) links to Thickthorn Junction are removed to implement the scheme.

Figure 11-4 Option 4 – Connection of Cantley Lane South to B1172 Norwich Road



Engineering Assessment

Highway Alignment

11.5.4 Option 4 connects Cantley Lane South with the B1172 to the west of the Thickthorn Junction. The proposed link passes over the A11 mainline and the A11 south to A47 east bi-directional interchange links.

11.5.5 The preliminary layout of Option 4 is shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01065, included in Appendix N. This drawing is for illustrative purposes only, and is subject to design development.

11.5.6 There will be a replacement for the existing footbridge across the A47 between Cantley Lane South and Cantley Lane, which has to be removed to accommodate the proposed A11 south to A47 east bi-directional Interchange links.

11.5.7 The alignment of the new local road link is constrained by:

- a house adjacent to Cantley Lane South;
- a Scheduled Monument, which is the site of two tumuli (round barrows) dating back to the bronze age;
- Cantley Stream; and
- Allowing for the future expansion of the Thickthorn Park and Ride.

11.5.8 In order for the geometrical alignment to fit within the existing constraints, a 70kph design speed is needed, so a 40mph speed limit would be required, which is subject to agreement with Norfolk County Council and the Police.

11.5.9 The resulting alignment of the proposed link - as shown in Figure 11-4 - has been designed in accordance with DMRB, with bends of 360m radii, and 5% super-elevation.

11.5.10 A design speed assessment that was undertaken in accordance with TD9/93, Section 1, indicated that Cantley Lane South, has a design speed of 85kph (50mph) in the vicinity of the junction with the proposed link.

11.5.11 However, the available visibility 2.4m back from the give way line (which is a 2 step relaxation used in exceptionally difficult circumstances) from the junction along Cantley Lane South is 120m, which corresponds to a 70kph (40mph) design speed. Agreement would therefore be needed with Norfolk County Council and the Police as to whether a local 40mph speed limit, or traffic calming would be required for that part of Cantley Lane South, or whether a Departure from Standards would be needed.

11.5.12 The earthworks associated with this option are designed to a 1 in 2.5 side slope.

Structures

11.5.13 The proposed local road link crosses over:

- The A47 westbound to A11 southbound interchange link, and the A11 mainline;
- The A11 northbound to A47 westbound interchange link; and
- The space in between

11.5.14 For illustrative purposes, a possible solution could be to provide separate structures as shown on Drg. No. HE551492-ACM-SBR-TJ-DR-CB-00241 included in Appendix O. This is subject to review at PCF Stage 3.

11.5.15 The illustrative design has four independent structures:

- **Structure 04-S1** - A single span bridge to carry the road over the A47 westbound to A11 southbound interchange link, and the A11 mainline.
- **Structure 04-S2** - A reinforced concrete box structure to carry the new road over the new A11 northbound to A47 eastbound interchange link;
- **Structure 04-S3** - A reinforced concrete backfilled U-shaped trough structure circa 31m long to retain the required road embankment in the area between the single span bridge (04-S1) and the RC box structure (04-S2); and
- **Structure 04-S4** - A reinforced concrete backfilled U-shaped trough structure circa 30m long to retain the required road embankment on the northern approach to the RC box structure (04-S2).

11.5.16 An overall cross section of 13m in width is proposed for the new structures to accommodate the 6m wide new carriageway and 3m wide raised verges.

11.5.17 The road embankment at the southern end of structure 04-S1 will be approximately 8m high. Realignment of the local road (possibly a farm access) that presently crosses under Cantley Lane Underpass will be required as the proposed embankment encroaches to the existing road. The road embankment on the northern end of the structure 04-S4 is anticipated to be over 10m in height.

Single Span Bridge (04-S1)

11.5.18 The bridge will be perpendicular to the A11 main trunk, with an approximate clear square span of 48m.

11.5.19 The proposed single span bridge has a composite deck comprising steel 'I' girders and a reinforced concrete deck slab. The required structural depth is 2m approximately and therefore the proposed vertical alignment is appropriate to cater for the headroom requirements set out in TD27/05.

11.5.20 The superstructure will be integral with its abutments. It is anticipated that the abutments will be founded on bored piles to transfer the loads to a competent ground strata and to minimise the likelihood of differential settlement between supports. A skeleton abutment in sleeves supported on a single row of bored piles and a reinforced earth wall are proposed for the southern abutment to provide a sufficiently slender abutment able to accommodate the thermal movements of the deck.

Reinforced Concrete Box (04-S2)

11.5.21 The proposed RC box structure will have a total height of circa 14m and a clear square span of 15.3m to accommodate the 9.3m wide carriageway and two verges of 2.5m and 3.5m each of the A11.

Backfilled U-Shaped Troughs (04-S3 and 04-S4)

11.5.22 The proposed backfilled U-shaped trough structures will be separate from the short wing walls of the RC box structure and the single span bridge. The U-shaped structures have been selected as they are more efficient than a pair of parallel typical cantilever retaining walls of the height retained here.

Buildability

11.5.23 Due to the expected length of the span of the single span bridge (04-S1), its construction will involve bolting together the girder splices on site to form the circa 50m long girders. An area close to the structure will need to be found and made available for these operations. In addition, full road closure of the A11 will be required during placement of the girders. It is advised that these operations will be carried out at night time and during off-peak hours.

11.5.24 The southern abutment of the single span bridge will preferably be constructed prior to construction of the A47 westbound to A11 southbound interchange link. Depending on the exact location and foundation level of the northern abutment, temporary closure of lane 1 of A11 northbound carriageway might be required for the construction of the abutment and foundation.

11.5.25 The new RC box structure and the adjacent U-shaped trough structures will preferably be constructed prior to construction of the A11 northbound to A47 eastbound interchange link.

11.5.26 Surcharge on the approaches to the structures might be required prior to construction of the new structures to reduce to a manageable level any post-construction settlements.

Culvert

11.5.27 There is a potential need to divert Cantley Stream, or to possibly introduce a new skewed culvert that crosses the proposed link at the junction with Cantley Lane South.

11.5.28 For either case, a small corrugated steel culvert or similar precast construction would appear to be sufficient. It is proposed that the existing culvert is demolished.

11.5.29 Consultation with the Environment Agency is strongly recommended with regards to construction or demolition works to be undertaken on and near to water courses.

Cantley Lane NMU Bridge

11.5.30 The new A47 Cantley Lane NMU bridge will span over the main A47 trunk road and the A11 south to A11 east bi-directional interchange links. The structure will have a total length of circa 111m. For economy the structure would be a 3-span bridge with middle piers located at each side of the A47 between the main road and the interchange links. The length of the southern, middle and northern spans would be circa 30m, 37m and 44m respectively.

11.5.31 For illustrative purposes, a possible solution could be to provide a steel truss in fully welded hollow section members supporting an integral stiffened steel deck as shown on Drg. No. HE551492-ACM-SBR-TJ-DR-CB-00242 included in Appendix O. This is subject to review at PCF Stage 3.

11.5.32 Approach ramps on earth embankments, or steel structures, will be required in order to provide a suitable approach gradient for NMUs.

11.5.33 Both abutments will be founded near the top of the cuttings in the new A47 slip roads. Piled foundations might be required. An area close to the structure will need to be found and made available for assembly of the steel truss.

11.5.34 Road closures will be required during lifting and placing of the deck. Temporary realignment could be considered to divert traffic through the southern slip road during road closures of the A47 main trunk road if required.

Drainage

11.5.35 The new link requires additional construction in the flood plain, which will require flood compensation to be provided.

11.5.36 There is a potential need to divert Cantley Stream, or to possibly introduce a new skewed culvert that crosses the proposed link at the junction with Cantley Lane South. Either could result in an increased flood risk to the property on the eastern side Cantley Lane South in the location of the proposed junction. A robust drainage collection system would be required on the upstream side of this property in order to mitigate this risk.

11.5.37 River modelling would therefore be required to determine flood risk to nearby residential properties as well as hydraulic connectivity modelling of the new diversion between the upstream and downstream of the watercourse.

11.5.38 Road drainage will be collected and discharged to soakaways wherever possible, with high level connections to Cantley Stream. Additional attenuation piping might be required at the connection to Cantley Lane South, if connections cannot be made to the proposed soakaways.

11.5.39 Additional hard paved areas and severing of the natural overland flows would be introduced between the A11 and B1172.

11.5.40 However, in comparison to the originally proposed design of the Single Option, there would be a reduction in the hard paving area that needs to be attenuated from the existing A47 drainage system, as a section of the existing drainage system along the A47 is no longer severed by A47 Cantley Lane underpass bridge structure.

Geotechnical

11.5.41 The embankment of the road linking Cantley Lane South with the B1172 Norwich Road will be constructed on top of an existing access track. In parts, the proposed road will be constructed on alluvium, which may cause settlement.

11.5.42 The Cantley Lane South Historic Landfill is located to the south of the A11, which is north of the proposed embankment. The landfill boundary is shown outside the footprint of the embankment. However, should the landfill material extend outside the demarked area, and into the footprint of the proposed embankment, settlement would be anticipated.

11.5.43 Construction of the proposed NMU bridge would need abutment foundations significantly deep in order to transfer loads safely below cutting level, and lateral loads need to be carefully considered.

Traffic

11.5.44 The connection between Cantley Lane South and the B1172 provides access to Thickthorn Junction, so no traffic would be routed along Cantley Lane (north), or through the West of Cringleford development.

11.5.45 Trips that currently return along Cantley Lane South from the recycling centre would no longer pass by the main group of residencies along Cantley Lane South.

11.5.46 The access distance from Cantley Lane South to Thickthorn Junction would be extended by up to approximately 1.5km compared to the current route. This is shorter than for the original Single Option for which the additional distance of the trip was 2.2km.

Environment

11.5.47 There is one residential property located in close proximity to the proposed road, which is likely to experience adverse air quality and noise/vibration effects.

11.5.48 There is a risk of potential effects on the Grade II listed milestone on B1172, on the setting of the Grade II listed Thickthorn Hall, and the new link road is close to western barrow mound.

11.5.49 The proposed road could have a visual effect on a couple of properties further south along Cantley Lane South and the public right of way (PRoW) which follows the railway.

11.5.50 Properties at Thickthorn Hall would also experience filtered views of the road. Loss of mature specimen trees and field boundaries in the fields to the north of the A11 as well as a woodland block south of the A11. This option could result in general fragmentation of the landscape.

Recommendations

11.5.51 The feasibility of Option 4 requires further investigation and confirmation during PCF Stage 3. However, notwithstanding the careful attention that will be needed to resolve the engineering design aspects and environmental mitigation. Option 4 is seen as presenting several benefits:

- It would fully resolve public concerns raised at the PIE with regards to the impacts caused by reconnecting Cantley Lane South to Cantley Lane. For this option, no

local traffic will be generated along Cantley Lane (north), or through the development West of Cringleford;

- Access to the existing properties on Cantley Lane South will not be restricted by the low (13’ 6’) railway bridge, which would be the case if improvements were only to be made to Station Lane Junction; and

- Access to the properties on Cantley Lane South will be maintained, whereas if improvements were only made to Station Lane, residents and emergency vehicles would be subject to a long detour as discussed later in the report.

11.6 Options 5, 6, 7 – Junction Improvement to facilitate Right Turn from Station Lane (south) to A11 Northbound

Background

11.6.1 The A11 Station Lane Junction was built as an at-grade all movements junction, but has since been converted to a left-in, left out junction.

11.6.2 This has prevented traffic from Station Lane, north and south of the A11, from turning right onto the A11.

11.6.3 Feedback from the PIE indicated that traffic heading southbound on the A11 to the recycling centre at Station Lane, returned north via Cantley Lane South. This traffic would continue to use Cantley Lane after the A47 Thickthorn Junction improvements were complete, as the main alternative is a long detour via the A11 Wymondham junction.

11.6.4 There were several suggestions that a junction at Station Lane capable of providing a right turn back towards the Thickthorn Junction (from the recycling centre) would be more convenient, and would cause less disruption to the residents of Cantley Lane and Cantley Lane South.

11.6.5 This idea received a unanimous vote at the extraordinary meeting of East Carleton & Ketteringham Parish Council on 6th April 2017. A proposal from the public was tabled at this meeting for consideration by the design team (Option 7).

