

Norwich Northern Distributor Road

Stage 2 Scheme Assessment Report

Part 1 of 3 – Main Report

Prepared by Norfolk County Council In conjunction with Mott MacDonald, February 2005

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NORWICH NORTHERN DISTRIBUTOR ROUTE

STAGE 2 SCHEME ASSESSMENT REPORT

February 2005

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EXECUTIVE SUMMARY

Purpose of the Report

In September 2004, the County Council resolved to adopt a revised Norwich Area Transportation Strategy (NATS 4). A Norwich Northern Distributor Road (NDR) is included as part of this strategy. Investigations into the NDR has resulted in the development of eight feasible western route options and three eastern route options.

The purpose of this report is to draw together the information relating to the route options for a Northern Distributor Route to enable a decision to be made on a preferred route, combining the best western option with the best eastern option. This report uses information from the following reports and studies to draw conclusions and to make a recommendation about the way forward:

- Provisional Engineering Layouts
- Stage 2 Environmental Assessment Report
- Traffic and Economic Assessment Report
- NDR Public Consultation Results Report

Scope of the Report

The report examines the following

- the existing conditions of the road network and surrounding land;
- the engineering layout of the route options;
- the impact of each route has on different aspects of the environment;
- the traffic and economic implications of each of the route options.
- The results of the 2004 public consultation

Conclusions

On the western side, all eight routes contribute to very good benefit to cost ratios (BCRs) of more than 2, representing high value for money. However, in line with government guidance, it is felt that the environmental impacts of the routes significantly diminish the value for money. All have 'very large adverse' environmental impacts which is the highest category of negative impact a road scheme can have. Most of these impacts relate to the landscape and ecology of the section of road between the A47 (west) and the A1067 Fakenham Road across the Wensum Valley.

On the eastern side, all three routes contribute to very good benefit to cost ratios (BCRs) of more than 2, representing high value for money. However, once again, all the eastern routes have large adverse impacts but these are not considered insurmountable in mitigation terms.

Whilst it is inevitable that any new rural road scheme will impact on landscape and ecology, it is part of scheme development that these impacts are mitigated as far as is reasonably possible until an acceptable level of impact is achieved. In this respect the Statutory environmental Bodies have key roles to play.

The responses from English Nature and Environment Agency indicate that, notwithstanding their concerns over proving the need for the NDR, the impacts of all routes are such that further work needs to be done to identify in more detail what the environmental constraints and detailed mitigation measures might be before a decision on the preferred route is taken.

1.0 INTRODUCTION

1.1 **Description**

In October 2004, the County Council resolved to adopt a revised Norwich Area Transportation Strategy (NATS 4). A Norwich Northern Distributor Road (NDR) is included as part of this strategy. However, at present there is no preferred route for the road.

The purpose of this report is to draw together the information relating to the alternative route options for an NDR, to enable a decision to be made on a preferred route. Assessment of different aspects of alternative routes for an NDR was undertaken during 2004. In addition, route options were subject to Public Consultation over the winter of 2004. This report uses information from the following reports and studies to draw conclusions and to make a recommendation about a preferred option:

- Provisional Engineering layouts
- Stage 2 Environmental Assessment
- Traffic and Economic Assessment Report
- Report on Public Consultation

The report does not cover justification for including a northern distributor road as part of the strategy. This is covered by a separate report entitled 'Norwich Area Transportation Strategy: Options Assessment Report'.

1.2 Scheme Development

A Norwich NDR was first considered in the early 1990's. Much work was undertaken then on alternative routes, including environmental assessments, and a public consultation undertaken in 1994 as part of a review of the Norfolk Structure Plan. The majority of respondents supported an NDR, but there were strong environmental objections to parts of the routes.

National policy also began to change towards a presumption against providing additional highway capacity, and less money was made available for road schemes. A review of the Norwich Area Transportation Strategy, underway at the time, reviewed and amended the previous strategy in the light of this transport policy. The new strategy sought to cater for the growth in trips by means other than the private car by bus (including park and ride) and improved facilities for cycling and walking. Road building and junction capacity improvements for private vehicles were given less emphasis as it was considered that increasing road capacity could lead to further growth in traffic demand. Therefore, this strategy (NATS3) adopted in 1997, did not include an NDR which also consequently, does not feature in the adopted Norfolk Structure Plan (1999).

In November 2001, the County Council's Cabinet resolved to undertake a review of NATS and to examine the feasibility and options for an NDR. During 2002, work was simultaneously undertaken on a review of NATS options, a comprehensive traffic survey in the Norwich area, leading to the development of a new traffic model and the identification and assessment of possible options for an NDR.

The work on the NDR involved a comprehensive desk study assessment of a wide variety of possible options and was reported in the Stage 1 Environmental Assessment, published in January 2003.

During 2003, more detailed studies were made on the most feasible options. This resulted in the identification of four possible corridors to the west of Norwich, between the A47 and the A140, and three possible corridors to the east, between the A140 and the A47. These were included in the Public Consultation about the County Council's preferred revised NATS, during the autumn of 2003.

The County Council had intended to choose a preferred route after this consultation. However, over twenty variations to routes or suggested alternatives were put forward by members of the public and organisations. There was also concern that there was insufficient information available from a desk study, on which to make a fully informed choice on a preferred route.

Following the 2003 Public Consultation, a stage 1 environmental assessment was carried out on all the suggested variations and alternatives, so they could be appraised on an equal basis as the original routes. Further work to stage 2 level was undertaken on those routes it was felt warranted further consideration.

All assessments have been carried out in accordance with recommendations and guidance set out in the Design Manual for Roads and Bridges, produced by the Department for Transport.

1.3 Stage 2 Assessment

The stage 2 assessment was carried out on all the original consultation alternatives. In addition, some variations to parts of these were assessed, as well as two new alternative options to the west of Norwich.

The assessment process involved preliminary engineering design, species surveys, environmental assessment and assessment of traffic and economics.

Preliminary horizontal and vertical alignments were designed, using level information from the Ordnance Survey. This information was used for checking and refining original cost estimates and forming the basis for the environmental assessment. Probable junction locations and layouts were also defined.

The impact that each option would have on traffic patterns in the Norwich Area was assessed using the traffic model developed from the traffic survey in 2002. This work was also used to determine whether the road should be a single or dual carriageway. The Traffic and Economic Appraisal Report gives the results of this work.

The stage 2 environmental surveys were carried out between February and September 2004. The assessment was carried out during the summer of 2004 and the results are in the Stage 2 Environmental Assessment Report

1.4 Stage 3 Assessment

It is anticipated that the following work will be carried out at the next stage:

Topographical Survey:	2005
Further Traffic Modelling:	2005 - 2006
Detailed Design	2005 - 2008
Stage 3 Environmental Surveys:	2006 - 2007
Geotechnical Survey:	2007 – 2008

2.0 EXISTING CONDITIONS

2.1 Existing Road Network

2.1.1 <u>Description</u>

The road network in Norwich is characterised by a pattern of radial routes converging at the city centre. The main radials on the north side of the city are the:

- A1067 Fakenham Road;
- A140 Cromer Road;
- A1151 Wroxham Road
- There are 5 other significant radial routes on the north side of the city:
- C261 Reepham Road;
- C246 Buxton Road;
- B1150 North Walsham Road
- C283 Salhouse Road
- C874 Plumstead Road

These routes are generally single carriageway and have 30mph or 40mph speed limits within the built up area.

Two ring roads cater for orbital movements, and north south through traffic. The Inner Ring Road (IRR) bounds the city centre office and retail area. The Outer Ring Road (ORR) lies half way between the IRR and the urban perimeter. Neither ring road is complete and both have long sections of single carriageway, which vary in width. To the south-east there is a common section which partly uses the radial routes. The IRR has a 30mph speed limit and the ORR alternates between 30mph and 40mph. Both ring roads have numerous access points. There are also a number of minor roads in the suburbs and north of the city, which run parallel to the ORR and are used by orbital traffic.

The A47 Norwich Southern Bypass, opened in Sept 1992, runs between the A47 west and the A47 east around the south of Norwich and lies around one to two kilometres outside the built up area. It has junctions with 5 of the southern radial routes and generally carries east-west through traffic.