11.6.6 In order to investigate these proposals, Options 5 to 7 have been considered:

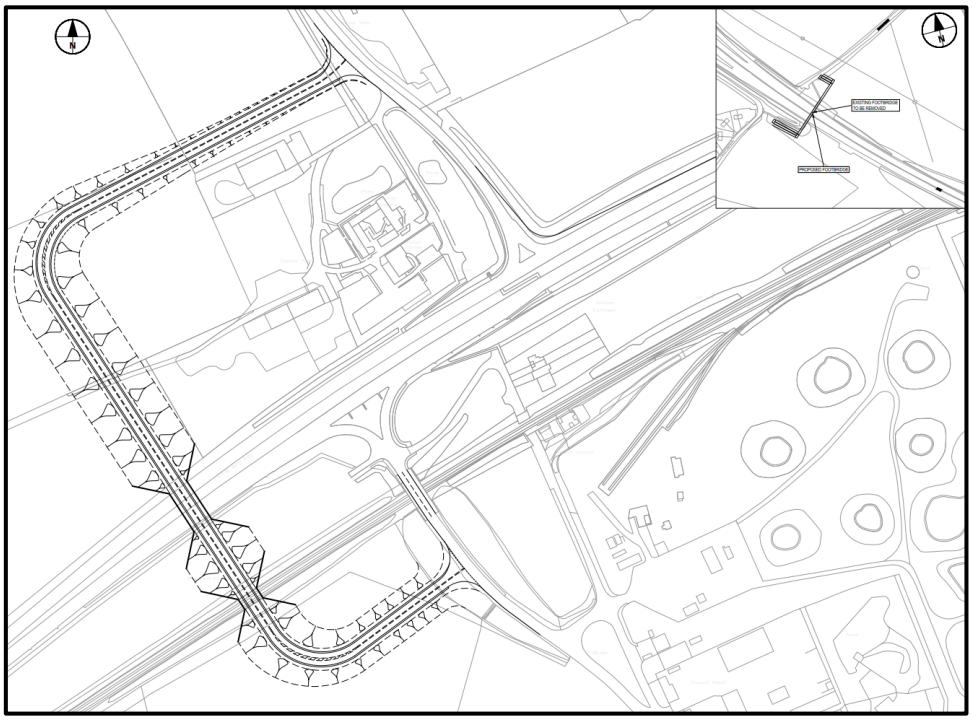
Option 5 – A11 Station Lane Compact Grade Separated Junction;

Option 6 – A11 Station Lane Roundabout;

Option 7 – A11 Underpass (as tabled at the Parish Council Meeting - refer to Appendix P)

Option 5 – A11 / Station Lane Compact Grade Separated Junction

Figure 11-5 Option 5 – A11 / Station Lane Compact Grade Separated Junction



Engineering Assessment

Highway Alignment

11.6.7 As shown in Figure 11-5, Option 5 is a compact grade separated junction, which is created by providing a link between Station Lane north and south, which crosses the Breckland Railway Line, and the A11 mainline. This junction provides full turning movements.

11.6.8 The preliminary layout of Option 5 is shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01070, included in Appendix N. This drawing is for illustrative purposes only, and is subject to design development.

11.6.9 There will be a replacement for the existing footbridge across the A47 between Cantley Lane South and Cantley Lane, which has to be removed to accommodate the proposed A11 south to A47 east bi-directional interchange links.

11.6.10 The design of the junction is in accordance with the DMRB, TD 40/94. The cross section of the carriageway is generally 9.9m, which includes two 3.65m running lanes separated by 0.6m central hatch markings, and two 1m hard strips. The verges are 2.5m wide, so the total width of the cross section is 14.9m. The cross section widens at the bends to allow for the vehicle swept path in accordance with TD 40/94 Table 6/3.

11.6.11 The existing Station Lane (north) is gated to the north to restrict access. A nearside A11 merging taper has therefore been introduced owing to the increased use of this A11 entry arising by traffic that can now turn right onto the A11 from Station Lane (south). The effect of this taper will be to further reduce the weaving length between Station Lane and the proposed A11 northbound to A47 eastbound bi-directional interchange link from 750m to 600m. This is a Departure from Standards, since TD 22/06 Para 4.38 requires that the desirable minimum

weaving length between a grade-separated junction and an at-grade junction for Rural All-Purpose Roads must be 1km.

11.6.12 Earthworks associated with this option have been designed to a 1 in 2.5 side slope.

Public Highways and Drainage

11.6.13 No information is currently available to indicate the extent of public highway (whether Highways England or the local Highway Authority), or the existence / location of any highway drainage or available watercourses to which the proposed roads could be connected to. The effect of this option on both private land and existing drainage has not therefore been considered.

Structures

11.6.14 Both overbridges (one spanning over the A11 and one spanning over the Breckland Railway Line) are roughly square to the abutments.

11.6.15 Provision of high embankments as included in the proposal (circa 8m high) may cause settlements in the area. The embankments may need to be constructed first or preloaded to minimise post-construction settlements. The abutments will most likely require piled foundation due to the high approach embankments. The piers would also be piled to minimise differential settlements.

11.6.16 Lightweight approach embankments or additional approach spans at both ends of the rail bridge might need consideration at latter stages of the scheme development if there is a risk of settlement to the railway. Additional works over the railway will introduce significant additional cost and impact on the programme, as well as introduce further stakeholder consultation requirements.

11.6.17 The northern Station Lane Overbridge would comprise 2 spans over the A11 with a total length of about 35 metres (circa 17.5m each). The central pier could be located within the A11 main trunk central reserve that appears to have enough width (circa 6m) at this location to accommodate the pier and an appropriate restraint system, including the required working width. Although a Departure from Standard seems not to be required this must be confirmed at a later stage. The pier would need to be of suitable design for pier impact.

11.6.18 The southern Station Lane Overbridge would comprise of a single span over the railway with an anticipated length of 15-20 metres.

11.6.19 A prestressed beam deck would be preferred in both cases in order to minimise the need for traffic closures on the A11 and railway possessions. Disruptions would be limited to erection operations, which should be programmed at night time and during off-peak hours.

11.6.20 The replacement Cantley Lane NMU bridge will be as discussed for Option 4. Refer to paras. 11.5.30 to 11.5.34.

Geotechnical

11.6.21 Construction of the proposed NMU bridge would need abutment foundations significantly deep in order to transfer loads safely below cutting level, and lateral loads need to be carefully considered.

11.6.22 There could be differential settlement between the proposed abutment and the embankments on the approaches to the Station Lane junction overbridges. Lightweight approach embankments or additional approach spans to the railway bridge may be required if there is a risk of settlement to the railway.

Traffic

11.6.23 A full movement junction for Station Lane would enable traffic returning from the recycling centre to use the A11, so traffic would only use Cantley Lane South for local access. This would eliminate the concerns relating to 'rat running' associated with the originally proposed Single Option.

11.6.24 Since Cantley Lane South and Cantley Lane will not be reconnected, no traffic would be routed along Cantley Lane (north) or through the West of Cringleford Development land as was the case with the originally proposed Single Option.

11.6.25 However, access to Cantley Lane South would only be available via a 13' 6'' height restricted bridge. This potentially restricts access not only for residents but also for deliveries, farmers and their equipment, movement of products and animals, etc.

11.6.26 Furthermore, the access distance from Cantley Lane South to Thickthorn Junction would be extended by up to approximately 5.2km, compared to the current route. This is much longer than for the original Single Option for which the additional distance of the trip was 2.2km.

Emergency Services

11.6.27 The 5.2km increase in the distance to the main group of properties on Cantley Lane South would increase the response times for the emergency services. Approximately 2.4km of the route would be along rural two-way single lane carriageway roads with limited passing places.

Environment

11.6.28 There are potential adverse effects on the Grade II listed buildings and on the two scheduled round barrow monuments at the junction between Cantley Lane South and Station Lane from construction traffic.

11.6.29 There is likely to be adverse landscape and visual effects because of the two new overbridges and associated embankments within the local landscape. This option removes visual effects associated with the originally proposed single option on the properties on Cantley Lane South and Cringleford.

11.6.30 The ponds to the south of the A11 have potential for Great Crested Newts (GCN) and habitats have potential for badgers, reptiles, nesting birds, bats (roosting and foraging and commuting).

Recommendations

11.6.31 Option 5 is not recommended for the following main reasons:

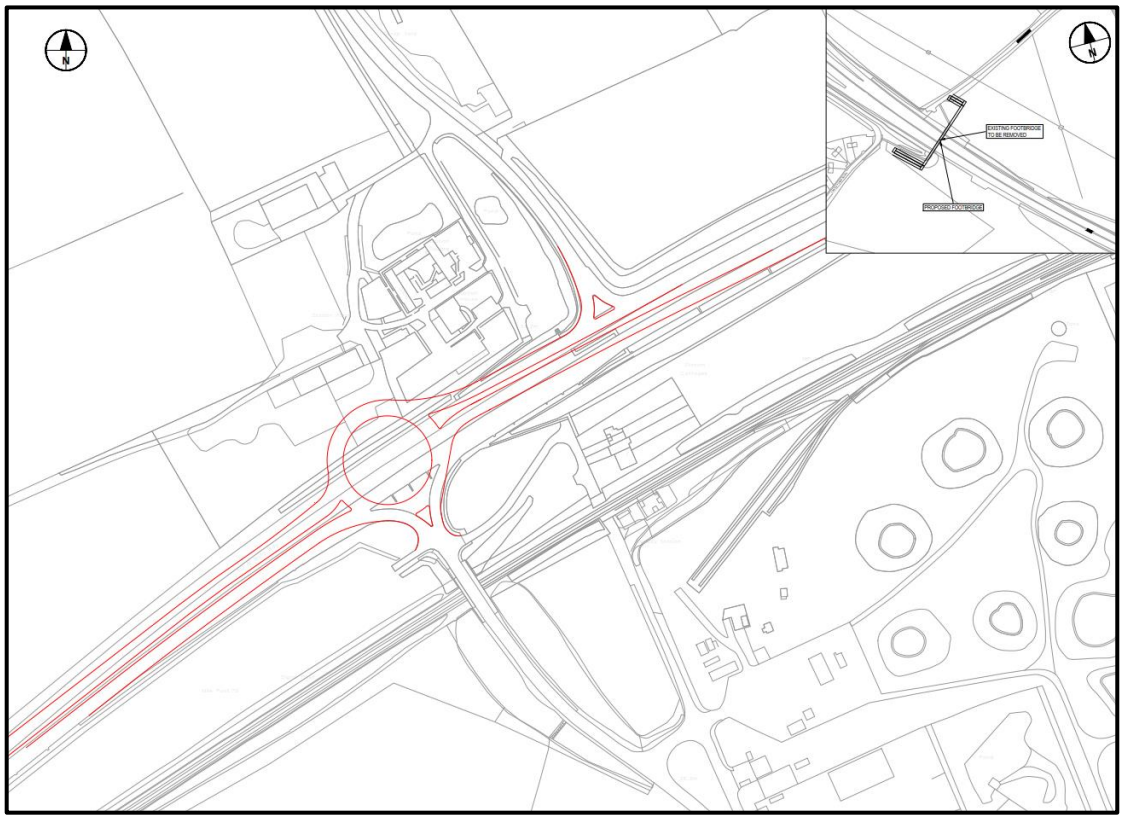
- The properties on Cantley Lane South will have to make a large detour of up to an additional 5.2km compared to the existing situation when travelling to Thickthorn Junction;
- The long detour to the main group of properties on Cantley Lane South, which includes approximately 2.4km of rural two-way single lane carriageway roads with limited passing places, would adversely affect emergency services response times;
- Access to the properties on Cantley Lane South will be restricted by the low railway bridge, which has a 13' 6'' headroom, which would restrict access not only for residents but also for deliveries, farmers and their equipment, movement of products and animals, etc.;

- There is likely to be adverse landscape and visual effects because of the two new overbridges and associated embankments within the local landscape; and

- There is a high cost associated with providing bridges over the railway, the A11 main line and an NMU bridge to reconnect Cantley Lane South to Cantley Lane. This may cause the scheme to become unaffordable as well as adversely impacting the economic case.

Option 6 – A11 / Station Lane Roundabout

Figure 11-6 Option 6 – A11 / Station Lane Roundabout



Engineering Assessment

Highway Alignment

11.6.32 As shown in Figure 11-6, Option 6 is an 'at grade' roundabout, which provides full turning movements between Station Lane (south) and the A11. This will enable traffic returning from the recycling centre to turn right onto the A11 towards Thickthorn Junction. The Station Lane (north) junction remains left-in, left out.

11.6.33 The preliminary layout of Option 6 is shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01071, included in Appendix N. This drawing is for illustrative purposes only, and is subject to design development.

11.6.34 The new roundabout entry for Station Lane (south) is constrained by the existing access to Station Cottages and the existing railway bridge.

11.6.35 The roundabout has a 75m inscribed circle diameter (ICD), and entry path deflection would be provided by realigning the A11 entries into the existing widened central reserve.

11.6.36 There will be a replacement for the existing footbridge across the A47 between Cantley Lane South and Cantley Lane, which has to be removed to accommodate the proposed A11 south to A47 east bi-directional interchange links.

Public Highways and Drainage

11.6.37 No information is currently available to indicate the extent of public highway (whether Highways England or the local Highway Authority), or the existence / location of any highway drainage or available watercourses to which the proposed roads could be connected to. The effect of this option on both private land and existing drainage has not therefore been considered.

Structures

11.6.38 The Cantley Lane NMU bridge will be as discussed for Option 4. Refer to paras. 11.5.30 to 11.5.34.

Geotechnical

11.6.39 Construction of the proposed NMU bridge would need abutment foundations significantly deep in order to transfer loads safely below cutting level, and lateral loads need to be carefully considered.

Traffic

11.6.40 The roundabout will enable traffic returning from the recycling centre to turn right from Station Lane (south) to the A11 towards Thickthorn Junction, so traffic would only use Cantley Lane South for local access. This would eliminate the concerns relating to 'rat running' along Cantley Lane South associated with the originally proposed Single Option.

11.6.41 Since Cantley Lane South and Cantley Lane will not be reconnected, no traffic would be routed along Cantley lane (north) or through the West of Cringleford Development land as was the case with the originally proposed Single Option.