2.1.2 Pedestrians, Cyclists, Equestrians and Community Effects

Pedestrians: There are many places to visit on a recreational basis, particularly around the Wensum Valley. A network of Public Rights of Way has been developed around the countryside surrounding the city. In particular, Marriotts Way, which follows the former M&CN railway line from the city centre to Reepham and Aylsham, has been developed for both cycle and pedestrian use and attracts many pedestrians, particularly at weekends. For pedestrians within the city, most of the IRR, ORR and radial routes have adjacent footways and limited crossing points, mostly at junctions or controlled crossings. Parts of the area inside the IRR are pedestrianised.

Cyclists: The cycle network in the area comprises a mix of on and off road facilities. There are two major off road cycleways within the study area. The first of these is Marriotts Way, described above. The other is the Old Catton to Spixworth cycleway, which runs alongside the C246 Buxton Road. Both are used for leisure and commuting. Present Government Policy is to increase cycling levels.

Community Effects: Within the study area, there are a wide range of community and educational facilities, serving the needs of the local residents. These include schools (primary and secondary), health centres, libraries, post offices and a range of sports and recreational facilities.

2.1.3 <u>Traffic</u>

Monitoring of traffic levels using the ring roads since 1989 shows increases on the ORR and decreases on the IRR. This is thought to be due to a combination of the traffic management measures implemented within the IRR and the significant increase of 'out of town' developments.

Journey time surveys were carried out in 1989 and 2003. Average speeds in Norwich within the ORR are broadly unchanged at around 19mph. However journey times vary in different parts of the city:

- Journey times for orbital or cross-city routes have increased, especially in the southwest area of the city.
- Journeys times from the city to the southeast appear to have decreased. This may be due to construction of the Southern Bypass.
- Journey times to the south have increased, especially during the peak hours, which could be a result of additional junctions on the A140.

Over the next 10 years, the Norfolk economy is likely to grow broadly in line with UK as a whole. Traffic growth has in the past been intrinsically linked to growth in GDP. Government forecasts predict that traffic would grow fastest in the districts of Breckland, Broadland, and North Norfolk.

2.1.4 Accidents

A series of personal injury accident data is available for the Greater Norwich Area from January 1998 to December 2002. The study area encompasses the greater Norwich northern urban area and the northern rural fringe.

The Greater Norwich Urban Area

This area covers the northern suburbs and comprises the Outer Ring Road and the parishes of:

- Costessey
- Hellesdon
- Drayton
- Taverham
- Old Catton
- Sprowston
- Thorpe St. Andrew

The following table shows the number of accidents by severity in each of the years:

Year	1998	1999	2000	2001	2002	Total
Fatal	2	3	5	2	3	15
Serious	40	46	47	43	28	204
Slight	202	207	207	188	184	988
Total	244	256	259	233	215	1207

The northern rural fringe

This area covers the rural roads and villages to the north of Norwich and comprises the parishes of:

- Easton (north of the A47)
- Honingham (north of the A47)
- Ringland
- Weston Longville
- Morton on the Hill
- Attlebridge
- Felthorpe
- Horsford
- Horsham St Faith
- Spixworth
- Beeston St Andrew
- Rackheath
- Little Plumstead
- Postwick (north of the A47)

The following table shows the number of accidents by severity in each of the years:

Year	1998	1999	2000	2001	2002	Total
Fatal	1	2	3	2	2	10
Serious	15	18	18	25	19	95
Slight	64	55	68	50	69	306
Total	80	75	89	77	90	411

2.2 Existing Land Use

2.2.1 Topography and Geology

Plans showing details of surface geology are shown in Part 3 of this report. The Norwich area is underlain by Cretaceous Upper Chalk beds up to 200m thick, which dip gently eastward. These beds are mostly covered by Pleistocene and Recent deposits. These deposits lie unconformably (i.e. they are no longer in their original sequence of deposition) on the Chalk surface, which is generally exposed in the river valleys.

The oldest Pleistocene formation is the Norwich Crag, extensive to the east but gradually disappearing to the west of Costessey. The Crag comprises interbedded sands and gravels with occasional lenticular clays. To the north of the River Wensum, Crag is overlain by Corton Till comprising glacial deposits of intercalated, mainly unbedded clays and loamy sands. South of the Wensum, Corton Till is absent and Lowestoft Till lies directly on either the Chalk surface or the Crag. The Lowestoft Till extends northwest by Easton and Weston Longville.

Glacial Sands and Gravels occur as masses below, within and above the Lowestoft Till. These sands and gravels are extensive around the city area and are commonly up to 10m thick within the river valleys. Valley Gravels occur sporadically, with recent alluvium, mainly silty or fine sand, occupying the valley centres and the recent river terraces.

Catton Grove Chalk Pit, just south of Mousehold Heath, is a Site of Special Scientific Interest (SSSI), notable for its Upper Chalk Catton Sponge Bed. This represents an important marker band in the chalk, the rare chalk exposure at the site revealing well preserved fauna (ammonites and numerous undefined sponges) in an early diagenetic hardground. However the site is remote from any of the route corridors and is unlikely to be affected by road development.

Away from the Wensum river valley, soils are sandy, or sand and coarse loamy, generally well drained and with a few stones. Water logging may occur where water tables are high. Soil associations (Soil Survey of England and Wales; Soils of Eastern England) are 541a (Bearsted 1) to the northeast. To the north the associations are 551e (Newport 2), 821c, 861a and 711a. To the northwest the associations are 551b, 551c, 572a and 861c. Along parts of the Wensum valley soils are silty and clayey, possibly with humus layering and a high water table, and are described as type 1024a (Adventurers 1).

Groundwater is known to occur in the superficial deposits, in the older Pleistocene deposits (Crag) and in the underlying Upper Chalk. As identified in the preceding section on water quality, the Upper Chalk bed is a major aquifer, comprising a soft white fine-grained Limestone with bands of flint nodules. Groundwater storage and flow occurs through the development of joints, fissures and along bedding planes. Fissure development is greatest in valleys and in the zone of water level fluctuation. To the south and west the Chalk groundwater may be confined by the Lowestoft Till which is absent in the north. The overlying sands and gravels of the Crag are defined as a minor aquifer, although this is largely due to their limited thickness and extent, rather than poor aquifer properties. The Crag may be highly permeable and is generally in hydraulic continuity with the underlying Chalk. Glacial Sands and gravels and River Terrace Gravels also comprise minor aquifers and may also be in hydraulic continuity with the Chalk below.

Apart from the Corton Till to the north of the area and the Lowestoft Till to the south and west, large areas of the surface are covered by relatively permeable deposits, allowing rapid infiltration to the underlying Chalk.

2.2.2 Landscape Setting and Character

The landscape character to the north of Norwich falls into two broadly distinct types, which approximately lie either side of the airport. The landscape to the east of the airport tends to occupy relatively flat arable land with no major rivers, although a cluster of historic parklands lies between Rackheath and Spixworth. In the west, the combination of major river valleys with pasture in the valley floor and steep glacial topography provide considerable constraints in terms of finding route options that are likely to be acceptable in landscape terms.

In general, away from the urban areas of Norwich the surrounding villages are old in character with varied features such as ancient churches and historic buildings and with a strong sense of history associated with their setting within the landscape.

Visual intrusion and the effects on the setting of the villages and built up areas surrounding Norwich are likely to occur where route options for an NDR are in close proximity. Areas to the west potentially affected include Weston Longville, Attlebridge, Ringland, Taverham, Costessey and New Costessey. Areas to the east include the northern and eastern fringes of Norwich and the villages of Horsham St Faith, Spixworth, Rackheath and Thorpe End.

2.2.3 <u>Cultural Heritage</u>

Cartographic evidence for the Norwich and the surrounding areas begins with a map of 1585, depicting the great expanse of Mousehold Heath. This points to the area to the east of Norwich being mostly open heath and sheepwalks until enclosure around 1800; the place names Mousehold and Rackheath are reminders of this former heath. From 1800 to the present, the area has remained divided into regular fields and closes, typical of Parliamentary Enclosure, crossed by long straight roads laid out as part of this campaign.

However, more comprehensive cartographic evidence for this area begins with Faden's map of 1797 showing the landscape before enclosure. Whilst Bryants map of 1826 and later maps, show the situation after enclosure and also show that since enclosure the landscape changed little, except for the gradual loss of hedges and the outward growth of Norwich.

Archaeological features have been recorded in the east and west of Norwich, including numerous cropmarks. Occupation and activity has been particularly concentrated on river systems, along valley bottoms and on river terraces above the Wensum valley. There are no Schedule Ancient Monuments on the English Heritage Sites and Monuments Records and no locally designated sites of archaeological importance.