11.6.42 Access to properties on Station Lane (south) would be improved, including the recycling centre, which was identified as being an issue of importance to local people during the PIE.

11.6.43 However, introduction of a roundabout on a currently free flowing section of the A11 would introduce delays, and could potentially increase queuing and increased numbers of accidents. Considering the current high level of demand, this could result in cumulative negative economic benefits.

11.6.44 Access to Cantley Lane South would only be available via a 13' 6'' height restricted bridge. This potentially restricts access not only for residents but also for deliveries, farmers and their equipment, movement of products and animals, etc.

11.6.45 The access distance from Cantley Lane South to Thickthorn Junction would be extended by up to approximately 4.7km, compared to the current route. This is much longer than for the original Single Option for which the additional distance of the trip was 2.2km.

11.6.46 Further traffic and economic assessment is required to quantify this impact, and to test the operational performance of the roundabout, for example by developing an ARCADY model.

11.6.47 The speed limit on the A11 may need to be reduced.

Emergency Services

11.6.48 The 4.7km increase in the distance to the main group of properties on Cantley Lane South would increase the response times for the emergency services. Approximately 2.4km of the route would be along rural two-way single lane carriageway roads with limited passing places.

Environment

11.6.49 As this option removes the extra traffic along Cantley Lane and Cantley Lane South, there is a potential benefit to the air quality for residential properties along Cantley Lane (north) and South compared to the originally proposed Single Option.

11.6.50 There is risk of potential effects on the Grade II listed buildings between Cantley Lane and Station Lane from construction traffic.

11.6.51 Landscape and visual effects on the properties on Cantley lane South and Cringleford, caused by the reconnection of Cantley Lane South to Cantley Lane, will be removed.

11.6.52 Ponds to the south of the A11 have the potential for GCN. Habitats have the potential for badgers, reptiles, nesting birds, bats (roosting and foraging and commuting).

11.6.53 One planning application, with the planning ID 2015/1059 (Reserved matters application following outline planning permission 2011/1804/O for road layout) is within close proximity to the scheme option.

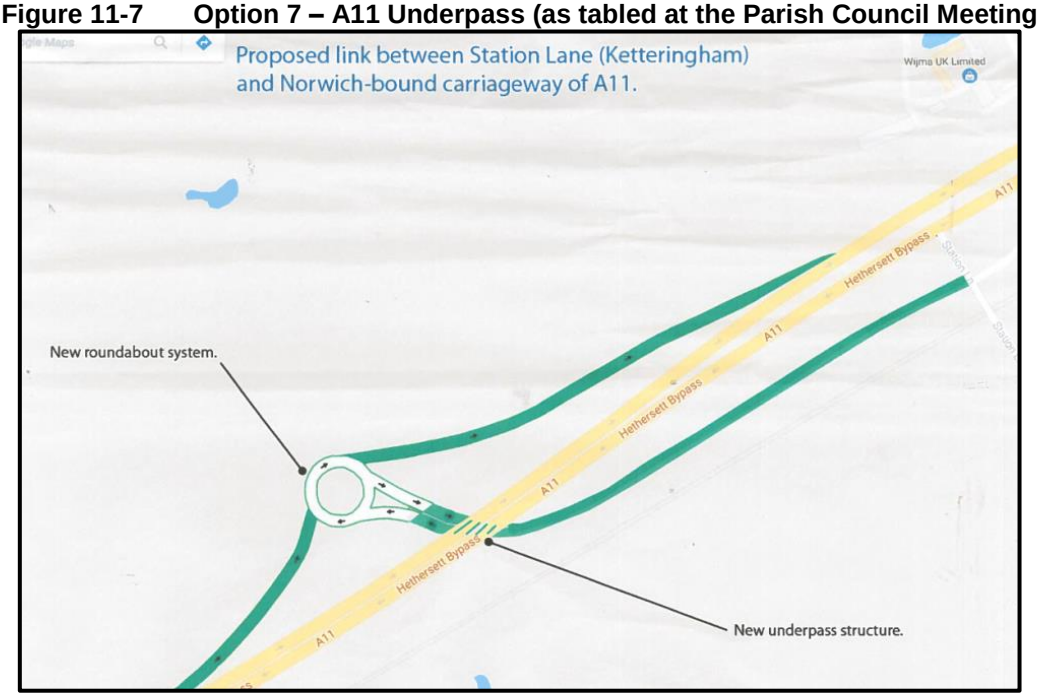
Recommendations

11.6.54 Option 6 is not recommended for the following main reasons:

- The properties on Cantley Lane South will have to make a large detour of an additional 4.7km compared to the existing situation when travelling to Thickthorn Junction;
- The long detour to the main group of properties on Cantley Lane South, which includes approximately 2.4km of rural two-way single lane carriageway roads with limited passing places, would adversely affect emergency services response times;
- Access to the properties on Cantley Lane South will be restricted by the low railway bridge, which has a 13’ 6’’ headroom, which would restrict access not only for residents but also for deliveries, farmers and their equipment, movement of products and animals, etc;
- The introduction of a roundabout on a free flowing section of the A11 is likely to cause delays, and may increase the number of accidents, which could introduce cumulative economic disbenefits.

Option 7 – A11 Underpass (as tabled at the Parish Council Meeting)

Figure 11-7 Option 7 – A11 Underpass (as tabled at the Parish Council Meeting



Engineering Assessment

Highway Alignment

11.6.55 Option 7 was proposed by a member of the public at the extraordinary meeting of East Carleton & Ketteringham Parish Council on 6th April 2017, the sketch being reproduced as Figure 11-7. For more detail refer to Appendix P.

11.6.56 A new 3 arm roundabout is proposed to the north of the A11, which connects to the proposed A11 northbound off-slip, and A11 northbound on-slip. This roundabout is located approximately 350m to the west of Station Lane (south).

11.6.57 The roundabout connects to Station Lane (south) via a two-way link, which passes beneath the A11 mainline.

11.6.58 The existing A11 southbound off-slip and on-slip for Station Lane (south) remain unchanged.

11.6.59 There are several problems with the proposed junction with Station Lane (south) relating to highway safety:

- Vehicles approaching from the left will be exiting the A11 mainline southbound carriageway, which has a design speed of 120kph. The visibility from the junction to the left should therefore be 295m, and in order to provide this, a large area of land would need to be acquired and maintained, and a significant area of trees and dense vegetation would need to be cleared.

- The visibility from the junction to the right is restricted by the existing concrete parapet for the railway bridge. The available visibility 2.4m back from the give way line (which is a 2 step relaxation used in exceptionally difficult circumstances) will be approximately 22m. Even if the speed limit on Station Lane (south), which is currently unrestricted, were to be reduced to 30mph, the required visibility to the right would be 70m, and the available visibility would still be highly substandard by

comparison. Any speed limit would require agreement with Norfolk County Council and the Police.

- The access to the Station Cottages is directly opposite the proposed junction, which is less safe than the preferred right/ left stagger arrangement.

11.6.60 The Station Lane (north) junction, which is unchanged by the proposal, remains left-in, left out.

11.6.61 The weaving length between the proposed A11 Northbound On-slip and Station Lane (south) is approximately 275m. This is a Departure from Standards which is unlikely to be accepted, since TD 22/06 Para 4.38 requires that the desirable minimum weaving length between a grade separated junction and an at-grade junction for Rural All-Purpose Roads must be 1km.

11.6.62 The new two-way link road between the proposed roundabout and Station Lane (south) is unusual since, whilst it is part of the proposed junction, it functions more as a local link road. Since it is part of the junction with the A11, it would need to be designed in accordance with the DMRB junction standards, and may require a Departure from Standards. For the purposes of this assessment it has been assumed that the design speed for this link is 70kph (40mph) which is appropriate for a slip road. However, this may be subject to change, since the design rationale would need to be agreed with Highways England SES, and Norfolk County Council and the Police, if a speed limit is deemed to be required.

11.6.63 The horizontal radius of the two-way link road is shown as having an approximate radius of 50m, whereas the desirable minimum radius for a 40mph design speed is 360m with a superelevation of 5%. The DMRB does not allow relaxations in the Stopping Sight Distance (SSD) on the approach to a roundabout, so the structure would therefore need to be wide enough to provide a 120m SSD.

Structures

11.6.64 Cantley Lane Footbridge will be as discussed for Option 4. Refer to paras. 11.5.30 to 11.5.34.

11.6.65 The underpass structure required to route the proposed new road under the A11 is expected to be a similar type of structure as structure reference 23-S5 for the originally proposed Single Option. Refer to the Scheme Assessment Report ref. HE5551492-ACM-GEN-TJ-RP-ZM-00006 section 7.11 for details.

11.6.66 The radius of the two-way link has been shown to be approximately 50m on the approach to the proposed underpass, and the underpass is indicated to have a skew angle of approximately 56^{o}. This substandard radius is not permissible in accordance with the DMRB for a 70kph design speed. However, it is noted that hypothetically, for this alignment to provide a 120m SSD on the approach to the roundabout, the underbridge would need a square span of approximately 26m.

11.6.67 If the bend for the two-way link were to have a 360m desirable minimum radius for a 70kph design speed, the skew of the structure would reduce to approximately 30^{o}. The carriageway cross section would comprise a 9.3m wide carriageway and two 2.5m wide verges, resulting in a square span of 14.3m.

11.6.68 The proposed construction would be to extend the abutments so that the skew span of the deck is reduced to allow for cast in-situ reinforced concrete deck construction. Precast deck construction could be considered to accelerate construction. The resulting length of the structure is estimated to be 85m.

11.6.69 Owing to the length of the structure, it is likely that it would need to be permanently lit.

Geotechnical

11.6.70 Construction of the proposed NMU bridge would need abutment foundations significantly deep in order to transfer loads safely below cutting level, and lateral loads need to be carefully considered.

Traffic

11.6.71 The underpass will enable traffic returning from the recycling centre to turn right from Station Lane (south) to the A11 towards Thickthorn Junction, so traffic would only use Cantley Lane South for local access. This would eliminate the concerns relating to 'rat running' along Cantley Lane South associated with the originally proposed Single Option.

11.6.72 Since Cantley Lane South and Cantley Lane will not be reconnected, no traffic would be routed along Cantley lane (north) or through the West of Cringleford Development land as was the case with the originally proposed Single Option.

11.6.73 Access to properties on Station Lane (south) would be improved, including the recycling centre, which was identified as being an issue of importance to local people during the PIE.

11.6.74 However, access to Cantley Lane South would only be available via a 13' 6'' height restricted bridge. This potentially restricts access not only for residents but also for deliveries, farmers and their equipment, movement of products and animals, etc.

11.6.75 Furthermore, the access distance from Cantley Lane South to Thickthorn Junction would be extended by up to approximately 5.3km, compared to the current route. This is much longer than for the original Single Option for which the additional distance of the trip was 2.2km.

Emergency Services

11.6.76 The 5.3km increase in the distance to the main group of properties on Cantley Lane South would increase the response times for the emergency services. Approximately 2.4km of the route would be along rural two-way single lane carriageway roads with limited passing places.

Environment

11.6.77 As this option removes the extra traffic along Cantley Lane and Cantley Lane South, there is a potential benefit to the air quality for residential properties along Cantley Lane (north) and South compared to the originally proposed Single Option.

11.6.78 There is risk of potential effects on the Grade II listed buildings between Cantley Lane South and Station Lane from construction traffic.

11.6.79 Landscape and visual effects on the properties on Cantley Lane South and Cringleford, caused by the reconnection of Cantley Lane South to Cantley Lane, will be removed.

11.6.80 Ponds to the south of the A11 have the potential for GCN. Habitats have the potential for badgers, reptiles, nesting birds, bats (roosting and foraging and commuting).

11.6.81 One planning application, with the planning ID 2015/1059 (Reserved matters application following outline planning permission 2011/1804/O for road layout) is within close proximity to the scheme option.

11.6.82 There are potential dewatering issues due to the proposed underpass.

Recommendations

11.6.83 Option 7 is not recommended for the following main reasons:

- The properties on Cantley Lane South will have to make a large detour of an additional 5.3km compared to the existing situation when travelling to Thickthorn Junction;

- The long detour to the main group of properties on Cantley Lane South, which includes approximately 2.4km of rural two-way single lane carriageway roads with limited passing places, would adversely affect emergency services response times;

- Access to the properties on Cantley Lane South will be restricted by the low railway bridge, which has a 13' 6'' headroom. This would restrict access not only for residents but also for deliveries, farmers and their equipment, movement of products and animals, etc;

- There are several problems relating to the highway safety of the junction for the proposed two-way link with Station Lane (south). Traffic using the junction will have high speed traffic approaching from the left on the A11 northbound. The visibility to the right along Station Lane is severely restricted by the concrete parapets for the existing railway bridge, and furthermore, the access directly opposite for Station Cottages, does not conform to the preferred right/ left stagger arrangement.

- There are safety concerns relating to the proposed A11 Northbound on-slip owing to the short weaving length to the Station Lane (south) Junction. Vehicles accelerating on this on-slip to join the A11 main line could suddenly encounter vehicles slowing down to turn into Station Lane (north), or slow moving vehicles emerging from Station Lane (north).

- The underbridge beneath the A11 would need a much greater skew, and would therefore be much longer than is indicated in Figure 11-7, in order for the alignment of the proposed two-way link to meet the requirements of the DMRB.

11.7 Further Environmental Impacts

11.7.87 Further environmental impacts applicable to most options have been identified during the ecology surveys:

- Trail camera surveys have shown that an area close to the proposed works is well used by mammals such as deer, fox, badger and possibly polecat. Badgers are known to be present in the area of the proposed works; however no setts have been discovered. It is possible that badger setts could occur on site in the future. Additional surveys will be required at Stage 3 and mitigation measures developed.

- Water voles were recorded along the west section of stream close to the A11 crossing. It is assessed that as water voles are present on site along the stream upstream and downstream of the A11 road crossing they represent a constraint to the proposed scheme. There is likely to be direct disturbance (e.g. habitat loss) and indirect disturbance (e.g. potential changes to flow/water quality) at the A11 crossing where water voles are present. No otter holts are currently present on site, although otters make use of the stream on the site for foraging/commuting

- Several Schedule 1 bird species such as hobby, barn owl, red kite as well as kingfisher, found breeding or could potentially nest within the zone of influence of the scheme. Mitigation measures will be required such as habitat enhancement, nest sites/nest boxes, and planting of scrub and trees to deter barn owls form the proposed scheme.

12 Summary of Tables of Traffic, Economics and Costs

12.1 Introduction

12.1.1 Highways England commissioned AECOM to evaluate A47 Thickthorn Junction scheme as part of the Road Investment Strategy (RIS) East Area 6. The traffic assessment has been undertaken using the NATS model (Norwich Area Transport Strategy) which was recalibrated and revalidated.

12.1.2 The RIS junction enhancement includes: the construction of an A11 south to an A47 east link road, the construction of an A47 east to A11 south link road; and the re-routing of Cantley Lane South to join the B1172, including its severance from Thickthorn junction.

12.2 Scheme Cost Estimates

12.2.1 Scheme construction costs were provided by Highways England Commercial Services Division (HECSD) in June 2017. The costs were provided in 2010 undiscounted prices.

12.2.2 The costs of the scheme comprise capital costs only. Additional costs related to operation and maintenance have not been provided by the estimator at this time.

12.3 Projected Expenditure Profile

12.3.1 The expenditure profile forecasts that were provided by Highways England Commercial for the economic assessment, prepared in 2010 prices, are summarised included in Table 12-1.

12.3.2 The costs shown are for economic purposes and not full outturn costs. The scheme costs in undiscounted 2010 prices are estimated to be £66.043M.

Table 12-1 : Economic Output Estimate - A47 Thickthorn

		2017	2018	2019	2020	2021	Total (Excl Historical)
A47 Thickthorn	**Preparation Expenditure Profile**	£1,564,207	£1,676,979	£3,437,966	£687,280	£0	£7,366,432
	Supervision Expenditure Profile	£0	£0	£0	£1,093,509	£306,555	£1,400,064
	Works Expenditure Profile	£0	£0	£0	£41,173,383	£14,609,251	£55,782,633
	Lands Expenditure Profile	£225,428	£0	£0	£1,268,859	£0	£1,494,286
	Total Expenditure Forecast (All Costs Included)	**£1,789,634**	**£1,676,979**	**£3,437,966**	**£44,223,029**	**£14,915,806**	**£66,043,415**

12.4 Traffic Modelling

12.4.1 The 2015 base year model network has been used as a basis for creating 2021 and 2036 Do Minimum (without scheme) forecast year networks by the inclusion of a number of 'committed' transport infrastructure schemes.

12.4.2 The proposed scheme incorporates new link roads between the A11 (south) and A47 (east) which enable a large volume of traffic to be removed from the main junction. The scheme also incorporates a proposal to divert Cantley Lane (South) to connect with the B1172 west of Thickthorn which will increase journey distance for some users on this route.

12.4.3 Forecasting has been undertaken following WebTAG guidance and has required the development of 2021 and 2036 forecast models to represent the scheme opening year and scheme design year. For car trips reference case demand matrices have been developed using local plan development assumptions although with growth constrained to NTEM forecasts. Freight demand has been forecast using Regional Traffic Forecasts based on NTM. For car trips growth is about 5% to 2021 and 19% to 2036, LGV growth is significantly higher at around 17% to 2021 and 55% to 2036 whilst HGV growth lies between the two at 7% to 2021 and 24% to 2036.

12.4.4 Variable demand modelling has been undertaken using DIADEM and this results in additional growth in the Do Minimum, particularly in 2021 and less so in 2036. The inclusion of additional capacity in the 'with scheme' scenario results in some further marginal growth in trip demand.

12.4.5 The impact of the scheme on trip demand has been analysed at a sector level and this indicates that changes look to be sensible given the location of the scheme. There is additional growth to and from traffic zones in Sector 1 which are directly impacted by the scheme as they lie along the A11 corridor.

12.4.6 In terms of the volume of traffic and their travel time, total vehicle-hours across the network are marginally lower in the AM and IP periods and marginally higher in the PM peak for the Do Something scenario. There are also predicted small increases in total vehicle-kilometres travelled in the DS compared to the DM scenarios both. These changes are similar in 2021 and 2036.

12.4.7 Traffic flows at Thickthorn are forecast to increase by significantly more than the general increase in trips. By 2021 forecast volumes in the DM are around 20%-30% higher compared to around a 6-8% increase in trips. By 2036 the increases in volumes at Thickthorn are 35-60% compared to 23-30% in trips. This results in some large increases in travel times through the Thickthorn and in particular on the A11 northbound approach with travel times increasing by 2 to 3 minutes by 2036.

12.4.8 The proposed scheme results in some significant reductions in traffic using the main Thickthorn junction. Except for the AM peak, reductions on the A11 immediately south of Thickthorn are around 35-40% whereas on the A47 east facing slip roads are around 60-70% lower. The reduction on the A11 in the northbound direction in the AM peak is significantly lower as traffic reassigns from other routes, particularly the B1172 as congestion reduces significantly.

12.4.9 The new slip roads are forecast to attract around 11000-12000 PCU's daily directionally in 2021 rising to between 14000 and 16000 in 2036. Maximum hourly flows are forecast at around 1600 PCU's in 2036 during the AM peak hour.

12.5 Economic Assessment

12.5.1 The economic assessment compares the monetised costs and benefits of the proposed scheme (the Do Something) against the alternative without scheme scenario (the Do Minimum).

12.5.2 The benefits of the scheme are calculated from Transport Economic Efficiency (TEE) benefits (savings relating to travel times, vehicle operating costs and user charges) obtained using TUBA. Highways inputs to TUBA were obtained from the NATS SATURN model following the application of the DIADEM variable demand model. Public transport inputs to TUBA were obtained from DIADEM. Benefit calculations also include the impact of construction and estimated changes in road traffic accidents. A 60 year period is assessed in TUBA from the Opening Year which is scheduled to be 2021.

Annualisation

12.5.3 Annualisation factors are used to convert traffic model outputs from the weekday periods they represent to a yearly equivalent. These factors have been derived from the continuous volumetric data available on the A11 in the vicinity of Station Lane southwest of Thickthorn junction. Basing annualisation factors on a single count is not ideal but there is limited continuous data in the vicinity of Thickthorn available. A continuous site was also available on the A47 east of Thickthorn but this was not used as one counter was determined to be inaccurate.

12.5.4 To determine which hours of the day the three model periods were representative of, weekday average hourly volumes for each month were divided by June weekday average hourly volumes for the modelled time periods. Where the average was 90% or more of the average hourly June volume for the modelled time period, it was classified as that particular period. The outcome of the analysis is indicated in Table 12-2.

Table 12-2 : Annualisation Factors

Time Period	Defined Period	Annualisation Factor
AM Peak	07:00-09:00	409
Inter-Peak	09:00-16:00; 18:00-19:00	1807
PM Peak	16:00-18:00	466

TUBA Results - User Benefits

12.5.5 Table 12-3 shows the distribution of user benefits by time period and indicates benefits of £68.44M. User benefits for the AM peak and Inter-Peak account for roughly 90% of the total benefits, with the PM peak accounting for only 10% of benefits. The significant difference in benefits between the two peak periods is that the delays at Thickthorn are generally greatest on the A11 northbound approach in the morning peak. The tidality of traffic is generally towards Norwich in the AM peak and away from Norwich in the PM peak. As it is the A11 south to A47 east traffic that incurs the most delay through Thickthorn and this volume is higher in the AM peak, this, and the fact that the reverse movement only traverses one set of signals, is another reason for the imbalance between the peak periods.

12.5.6 No forecast year PT demand matrices were available and the input PT demand to the 2021 and 2036 DIADEM process were the 2015 base year trip matrices. DIADEM requires PT demand to be provided for car available and non-car available segments. However as these segment definitions were not available for the 2015 base year Amey have specified the same PT reference demand for both segments in the DM forecasting process. This resulted in the DM PT demand being significantly higher than the 2015 base year demand. For the Thickthorn DS forecasts the input PT matrices were the outputs from the DM scenario and hence these were for car and non-car available.

12.5.7 Due to these issues and the lack of confidence in the PT related outcomes Highways England have instructed that this element of the TUBA outputs should be excluded at this stage. Given the issues regarding the PT data in practice the Do Minimum and Do Something scenarios should be redone to exclude the PT elements within the demand model. Doing so would likely have a bearing on the TUBA outcomes and may reduce other benefits, but there is insufficient time to do so at this stage. This is something that should be addressed during Stage 3.

Table 12-3 : 60 Year User benefits by Time Period (in 2010 prices and values)

Benefit Measure	Benefits (£ Million)			
	AM Peak	Inter-peak	PM Peak	Total
Travel Time	31.77	39.73	12.98	84.47
Vehicle Operating Costs (Fuel)	-0.70	-2.92	-0.93	-4.55
Vehicle Operating Costs (Non-Fuel)	-3.11	-4.47	-3.17	-10.75
User Charges	0.60	-0.59	-0.74	-0.73
Private Sector Revenue	Excluded	Excluded	Excluded	Excluded
Total	**28.56**	**31.75**	**8.14**	**68.44**

Accident Analysis

12.5.8 Observed accident data has been obtained for roads in the vicinity of Thickthorn junction for the period from 1 April 2012 to 31 March 2017. This data have been reviewed and only accidents within 20 metres of Thickthorn gyratory have been selected. Over the 5 year period there were 16 accidents that resulted in casualties.

12.5.9 It should be noted that based on observed accidents over a 5 year period from 2012 to 2017 that the observed accident rate calculated by COBALT is only about 50% of the default rate for a signalled roundabout. Further analysis of observed data is required as the traffic volumes used by COBALT are derived from the base year model and these may be different to actual volumes. However if this rate is correct the accident benefits would reduce to £5.7M. This method results in a forecast reduction of 147 accidents which equates to a saving of 200 casualties (0.5 fatal, 12 serious and 197 Slight).

Delays during Construction for the modelled time periods

12.5.10 The modelling of delays during construction has been split into two phases covering a 15 month construction period from March 2020. Phase 1 is the first 3 months of the construction programme when the A47 east to A11 south link road is built. Phase 2 forms the main phase of works for 12 months during which the A11 south to A47 east link road is constructed. During this phase the A47 east to A11 south link road will be open to traffic but A47 westbound off-slip traffic will not be able to access Thickthorn junction.

12.5.11 Table 12-4 shows the disbenefits from delays during construction for all time periods including the factored off-peak and weekend values. This indicates that the PVB of additional delays during construction would be -£4.6M.

Table 12-4 : Disbenefits due to delays during construction in ALL time periods (in 2010 prices and values, £000s)

	Phases 1 and 2
Greenhouse Gases	-7
Economic Efficiency: Consumer Users (Commuting)	-1024
Economic Efficiency: Consumer Users (Other)	-1994
Economic Efficiency: Business Users and Providers	-1567
Wider Public Finances (Indirect Taxation Revenues)	37
Present Value of Benefits (PVB)	**-4554**
Broad Transport Budget	57
Present Value of Costs (PVC)	**57**
OVERALL IMPACTS	
Net Present Value (NPV)	**-4611**

12.6 Economic Sensitivity Tests

12.6.1 This section presents the results for the sensitivity tests that were carried out around the Core Scenario for the Without- and With-Scheme cases. Two sensitivity tests were modelled and assessed:

- Low growth – assuming a lower Reference Case (RC) demand; and
- High growth – assuming a higher RC demand with additional developments to generate demand.

12.6.2 The Low growth sensitivity test focuses on reducing the RC demand fed to the demand model to assess the impact on traffic levels and on the economic results. The High sensitivity test assesses the impact of applying higher growth than predicted by NTEM.

12.6.3 The highway RC demand was adjusted in line with the uncertainty definition on the NTEM forecasts as per the WebTAG guidance on uncertainty in unit 3.15.5, Paragraph 1.4.13. The values used are presented in Table 12-5 and derived from the WebTAG formulation. The highway RC demand was reduced/increased by the above percentages of the base demand for the forecast years. The resultant matrices were run through the demand model.

Table 12-5 : Growth Sensitivity Adjustment Factors

Model Year	Years from Base	Adjustment Factor
2021	6	+/-6.12
2036	21	+/-11.46

12.6.4 Table 12-6 summaries the main outcomes from TUBA for the Low and High growth scenarios as well as those from the Core growth scenario. The overall user benefits range from £41.0M for the Low growth scenario through to £80.9M for the High growth scenario. The Low growth benefits are some £23M or about one third lower than those in the Core scenario whereas the High growth benefits are about £17M, or 25%, higher.

Table 12-6 : Transport Economic Efficiency (TEE) Table (in 2010 prices and values, £ millions)

	Low	Core	High
Consumer – Commuting user benefits	**All Modes**	**All Modes**	**All Modes**
Travel Time	16.108	22.325	28.395
Vehicle operating costs	-2.822	-5.256	-3.512
User Charges	-0.027	-0.01	1.03
During Construction & Maintenance	-0.976	-1.024	-1.136
NET CONSUMER - COMMUTING BENEFITS	**12.283**	**16.035**	**24.777**
Consumer – Other user benefits	**All Modes**	**All Modes**	**All Modes**
Travel Time	12.277	23.486	23.804
Vehicle operating costs	-3.376	-7.439	-5.145
User Charges	0.257	-0.573	-0.02
During Construction & Maintenance	-1.807	-1.994	-2.008
NET CONSUMER - OTHER BENEFITS	**7.351**	**13.48**	**16.631**
Business	**All Modes**	**All Modes**	**All Modes**
Travel Time	25.039	38.662	42.982
Vehicle operating costs	-2.381	-2.603	-1.873
User Charges	0.153	-0.151	-0.028
During Construction & Maintenance	-1.444	-1.567	-1.566
NET BUSINESS IMPACT	**21.367**	**34.341**	**39.515**
Present Value of Transport Economic Efficiency Benefits (TEE)	**41.00**	**63.86**	**80.92**

12.6.5 Table 12-7 provides the Analysis of Monetised Costs and Benefits (AMCB) values for the Low, Core and High growth scenarios. Overall PVB ranges from £49M for Low growth to £91M for High growth, with NPV ranging from -£7M to £34M. This results in a BCR of 0.87 under the Low growth scenario, BCR of 1.38 for the Core scenario and 1.60 for the High growth scenario.

Table 12-7 : Analysis of Monetised Costs and Benefits (AMCB) Table (in 2010 prices and values)

	Low	Core	High	
Noise	n/a	n/a	n/a	*(12)*
Local Air Quality	n/a	n/a	n/a	*(13)*
Greenhouse Gases	-£2,827,000	-£5,467,000	-£4,203,000	*(14)*
Journey Quality	n/a	n/a	n/a	*(15)*
Physical Activity	n/a	n/a	n/a	*(16)*
Accidents	£4,600,200	£5,673,700	£4,852,500	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£12,283,000	£16,035,000	£24,777,000	*(1a)*
Economic Efficiency: Consumer Users (Other)	£7,351,000	£13,480,000	£16,631,000	*(1b)*
Economic Efficiency: Business Users and Providers	£21,367,000	£34,341,000	£39,515,000	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	£6,368,000	£11,882,000	£9,315,000	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	**£49,142,200**	**£75,944,700**	**£90,887,500**	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	£56,403,000	£55,132,000	£56,864,000	*(10)*
Present Value of Costs (see notes) (PVC)	**£56,403,000**	**£55,132,000**	**£56,864,000**	*(PVC) = (10)*
OVERALL IMPACTS				
Net Present Value (NPV)	**-£7,260,800**	**£20,812,700**	**£34,023,500**	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	**0.87**	**1.38**	**1.60**	BCR=PVB/PVC

Note: This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

12.7 Economic Assessment Summary

12.7.1 For this Scheme investment costs were provided by HECSD. These costs which were provided in 2010 undiscounted prices and were calculated to be £66.04M. Operating and maintenance costs have not been made available and hence the current assessment will understate the costs associated with the proposed Thickthorn scheme.

12.7.2 For the Core Scenario, the modelling and economic assessment estimates that the RIS Thickthorn Interchange Improvement scheme is likely to generate present value benefits (PVB) of £75.94M. This accounts for the disbenefits associated with delays during construction but not for delays during maintenance periods. This also only includes carbon emissions extracted from TUBA which is likely to be lower than those that would be obtained from those using the Emissions Factor Toolkit (EFT).

12.7.3 The user benefits, including time benefits, vehicle operating benefits, and user charges were assessed using the TUBA software, from information extracted from the traffic models. It identified that the user benefits are driven by time savings, which occur for all three trip purpose categories. The Scheme results in disbenefits for all other benefit measures.

12.7.4 Travel time disbenefits during construction and maintenance have been calculated to be £4.55M or around 7% of the PVC.

12.7.5 The accident assessment, carried out using CoBALT and based on default accident rates in the model simulation area, contributes some £5.7M benefits over 60 years in the Core Scenario, saving 147 accidents (200 casualties) in total. These have been based on observed rates at Thickthorn junction over the 5 year period from 2012-17. It is noted that not modelling Thickthorn in 'junction only' mode would result in much lower accident benefits.

12.7.6 An economic assessment of low and high growth scenarios has not been undertaken. It is intended that these will be undertaken prior to the completion of the Stage 2 programme.

12.7.7 Assessment of journey time reliability has not been undertaken as part of this stage.

12.7.8 The economic assessment for the Core growth scenario yields a Benefit to Cost Ratio (BCR) of **1.38**. A BCR of this value would place it in the 'low value for money' category.

12.7.9 An economic assessment of low and high growth scenarios has also been undertaken. This results in a BCR of 0.87 under the Low growth scenario placing it in the poor value for money category, whereas under the High growth scenario there is a predicted BCR of 1.60 which places the scheme in the medium value for money category.

Economic Summary Tables

12.7.10 The preliminary Transport Economic Efficiency (TEE) user costs and benefits calculated by TUBA are presented in the Table 12-8. TUBA also calculates the Present Value of Costs (PVC), based on the input scheme investment and maintenance data, and indirect tax revenues to central government. These are presented in the form of the Public Accounts (PA) Table 12-9.

12.7.11 The TEE benefits and Public Accounts information are combined (along with benefits from reductions in accidents and carbon emissions) to produce an overall value for money assessment, as presented in the Analysis of Monetised Costs and Benefits (AMCB) Table 12-10.

12.7.12 The Appraisal Summary Table is provided as Appendix R. Due to time limitations some of the elements have only been assessed qualitatively.

Table 12-8 : Economic Efficiency of the Transport System (TEE)

Non-business: Commuting	**ALL MODES**		**ROAD**	
User benefits	**TOTAL**		**Private Cars and LGVs**	
Travel time	£22,325,000		£22,325,000	
Vehicle operating costs	-£5,256,000		-£5,256,000	
User charges	-£10,000		-£10,000	
During Construction & Maintenance	-£1,024,000		-£1,024,000	
NET NON-BUSINESS BENEFITS: COMMUTING	£16,035,000	*(1a)*	£16,035,000	
Non-business: Other	**ALL MODES**		**ROAD**	
User benefits	**TOTAL**		**Private Cars and LGVs**	
Travel time	£23,486,000		£23,486,000	
Vehicle operating costs	-£7,439,000		-£7,439,000	
User charges	-£573,000		-£573,000	
During Construction	-£1,994,000		-£1,994,000	
NET NON-BUSINESS BENEFITS: OTHER	£13,480,000	*(1b)*	£13,480,000	
Business				
User benefits			**Goods Vehicles**	**Business Cars & LGVs**
Travel time	£38,662,000		£20,836,000	£17,826,000
Vehicle operating costs	-£2,603,000		-£2,607,000	£4,000
User charges	-£151,000		£0	-£151,000
During Construction	-£1,567,000		-£796,000	-£771,000
Subtotal	£34,341,000	*(2)*	£17,433,000	£16,908,000
Private sector provider impacts				
Revenue	£0			
Operating costs	£0			
Investment costs	£0			
Grant/subsidy	£0			
Subtotal	£0	*(3)*		
Other business impacts				
Developer contributions	£0	*(4)*		
NET BUSINESS IMPACT	£34,341,000	*(5) = (2) + (3) + (4)*		
TOTAL				
Present Value of Transport Economic Efficiency Benefits (TEE)	£63,856,000	*(6) = (1a) + (1b) + (5)*		

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

Table 12-9 : Public Accounts (PA)

	ALL MODES		ROAD	BUS and COACH	
Local Government Funding	**TOTAL**		**INFRASTRUCTURE**		
Revenue	-£524,000		-£524,000		
Operating Costs	£0		£0		
Investment Costs	£0		£0		
Developer and Other Contributions	£0		£0		
Grant/Subsidy Payments	£0		£0		
NET IMPACT	-£524,000	*(7)*	-£524,000		
Central Government Funding: Transport					
Revenue	£0		£0		
Operating costs	£0		£0		
Investment Costs	£55,656,000		£55,656,000		
Developer and Other Contributions	£0		£0		
Grant/Subsidy Payments	£0		£0		
NET IMPACT	£55,656,000	*(8)*	£55,656,000		
Central Government Funding: Non-Transport					
Indirect Tax Revenues	-£11,882,000	*(9)*	-£11,882,000	£0	
TOTALS					
Broad Transport Budget	£55,132,000	*(10) = (7) + (8)*			
Wider Public Finances	-£11,882,000	*(11) = (9)*			

Table 12-10 : Analysis of Monetised Costs and Benefits (AMCB)

Noise	n/a	*(12)*
Local Air Quality	n/a	*(13)*
Greenhouse Gases	-£5,467,000	*(14)*
Journey Quality	n/a	*(15)*
Physical Activity	n/a	*(16)*
Accidents	£5,673,700	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£16,035,000	*(1a)*
Economic Efficiency: Consumer Users (Other)	£13,480,000	*(1b)*
Economic Efficiency: Business Users and Providers	£34,341,000	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	£11,882,000	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	£75,944,700	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	£55,132,000	*(10)*
Present Value of Costs (see notes) (PVC)	£55,132,000	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	£20,812,700	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.38	BCR=PVB/PVC

Note: This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

13 Summary of Environmental Assessment and Environmental Design

13.1 Introduction

13.1.1 This chapter initially summarises the environmental baseline conditions in the vicinity of the proposed Scheme followed by a summary of the potential environmental effects associated with proposed Scheme construction and operation taking into account impact avoidance measures embedded into the proposed Scheme design, and standard management activities that would be adopted.

13.1.2 This assessment, which applies to the entire scheme, considers Options 3 and 4, and for the purposes of this section of the report:

- **Option 3** refers to the Single Option incorporating Local Road Option 3 as shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01064 included in Appendix N; and
- **Option 4** refers to the Single Option incorporating Local Road Option 4 as shown on Drg. No. HE551492-ACM-HML-TJ-DR-HE-01065 included in Appendix N.

13.2 Baseline Environmental Conditions

Air Quality

13.2.1 There are currently no declared Air Quality Management Areas (AQMAs) within the study area. South Norfolk District Council currently undertakes non-automatic monitoring of NO_2 using a network of passive diffusion tubes. Of the twenty nine monitored locations, three roadside sites are located in close proximity to the Scheme. The most recent available annual mean NO_2 concentrations at these locations for 2015 show that the annual mean objective for NO_2 (40µg/m^3) has not been exceeded at any of the monitoring locations during 2015.

13.2.2 Annual average background pollutant concentrations estimates have been sourced from Defra's 2013 based background maps for 2015 for the study area and indicate that annual background concentrations of both NO_2 and particulates (PM_{10}) are well below annual air quality objectives.

13.2.3 A range of potentially sensitive receptors have been identified within the Thickthorn Junction study area. Small groups of residential properties are located at East Lodge/Thickthorn Cottages on the B1172. On Cantley Lane South there is one group of 12 properties (approximately 55m to 160m from the A47) and a further five properties (ranging from 250m to 500m) southwest of the A47. An individual residential property (the Round House) is located to the east of Thickthorn Junction approximately 50m north of the A11. There are residential properties concentrated in Cringleford to the east of the A47, both to the north and south of the A11 and plans to develop 1200 additional residential units close to the junction. There are also a number of non-residential sensitive receptors in Cringleford, including a primary school.

13.2.4 The Norfolk Valley Fens Special Area of Conservation is over 3km from the Scheme and it is considered there will be no air quality effects on this site.

Cultural Heritage

13.2.5 Within the study area there are 144 recorded heritage assets. There is one Scheduled Monument, the site of two Bronze Age tumuli (round barrows) recorded to the south of the current junction. There are 16 listed buildings, 15 of which are Grade II listed and one Grade II* listed. There are six non-designated historic buildings. There is one entry on the Register of Parks and Gardens (Intwood Hall), which is Grade II* registered. It is a manor house with walled gardens of 16th century origins set in a diminutive mid-18th century park. Cringleford Conservation Area (*c.* 800m east of Thickthorn Junction, adjoining Newmarket Road) and Eaton Conservation Area (*c.* 1km east of Round House Roundabout) are located to the east of Thickthorn Junction. There are no World Heritage Sites or Registered Battlefields recorded within the study area.

13.2.6 There are 49 sites with evidence of prehistoric date recorded in the study area. The earliest is of Palaeolithic date (up to *c*. 10,000 BC) with the latest being of Roman date (AD 43 to AD 450). There are 44 sites with evidence of medieval date (1066-1500) and 58 assets with evidence of post-medieval date (1500 to 1900). Two assets are related to the modern period and there are a small number of sites of unknown or uncertain date.

Landscape and Visual

13.2.7 The Scheme footprint lies adjacent to and encompasses the existing A47 near the settlements of Cringleford and Hethersett to the west of Norwich. This is a lowland agricultural area, characterised by medium scale rectilinear fields bound by hedgerows and linear belts of trees.

13.2.8 Intwood Hall is a Grade II listed Registered Park and Garden (RPG) at the eastern extent of the study area and is enclosed by woodland. The national landscape character of the study area is located within Area 84: Mid Norfolk, the local Landscape Character Areas of C: 1 Yare Tributary Farmland with Parkland; and F1 Yare Valley Urban Fringe.

13.2.9 Visual receptors include the settlements of Cringleford, Round House Park, properties at Thickthorn Hall and Cantley Lane South and Norwich Road. Views from two recreational routes, three public rights of way and from roads in the study area are also considered.

Biodiversity

13.2.10 Within the biodiversity study area there is one international/European statutory designated site, the Norfolk Valley Fens Special Area of Conservation, one nationally designated site; Eaton Chalk Pit Site of Special Scientific Interest designated for its underground chalk caves and two Countryside Wildlife Sites (Meadow Farm Meadow and Intwood Carr) with potential links to the Scheme site. Many notable habitats and protected species of international and national importance are identified across study area.

Noise and Vibration

13.2.11 A baseline noise survey was undertaken on 22 and 24 June 2016 at a total of three locations representative of some of the closest identified potentially sensitive receptors at:

- Site 1 – Cantley Lane South, south-west of the A47;
- Site 2 – Cantley Lane, east of the A47; and
- Site 3 - Newmarket Road, east of the Round House roundabout on the A11

(Road traffic noise was noted as the dominant noise source at all three monitoring locations.)

13.2.12 A range of potentially sensitive receptors have been identified within the Thickthorn Junction study area. Human receptors reside in small groups of residential properties located at East

Lodge/Thickthorn Cottages on the B1172. On Cantley Lane South here is one group of 12 properties and a further five properties further southwest of the A47. An individual residential property (the Round House) is located to the east of Thickthorn Junction approximately 50m north of the A11. There are residential properties concentrated in Cringleford to the east of the A47, both to the north and south of the A11 and plans to develop 1200 additional residential units close to the junction. There are also a number of non-residential sensitive receptors in Cringleford, including a primary school. There are two Noise Important Areas east of the Round House Roundabout on the A11 but there no designated ecological sites within the noise and vibration study area.

Road Drainage and Water

13.2.13 The Scheme study area is located within two river catchment areas; it overlies Flood Zones 1, 2 and 3, with Flood Zones 2 and 3 associated with the Cantley Stream that flows through the study area and joins the River Yare downstream.

13.2.14 The area is underlain with two Groundwater Source Protection Zones (2 and 3) due to the presence of a Secondary A superficial aquifer and a Principal aquifer.

People and Communities

13.2.15 There are several community facilities within the study area including a service station, veterinarian surgery, doctor's surgery, 90m south of A11 Newmarket Road, two fast food restaurants, a hotel, a Park and Ride, a community centre, Intwood Hall RPG, a Church hall, and a Primary school. The development of Cringleford lies to the east of the study area as do Hillgrove Care Home and St. Peters Church. There are no National Cycle Network routes or national walkways within the study area though there are two local cycle routes and Pedalways. There are also two local walking routes, one equestrian bridleway and seven PRoW including Cringleford FP4a which runs from Cantley Lane to a footbridge over the A47, providing a link to Cantley Lane South. There is a shared-use footway on the northern side of the Thickthorn Junction gyratory from the B1172 (Thickthorn Park and Ride) arm to the old Newmarket Road arm. There are several Toucan crossings on the A47 and A11.

13.2.16 The study area is on the fringe of the urban area of Norwich with surrounding agricultural land and woodland. Within the *Cringleford Neighbourhood Development Plan 2013-2026* several areas in the study area zoned for future development or protected by policy initiatives.

13.2.17 Vehicle travellers have restricted views both on national and main roads in the study area and driver stress across the local network can be at times high.

Geology, Soils and Materials

13.2.18 British Geological Survey (BGS), '*borehole records'* confirmed that the area is underlain by up to 0.4m of topsoil which is underlain by up to 13m of superficial deposits interpreted as the Lowestoft Formation. The Lowestoft Formation is further underlain by up to 7m of the Sheringham Cliffs Formation. Four of the borehole records confirmed that the underlying bedrock comprises undifferentiated Chalk strata at a shallow depth of 2m bgl to the south east of the junction in the vicinity of the tributary is directly overlain by a thin layer (1.7m) of sand and gravel. Mineral records show that glaciofluvial sands and gravels is present across the majority of the study area,

13.2.19 The BGS 'borehole records' did not identify the presence of shallow groundwater within the topsoil or in the Lowestoft Formation. The Chalk is the main water-bearing strata beneath the Scheme site and is designated as a Principal aquifer with the superficial deposits of the Lowestoft Formation designated a Secondary aquifer. The site lies within a groundwater Source Protection Zone (SPZ) 2 for a public water supply.

13.2.20 There are no designated or sensitive geological assets identified within the study area. The soils across the area are mapped as Grade 3 – good to moderate agricultural land. A former

quarry has been backfilled within the study area with inert, commercial, domestic and industrial wastes. Materials on the site include greenfield agricultural soils, other soils and stones including potential contaminated materials and where the current road network is to be re-profiled, made ground.

13.3 Assessment of Environmental Effects

Air Quality

13.3.1 Given that measured pollutant concentrations are well below the air quality objectives in the area, and provided that for both options standard design measures and mitigation measures are implemented, it is likely that the construction and operation of the Scheme will have a **Negligible** change and therefore it is likely that there will be no significant adverse impacts on air quality at sensitive receptors. However further assessment will be required at the next stage of the project.

Cultural Heritage

13.3.2 Within the 500m study area for both options, there are 144 recorded heritage assets. These are largely of prehistoric, medieval and post-medieval date, and include a pair of scheduled Bronze Age barrows, numerous find spots, cropmarks and the Grade II listed Thickthorn Hall. A number of assets have been identified within the proposed junction improvements. These are of medium, low and negligible value, except for the high value barrows. There will be a **Slight Adverse** impact upon seven assets and a potential **Moderate Adverse** effect on the Bronze Age barrows. All other effects are considered to be **Neutral**.

Landscape and Visual

Option 3

13.3.3 This Scheme option would not result in any significant impacts on the landscape character within the study area. However a number of visual receptors would experience significant effects particularly during construction and at Scheme opening (Year 1).

13.3.4 At construction, both landscape character areas would experience a **Slight Adverse** effect. Whereas three of the seven visual receptors would experience a **Large Adverse** and a **Moderate Adverse** effect primarily due to the proximity of highly sensitive receptors to the Scheme.

13.3.5 At Scheme opening (Year 1), the significance of effect for both landscape character areas would remain **Slight Adverse** and therefore not significant. Four of the seven visual receptors would result in **Moderate Adverse** effects.

13.3.6 At year 15 the significance of effect would reduce to **Neutral** for both landscape character areas. Those visual receptors that experience **Moderate effects** at year 1 would reduce to **Slight Adverse** with the exception of PRoW- Cringleford FP1 where the significance of effect would remain **Moderate Adverse**.

Option 4

13.3.7 This Scheme option would not result in significant landscape effects within the study area. Visual receptors would however experience significant effects during construction and at Scheme opening (year 1).

13.3.8 During construction, landscape effects would range from **Neutral** to **Slight Adverse** and therefore not significant. However there would be a number of significant visual effects. Two visual receptors would experience **Large Adverse** effects whilst one visual receptor would

result in a **Moderate Adverse** effects, the remaining four visual receptors would result in **Slight Adverse** effects.

13.3.9 At Scheme opening (Year1), three of the seven visual receptors would experience a **Moderate Adverse** effect.

13.3.10 At year 15, the significant visual effects would be reduced to **Slight Adverse** and **Neutral**.

Biodiversity

13.3.11 Based on the survey results to date significant adverse effects (without mitigation measures) have been identified on the following ecological features during the construction and operational phases for both Option 3 and Option 4: Eaton Chalk Pit SSSI: (disturbance to bats); Bats; Breeding birds; Water vole; Otter; European polecat; and Rare / Scarce Flora.

13.3.12 Ponds to the south of the A11 have the potential for GCN and evidence has been found for deer, fox, badger and possibly polecat, Schedule 1 birds[2], water vole and otter. Further surveys will be required at Stage 3 and mitigation measures developed. Further consultation will be required with statutory and non-statutory consultees (where applicable). It is considered that any potentially significant adverse effects identified at Stage 2 would be reduced to non-significant levels.

Noise and Vibration

13.3.13 For both options there is the potential for temporary direct **Moderate/Large Adverse** noise/vibration effects due to the construction of the junction improvement works, particularly for the hotel and the closest residential properties on Cantley Lane south and the western edge of Cringleford. This is particularly the case if the works are required to be undertaken at night. During operation, based upon the high sensitivity classification of residential receptors, the potential impact magnitude of up to moderate at the potentially worst affected Noise Sensitive Receptors (NSRs) (properties on Cantley Lane South), would result in a permanent direct **Moderate Adverse** effect.

Road Drainage and Water

13.3.14 Both options will result in increased surface water run-off from impermeable areas that could cause adverse effects on receiving waterbodies or groundwater. Both options may also result in physical modification of the Cantley Stream. In addition, Option 4 would most likely require a diversion of the stream channel. Groundwater is at risk from both option designs with potential impacts to groundwater flow and quality. Further groundwater assessment is recommended. A flood risk assessment (FRA) has been conducted and has shown that both design options can be developed without impacting flood risk elsewhere.

13.3.15 With design recommendations provided within the FRA drainage strategy implemented, the outcome of recommended groundwater assessments at Stage 3 considered and an appropriate Construction Environment Management Plan (CEMP) in place during construction, it is considered that significant adverse effects to road drainage and water environment receptors during both construction and operation of either design option can be avoided.

Peoples and Communities

13.3.16 During construction, both Options 3 and 4 are likely to have a Slight Adverse effect on Pedestrians, cyclists and equestrians and community effects and views from the road. Land take of development land will also occur resulting in a Moderate Adverse effect. Neutral/Slight Adverse effects are likely for views from the road and driver stress.

[2] Such as hobby, barn owl, red kite, kingfisher.

Construction plant and traffic management will partially obscure views and will attract the attention of vehicle travellers away from available views along A11 and A47. Overall, for both options during construction, a **Neutral/ Slight Adverse** effect is expected.

13.3.17 During operation, both options are likely to have a **Neutral/Slight Adverse** effect on Pedestrians, cyclists and equestrians and community effects views from the road. A Moderate Adverse effect is likely for land use as permanent land take will occur. There will be new views from the road occurring from both options. Views to the south from the existing A11 and east and west from the A47 being crossed by the Option 3 will become intermittent and restricted in places. Road users using the new underpass beneath the A47 and passing through the West of Cringleford will have closed views . For Option 4 views to the south from the existing B1172, A11 and east and west from the A47 will become intermittent and restricted in places. Road users using the new overpass will have new open views. For both options, driver stress levels are expected to reduce as driver frustration, fear of accidents and route uncertainty will be improved. Overall, for operation, it is considered that Option 3 will result in a **Neutral/ Slight Adverse** effect whereas Option 4 will have a **Neutral/Slight Beneficial** effect for People and Communities.

Geology, Soils and Materials

13.3.18 There are no sensitive geologically important features in the vicinity of the junction. Scheme improvements will require land take, land and vegetation clearance, new routes, embankments, associated ground profiling and the re-profiling of existing road network structures and features. The existing materials that make up the current structures may contain backfill/unknown contaminated materials which may be disturbed as part of the proposed works. Materials generated during the ground works particularly for Option 4, may include backfilled materials and/or contaminated soils especially in the vicinity of the historical landfill where landfill gases and leachate may be present. The Chalk aquifer is of high sensitivity. Locally, it is present close to the ground surface and vulnerable to impacts from surface contaminative activities. Currently, it is assumed that dewatering of the Chalk will not be necessary. If dewatering is required, it may result in a potential constraint for the Scheme. Dewatering of the superficial deposits and possibly the Chalk may be necessary to facilitate construction of the underpass beneath the A47 proposed in Option 3.

13.3.19 Overall the Geology, Soils and Materials assessment indicates that for both Options 3 and 4, construction of the proposed Scheme will have an impact of minor magnitude and an effect of **Slight Adverse** significance.

13.3.20 For the operational phase, it is considered that both Scheme options do not pose any significant risk to the ground and groundwater conditions. Any impacts will be of a negligible magnitude resulting in an effect of **Neutra**l significance.

Cumulative Effects

13.3.21 The potential interactions of impacts between environmental topics have been considered and identified within the Environmental Assessment Report (EAR) for the design options of the proposed Scheme. The results of the planning search are presented in Chapter 11 of the EAR. There are a number of committed developments within 600m of the Scheme and these are significant in both size and type of project. Residential development is underway and almost completed north of Round House Roundabout and further residential development is planned adjacent to the proposed design of both Option 3 and Option 4. Significant residential development is also planned at Hethersett (west of Thickthorn Junction) which shall link the road network to a proposed extension to Thickthorn Park and Ride. Should construction of these new residential developments coincide with the construction works proposed to improve Thickthorn Junction, it is assumed that a combined adverse effect would occur to road users and other sensitive receptors on and in proximity to the road network from construction impacts including air quality and noise and vehicle traveller and NMU diversions.

13.3.22 Of the other A47 Schemes under assessment within the A47 Improvement Programme the A47 North Tuddenham to Easton Scheme is approximately 8km north of Thickthorn Junction. There is therefore potential that the Thickthorn Junction and this Scheme will impact upon each other and cause combined adverse effects both to the local and regional road network users and sensitive receptors should they be under construction at the same time. The cumulative effects of these potential situations may be considered at a later Stage in the assessment process. The remaining four schemes are sufficiently distant from the A47 Thickthorn Scheme and therefore are not expected to have a combined effect in a local sense.

13.3.23 Regionally this may be more significant for network users should the Thickthorn Scheme undergo construction at the same time as any other one or more of the A47 Schemes. Regional travellers of the A47 road network may face significant adverse effects in combination. The cumulative effects of these potential situations will also be considered later in the assessment process.

13.4 Presentation of Key Environmental Issues

13.4.1 Table 13.3. outlines those effects which are considered significant. These include Cultural Heritage impacts due to the proximity to the scheduled Bronze age barrows; Biodiversity impacts due to the proximity of Eaton Chalk Pit SSSI and disturbance to Bats; Breeding birds; Water vole; Otter; European polecat; and Rare / Scarce Flora; and, Noise and Vibration impacts due to construction activities nearby particularly at the hotel and residential properties on Cantley Lane South and on the western edge of Cringleford.

Construction

13.4.2 The Environmental Assessment Report has identified that there is potential for significant adverse effects to occur to receptors identified in the Biodiversity and Noise and Vibration chapters during the construction phase of the Scheme. All potential significant effects were identified to occur with both Scheme Options. In all cases, these are potential effects as further biodiversity surveys are to be completed, air and noise modelling undertaken. Table 9.1 details these effects, their receptors, mitigation measures and potential monitoring requirements.

Operational

13.4.3 It has been identified that there is the potential for significant adverse effects to occur to receptors identified in the Cultural Heritage, Biodiversity and Noise and Vibration chapters. In all cases, these are also potential effects which need to be confirmed or otherwise, when surveys are completed and modelling results evaluated.

13.4.4 Potential biodiversity beneficial effects have been identified for the operational phase of the Scheme should ecological design and construction mitigation be implemented.

Table 13-1 – Summary of Potential Significant Adverse Effects, Mitigation and Monitoring

Chapter	Option and Phase	Significant Effect and Receptor	Mitigation Measures	Monitoring Requirement
Cultural Heritage	Option 3 & 4 Operationall	Potential Moderate Adverse effect – Bronze age barrows	Tree planting in design to provide screening	Standard construction monitoring. Post construction monitoring of any planting design.
Biodiversity	Option 3 & 4 Construction	• Eaton Chalk Pit SSSI: potentially a Moderate Adverse significant effect at up to the county or unitary authority level. • Bats (all species) – potentially a Large Adverse significant effect at up to the regional level. • Breeding birds: – potentially a Moderate Adverse significant effect at up to the county or unitary authority level. • Water vole: – potentially a Moderate Adverse significant effect at up to the county or unitary authority level. • Otter:– potentially a Moderate Adverse significant effect at up to the county or unitary authority level. • European polecat:– potentially a Moderate Adverse significant effect at up to the	**General Mitigation** • Landscape design including mitigation and enhancement of habitats: • Legally protected species and Natural England licences: Standard environmental best practice and mitigation would be implemented • Ecology Construction Environmental Management Plan • Pollution prevention control measures • Pre-construction surveys • Site vegetation clearance to avoid the nesting bird period • Sensitive lighting design to minimise impacts on bats • Ecological enhancement of areas to be used as construction compounds and/or flood compensation areas • Enhancing the wildlife corridor and ecosystem function of the proposed scheme: • Handover Environmental Management Plan (HEMP): A five year aftercare period **Specific Mitigation** • Arable field margins: Field margins to be	It is proposed that ecological monitoring is undertaken during the scheme construction and operational phases.

Chapter	Option and Phase	Significant Effect and Receptor	Mitigation Measures	Monitoring Requirement
		county or unitary authority level. • Rare / Scarce Flora:– potentially a Large Adverse significant effect at up to the regional level.	incorporated into the landscape design • Meadow Farm Meadow CWS: Compensate for any habitat lost • Thickthorn and Eaton Chalk Pit SSSI: Bat roost, foraging and commuting habitat mitigation • Landscape planting to mitigate for loss of habitat, which is known to support protected/notable species • Mitigation of watercourse loss • Pre-construction Reptile translocation and vegetation removal under method statement • Reptile mitigation to minimise killing / injury during operation • Invasive Species Management Planning • Barn owl mitigation • Water vole and otter mitigation • European Polecat mitigation	
Biodiversity	Option 3 & 4 Operational	• Eaton Chalk Pit SSSI:– potentially a Large Adverse significant effect at up to the regional level. • Bats (all species) roosting, foraging and commuting – potentially a Large Adverse significant effect at up to the regional level. • Reptiles (including a low population of reptiles):– potentially a Moderate Adverse significant effect at up to the county or unitary authority level. • Birds (barn owl): vehicles – potentially a Moderate Adverse significant effect at up to the county or unitary authority level. • Otter and European polecat:– potentially a Moderate		

Chapter	Option and Phase	Significant Effect and Receptor	Mitigation Measures	Monitoring Requirement
		Adverse significant effect at up to the county or unitary authority level.		
Noise and Vibration	Option 3 Construction	Potential Large / Moderate Adverse effect - Residential receptors particularly at the hotel, residential properties on Cantley Lane South and on the western edge of Cringleford	Mitigation measures that could be considered to reduce the impact of traffic noise on local NSRs, if required, include: • Maximising the distance between new/realigned sections of road and nearby receptors; • Minimising changes in traffic flow, speed and composition on existing roads as a result of the scheme; • Earth bunds/noise barriers to screen nearby receptors. Where there is sufficient land available, earth bunds/noise barriers can be designed in consultation with the landscape design to help integrate the route of new/realigned sections of road into the surrounding area. This can also provide visual mitigation; • Low noise surfacing, if traffic speeds are sufficient for a low noise surface to be effective. Current guidance in the DMRB advises that a noise benefit from a low noise surface should only be assumed at speeds of 75 km/hr or more; and • Noise insulation of individual properties to protect the internal noise environment.	Monitoring of construction noise levels at a selection of the closest NSRs may be considered appropriate should the outcome of further assessment at Stage 3 confirm potentially significant effects remain, particularly at night. The scope of the monitoring would be defined at that stage.
Noise and Vibration	Option 4 Construction	Potential Moderate Adverse effect - Residential receptors particularly at the hotel, residential properties on B1172, Cantley Lane South and on the western edge of Cringleford		
Noise and Vibration	Option 3 & 4 Operational	Potential Moderate Adverse effect - Residential Receptors particularly properties on Cantley Lane South		The need for monitoring due to significant adverse operational effects may be appropriate, should the outcome of further assessment at Stage 3 confirm potentially significant effects remain. The scope of the monitoring would be defined at that stage.

13.5 Sources of Information

13.5.1 The information as presented herein is sourced from the PCF Stage 2 EAR.

13.6 Consultations

13.6.1 Consultation activities have been undertaken with statutory and non-statutory organisations throughout the development of the proposed scheme design and the assessment of options. Ad hoc consultation with statutory and non-statutory bodies by environmental disciplines includes consultation with South Norfolk Council, the Environment Agency and Historic England.

13.7 Limitations

13.7.1 The assumptions and limitations as associated with the assessment of potential environmental effects as detailed within the EAR are included within each technical chapter (refer to EAR Chapters 5 through 14). In particular, the air quality, noise and vibration, surface water quality and spillage risk assessments (Road Drainage and Water) are based on qualitative assessments only. Ground investigation data was also not available to inform Geology, Soils and Material assessment. These environmental elements will be assessed in more detail within PCF Stage 3 when traffic data and ground investigation results become available. Also, a number of additional land-take requirements are not considered within the EAR as the location of such areas are currently not known, namely flood storage compensation areas; construction compounds; material storage areas; and provision of additional access. The environmental implications associated with these additional land-take requirements will be considered during the environmental assessment during PCF Stage 3.

13.8 Next Stages

It is currently considered that the proposed scheme constitutes an NSIP. Thus, following the PRA, it is anticipated that in order for the necessary statutory provisions to be secured and to enable the proposed scheme to proceed, it will be necessary to make a DCO application to the Planning Inspectorate (PINS). The DCO application will need to be accompanied by an EIA as reported within an Environmental Statement.

14 Consultation with Public Bodies

14.1 Summary of Consultation with Public Bodies

14.1.1 Extensive consultations were undertaken at Stage 1. The information gathered and the opinions expressed were taken forward into the accelerated Stage 2 process. Owing to the short timescale between Stage 1 and Stage 2 and the use of a Single Option, only one public body was consulted during PCF Stage 2 process prior to the PRA, further to those which were reported in Section 19 of the original TAR Ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032. Consultations were undertaken with Historic England, due to the proximity of scheduled monuments on the Thickthorn Junction. Further consultation will be undertaken with Historic England and Natural England on publication of the Stage 2 Environmental Assessment Report.

15 Conclusions

15.1 Introduction

15.1.1 This section summarises the scheme development stages that were undertaken which resulted in the decision to recommend a Single Option for presentation at the Public Information Exhibitions (PIEs), and subsequent developments to the Single Option following feedback from the PIEs, resulting in a recommendation for the Preferred Route Announcement.

15.2 Do-Nothing Option

15.2.1 The junction capacity assessments undertaken in 2014 for the A47/A12 Corridor Feasibility Study indicated that Thickthorn Junction was operating over capacity on a number of approaches. By 2031, this is predicted to worsen owing to the proposed developments in the vicinity that will increase traffic at this junction.

15.2.2 A Solutions Assessment Report, produced at PCF Stage 0, identified the unsuitability of the current junction layout to accommodate both the dominant movement between the A11 south and A47 east (in both directions), and the strong tidal movement through the junction on the A11, during both peak hours. This is predicted to worsen in future years due to the future growth in strategic traffic, and growth from the large local residential developments in Hethersett and Cringleford.

15.2.3 During PCF Stage 1, it was confirmed that the findings of the A47/A12 Corridor Feasibility Study were correct in stating that Thickthorn Junction is currently operating over capacity on a number of approaches. By 2036 this problem will be further exacerbated by natural growth and the potential future developments in the area which are noted within the Greater Norwich Infrastructure Plan. The potential increase in traffic flow is anticipated to lead to increased congestion.

15.2.4 The stage 2 traffic and economic assessment was based on an updated version of the Norwich Area Transport Study (NATS) strategic model.

15.3 Alternative Options for Strategic Road Network

15.3.1 The options that were considered during PCF Stage 1 are documented in the Technical Appraisal Report (ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032).

15.3.2 However, none of the options that were developed during PCF Stage 1 were considered to be suitable to be included in the PIE.

15.3.3 Following the completion of PCF Stage 1, an attempt was made to identify an affordable, value for money (AVFM) solution prior to the next IDC review. This exercise, which was informally referred to as the ‘Deep Dive’ resulted in a Single Option.

15.3.4 Details of the development of the originally proposed Single Option are documented in the addendum to the Technical Appraisal Report, ref. HE551492-ACM-GEN-TJ-RP-ZM-00019.

15.3.5 Since the Single Option was the only potentially feasible option, it was recommended that that this should be the only option to be presented to the public in 2017.

15.4 The originally proposed Single Option

15.4.1 The Single Option, which emerged from the 'Deep Dive' process, incorporates A11 south to A47 east bi-directional interchange link roads, which improve the junction by removing traffic from the Thickthorn Junction gyratory. This will reduce the conflict between the dominant traffic flows between the A11 south and A47 east (in both directions), and the strong tidal movement through the junction on the A11, during both peak hours.

15.4.2 The scheme incorporates improvements to the Thickthorn Junction gyratory, the A11 Newmarket Road, and Round House Roundabout, which are to be provided by developers as conditioned within their respective planning approvals.

15.4.3 Owing to the severance of Cantley Lane South, caused by the proposed A11 south to A47 east bi-directional interchange links, the originally proposed Single Option reconnected Cantley Lane South to Cantley Lane (north) via an underpass beneath the A47.

15.5 Traffic, Economics and Costs

15.5.1 For this Scheme investment costs were provided by HECSD. These costs which were provided in 2010 undiscounted prices and were calculated to be £66.04M. Operating and maintenance costs have not been made available and hence the current assessment will understate the costs associated with the proposed Thickthorn scheme.

15.5.2 For the Core Scenario, the modelling and economic assessment estimates that the RIS Thickthorn Interchange Improvement scheme is likely to generate present value benefits (PVB) of £75.94M. This accounts for the disbenefits associated with delays during construction but not for delays during maintenance periods. This also only includes carbon emissions extracted from TUBA which is likely to be lower than those that would be obtained from those using the Emissions Factor Toolkit (EFT).

15.5.3 The user benefits, including time benefits, vehicle operating benefits, and user charges were assessed using the TUBA software, from information extracted from the traffic models. It identified that the user benefits are driven by time savings, which occur for all three trip purpose categories. The Scheme results in disbenefits for all other benefit measures.

15.5.4 Travel time disbenefits during construction and maintenance have been calculated to be £4.55M or around 7% of the PVC.

15.5.5 The accident assessment, carried out using CoBALT and based on default accident rates in the model simulation area, contributes some £5.7M benefits over 60 years in the Core Scenario, saving 147 accidents (200 casualties) in total. These have been based on observed rates at Thickthorn junction over the 5 year period from 2012-17. It is noted that not modelling Thickthorn in 'junction only' mode would result in much lower accident benefits.

15.5.6 Due to the lack of confidence in the PT related outcomes Highways England have instructed that this element of the TUBA outputs should be excluded at this stage. Given the issues regarding the PT data in practice the Do Minimum and Do Something scenarios should be redone to exclude the PT elements within the demand model. Doing so would likely have a bearing on the TUBA outcomes and may reduce other benefits. This is something that should be addressed during Stage 3.

15.5.7 The economic assessment for the Core growth scenario yields a Benefit to Cost Ratio (BCR) of 1.38. A BCR of this value would place it in the 'low value for money' category.

15.5.8 Assessment of journey time reliability has not been undertaken as part of this stage.

15.5.9 An economic assessment of low and high growth scenarios has also been undertaken. This results in a BCR of 0.87 under the Low growth scenario placing it in the poor value for money

category, whereas under the High growth scenario there is a predicted BCR of 1.60 which places the scheme in the medium value for money category.

15.6 Operational Maintenance Assessment

15.6.1 The proposal for the improvements of the A47 Thickthorn Junction would result in an arrangement that would be safe to operate by all users.

15.6.2 The layout of the proposed junction design would improve network resilience compared with the existing junction, particularly in the situation of maintenance on the network.

15.6.3 Further detailed development of the maintenance requirements and operation will be carried out in later development stages of the scheme.

15.7 Feedback from the Public Consultation

15.7.1 Many of the concerns from the public that arose during the Public Information Exhibitions (PIEs), and follow-up meetings, were associated with the proposal for the local road link to reconnect Cantley Lane South to Cantley Lane.

15.7.2 The concerns raised by the affected parties included:

- Routing of traffic from Cantley Lane South onto Cantley Lane (north) which is considered to be too narrow;
- 'Rat Running' to the A11 at Station Lane;
- Impact on private land;
- Proximity of the proposed road to properties adjacent to the A47;
- Impact of noise from the A47;
- The existing footbridge bridge should be retained or replaced with a new one;
- Impact on key cycle path and walking route;
- Environmental impact on vegetation and wildlife.

15.7.3 As a consequence of this and other similar feedback, further options for the reconnection of Cantley Lane South to the main highway network were developed.

15.8 Options for Local Road Network

15.8.1 Preliminary designs for a total of six options developed by AECOM, and one option suggested by a member of the public, have been assessed. A full assessment of the options is included in Section 11 of this report. These options fall into four main categories:

- Connection of Cantley Lane South to Round House Roundabout via an Overbridge across the A47 **(Options 1 and 2)**;
- Connection of Cantley Lane South to Roundhouse Roundabout via an Underbridge beneath the A47 **(Option 3)**;
- Connection of Cantley Lane South to B1172 Norwich Road to A11 Northbound **(Option 4)**; and

- Junction Improvement to facilitate right turns from Station Lane (south) to A11 northbound **(Options 5, 6 and 7)**.

15.8.2 Based on the issues raised from the consultation and design rationalisation considered for the local route options, Options 3 and 4 have been taken forward as potential options.

15.9 Environmental Assessment of the originally proposed Single Option

15.9.1 No further environmental assessment was undertaken for the originally proposed Single Option as a result of feedback from the PIE. A summary of the environmental effects are included in the addendum to the TAR, ref. HE551492-ACM-GEN-TJ-RP-ZM-00019.

15.10 Environmental Assessment of the originally proposed Single Option with Options 3 and 4 for the Local Road Network

15.10.1 The Environmental Assessment Report (EAR) for local route designs; Option 3 and Option 4, was specific to the environmental baseline conditions, followed by a summary of the potential environmental effects. The following environmental topics were considered:

- Air quality;
- Cultural heritage;
- Landscape and visual;
- Biodiversity;
- Noise and vibration;
- Road drainage and the water environment;
- People and communities;
- Geology, soils & materials; and
- Cumulative impacts.

15.10.2 Baseline surveys identified a number of environmental assets across the study area including designated and important sites, protected areas, habitats and species. As the junction options are very close together the majority of environmental impacts are assessed to relate to both.

15.10.3 Residents on Cantley Lane South, the B1172 Norwich Road, the A11 Newmarket Road, on Cantley Lane, and those on the west of Cringleford are sensitive receptors to environmental impacts. One Schedule Monument (Bronze Age burial mounds), was in proximity to both option designs and visual receptors on Public Rights of Way (PRoW), properties, roads and settlements are identified. Within the biodiversity study area (for both options), a number of important ecological features (habitats and species) are present with linkages to Norfolk Valley Fens Special Area of Conservation (SAC) and Eaton Chalk Pit Site of Special Scientific Interest (SSSI).

15.10.4 The EAR ascertained that there is potential for significant adverse effects (pre-mitigation measures) to occur to Biodiversity and Noise and Vibration receptors during the construction phase of both Option 3 and Option 4.

15.10.5 During the operational phase, there is the potential for significant adverse effects to occur to Cultural Heritage, Biodiversity and Noise and Vibration receptors, again to both Option 3 and Option 4.

15.10.6 Additional environmental surveys and assessment were completed to clarify the extent of the potential effects. The biodiversity surveys surveys were completed in October 2017. Air and noise modelling and ground investigations, have not been possible to complete at this stage of the project.

16 The Recommended Route

16.1 Introduction

16.1.1 During PCF Stage 1 numerous options were considered for the improvement of the A47 Thickthorn Junction. However, none of the leading options were considered to be suitable for presentation at the PIEs, as further refinement was needed in order to reduce the cost and improve the economic benefits.

16.1.2 The options which were considered during PCF Stage 1 and the options selection process that was undertaken is fully documented in the TAR Ref. A47IMPS1-AEC-TJ-ZZ-DO-J0032.

16.2 Process for Selecting the Preferred Route

16.2.1 Prior to the commencement of PCF Stage 2, an attempt was made to identify an affordable, value for money solution prior to the next IDC review. This exercise, which was informally referred to as the 'Deep Dive' resulted in a Single Option.

16.2.2 The Single Option that emerged was similar in concept to the leading option from PCF Stage 1 in that it included bi-directional interchange links between the A11 south and A47 east, which removed traffic from the Thickthorn Junction gyratory.

16.2.3 The Single Option includes interchange links in both directions between A11 south and A47 east. These links will provide relief to the Thickthorn Junction gyratory, by segregating the dominant movement between the A11 south and A47 east (in both directions) and the strong tidal movement through the junction on the A11, during both peak hours.

16.2.4 The evolution of the originally proposed Single Option is fully documented in the addendum to the TAR, ref. HE551492-ACM-GEN-TJ-RP-ZM-00019.

16.2.5 Since the bi-directional interchange links sever Cantley Lane South, it is necessary to provide an alternative way of reconnecting Cantley Lane South the main highway network.

16.2.6 For the originally proposed Single Option, which was presented at the PIE, it was proposed to connect Cantley Lane South to Cantley Lane (north) via an underpass beneath the A47.

16.2.7 However, while the feedback from the PIE indicated that there was a good level of support for the proposed junction improvement, there was strong opposition to the proposal to reconnect Cantley Lane South to Cantley Lane (north).

16.2.8 Therefore, following the PIE, further options for reconnecting Cantley Lane South were assessed.

16.3 Comparing the Options for Potential Reconnection of Cantley Lane South

16.3.1 Preliminary designs for a total of six options developed by AECOM, and one option suggested by a member of the public have been assessed. These options fall into four main concepts:

Concept 1 - Connection of Cantley Lane South to Round House Roundabout via an Overbridge across the A47

16.3.2 Following a request from property owners on Cantley Lane South, Options 1 and 2 were considered for reconnecting Cantley Lane South via a bridge over the A47, rather than via an underbridge as originally proposed. Instead of connecting to Cantley Lane (north), local traffic would be routed to Round House Roundabout via the estate roads within the West of

Cringleford Development. A full assessment is included in Section 11 of this report, but the main reasons in common for why this is not recommended are:

- The overbridge, and its high approach embankments, would be far more visually intrusive to the residents of Cantley Lane South than the originally proposed underbridge;
- There are highway safety concerns with regards to providing a highway alignment with tight bends and steep gradients so close to live elevated high voltage electricity cables to the north of the A47.
- There is potential for greater propagation of traffic noise from Cantley Lane South due to the overbridge and traffic being much closer to the residential properties than the originally proposed scheme; and
- The option will result in local trips through the development West of Cringleford by vehicles returning from the recycling centre at Station Lane, and a potential increase in traffic through the development and along Cantley Lane South due to 'rat running' to the A11 via Station Lane.

Concept 2 - Connection of Cantley Lane South to Roundhouse Roundabout via an Underbridge beneath the A47

16.3.3 Option 3 for reconnecting Cantley Lane South is a refinement of the originally proposed Single Option. It was primarily developed, following objections from a landowner with regards to the severance of his triangle of land between Cantley Lane South, the A47, and Breckland Railway Line. Instead of connecting to Cantley Lane (north), local traffic would be routed to Round House Roundabout via the estate roads within the West of Cringleford Development. A full assessment is included in Section 11 of this report, but one of the main constraints is:

- The option will result in local trips through the development West of Cringleford by vehicles returning from the recycling centre at Station Lane, and a potential increase in traffic through the development and along Cantley Lane South due to 'rat running' to the A11 via Station Lane.

Concept 3 - Connection of Cantley Lane South to B1172 Norwich Road

16.3.4 Option 4 is to reconnect Cantley Lane South to the B1172 Norwich Road. A full assessment is included in Section 11 of this report. The feasibility of Option 4 requires further investigation and confirmation during PCF Stage 3. However, notwithstanding the careful attention that will be needed to resolve the engineering design aspects and environmental mitigation, Option 4 presents several benefits:

- It would fully resolve public concerns raised at the PIE with regards to the impacts caused by reconnecting Cantley Lane South to Cantley Lane. For this option, no local traffic will be generated along Cantley Lane (north), or through the development West of Cringleford;
- Access to the existing properties on Cantley Lane South will not be restricted by the low (13' 6') railway bridge, which would be the case if improvements were only to be made to Station Lane Junction; and
- Access to the properties on Cantley Lane South will be maintained, whereas if improvements were only made to Station Lane, residents and emergency vehicles would be subject to a long detour.

Concept 4 – Junction Improvement to Facilitate Right Turn from Station Lane (south) to A11 Northbound

16.3.5 The A11 Station Lane Junction was originally built as an all movement at-grade junction, but has since been converted to a left-in, left out junction. This has prevented traffic from Station Lane, north and south of the A11, from turning right onto the A11.

16.3.6 There were several suggestions from the public that a junction at Station Lane capable of providing a right turn back towards the Thickthorn Junction (from the recycling centre) would be more convenient, and would cause less disruption to the residents of Cantley Lane and Cantley Lane South.

16.3.7 This idea received a unanimous vote at the extraordinary meeting of East Carleton & Ketteringham Parish Council on 6th April 2017.

16.3.8 Options 5 to 7 all relate to the concept of improving Station Lane Junction. A full assessment of these options is included in Section 11 of this report, but the main reasons in common for why this is not recommended are:

- The properties on Cantley Lane South will have to make a large detour of up to an additional 4.7km to 5.3km depending on the option, compared to the existing situation when travelling to Thickthorn Junction;
- The long detour to the main group of properties on Cantley Lane South, which includes approximately 2.4km of rural two-way single lane carriageway roads with limited passing places, would adversely affect emergency services response times;
- Access to the properties on Cantley Lane South will be restricted by the low railway bridge, which has a 13' 6'' headroom, which would restrict access not only for residents but also for deliveries, farmers and their equipment, movement of products and animals, etc;

16.4 Matters still to be Resolved

16.4.1 The design of the options to reconnect Cantley Lane South are preliminary.

16.4.2 For Cantley Lane South Reconnection, Option 4, there are significant engineering design and environmental aspects that need to be resolved. It is therefore recommended that further investigation and confirmation relating to the feasibility of this option to be undertaken during PCF Stage 3.

16.4.3 This assessment and selection of the merges and diverges was based on preliminary traffic flows and will have to be carried out again in PCF Stage 3. This could affect the number of Departures from Standards required for proposed merges and diverges.

16.5 The Recommended Route

16.5.1 Subject to the matters still to be resolved, the Single Option incorporating Cantley Lane South Reconnection Option 4 is recommended.

16.5.2 There was a good level of support for the originally proposed Single Option that was presented at the PIE. However, the adverse comment was received with regards to the proposal to reconnect Cantley Lane South to Cantley Lane (north).

16.5.3 Cantley Lane South Reconnection Option 4 is considered to be the best option to overcome the public concerns arising from the PIE, while not compromising access arrangements for the residents on Cantley Lane South.

16.5.4 A final decision on a solution for Cantley Lane South Reconnection will need to be made during the Stage 3 of the project also known as preliminary design.