There are a numerous listed buildings to the east and west of Norwich. The most significant of these is Morton Lodge a grade II listed building adjacent to the A1067 at Attlebridge. To the east of Norwich there remains significant areas of historic parkland that remain intact.

2.2.4 Environmental Status and Designations

Numerous sites of international, national or regional importance have been designated within the scheme corridor, more detail can be found in chapter 5.

Nature conservation designations in the study area include the River Wensum SAC and SSSI, all western route options cross the SAC. Numerous County Wildlife Sites have been classified and are of non-statutory conservation importance, of which 10 are directly affected by one or other of the route options.

There are six areas of ancient woodland, none of which would be directly affected.

One Roadside Nature Reserve has been notified on the A1067 between Attlebridge and Taverham.

Several existing and new records of protected species, including great crested newts, badgers, otters and water vole can be found throughout the corridor.

The River Wensum also forms part of the Broads ESA scheme which aims to promote and improve the landscape.

2.3 Drainage and Hydrology

The River Wensum, River Tud, a tributary of the River Bure and a tributary of the River Yare all flow through the study area. Also in the vicinity are the Rivers Yare, Tiffey and Tas. However, these are all considered to be sufficiently separated from the proposed routes that they have not been considered in detail in this assessment.

Flow gauging stations on the Rivers Wensum and Tud show that the mean annual flood flows are 18.6 $m^3 s^{-1}$ for the Wensum and 3.2 $m^3 s^{-1}$ for the Tud and base flow index is 0.73 and 0.65 respectively. Further details can be found in chapter 5.

Minor rivers and streams are likely to run dry during periods of low groundwater levels, in particular during summer months. This is typical of Chalk areas, where surface waters have high base flow indices, i.e. are largely fed by groundwater.

Schedules of discharge consents and existing Integrated Pollution Control (IPC) and Pollution Prevention and Control (PPC) licences, issued by the Environment Agency, have been examined. The presence of these discharges has been noted in order to indicate current stresses on surface waters within the study area, details if this can be found in chapter 5.

Areas of the study area have been designated as protected resources and of high groundwater vulnerability. Also, source protection zones have been designated around the public water supply abstraction point on the River Wensum.

Drainage measures would need to be provided on cut slopes and carriageways to deal with groundwater and surface runoff. At this stage, it is proposed that all runoff would be treated through SUDS with outfalls where necessary to groundwater only, and details will be developed at Stage 3. Further detail can be found in Chapter Five.

2.4 **Public Utilities (Statutory Services)**

The study area has an extensive network of public utilities (services such as electricity, gas and communications), concentrated mainly in urban areas and along roads. The construction of sections of a route in these areas would involve disturbance to, and possibly relocation of these services. It is expected that utility plant would be encountered where route links cross or follow existing roads, in which case normal countermeasures would be taken.

Overhead High Voltage electricity cables run west of Easton and may have some impact on the alignment of the two most western routes. Overhead High Voltage electricity cables also run north-west from Broadland Business Park and will be a consideration for the alignment at the eastern end. Other major utility plant which the route corridors would cross include an oil pipeline and a major natural gas pipeline (part of the national grid), both to the west of Aylsham Road. At this stage in the planning process there has been no consultation with the various utility service providers other than to establish the location of the major plant identified above.

3.0 DESCRIPTION OF ROUTE OPTIONS

3.1 Introduction

Assessments of the eleven route options have been undertaken to identify the environmental, engineering, economic and traffic impacts and constraints associated with each. The locations of these various route options are shown on the drawings contained in Part 3 of this report.

Eight of the routes run from the A47 west of Norwich to the A140 north of Norwich and are referred to as the western options. The three eastern options run from the A140 to the A47 east of Norwich. It is intended that the best western and best eastern option will be chosen from the 24 route combinations to deliver a full route around the north of Norwich.

3.2 Western Options

There are eight western routes comprising the green, orange, blue, red, brown and purple routes plus two variation options based on the brown and purple routes. The first four of these route corridors were consulted on in 2003 and amended slightly as a result of the consultation and the findings of the Stage 2 Environmental Assessment Report. The latter four routes were included as a result of suggestions made during the 2003 consultation.

All routes are described from the A47 to the west of Norwich to the A140 Cromer Road.

3.2.1 Green Route

The green route is the closest western option to Norwich, running between the main Norwich urban area and the outlying suburbs of Costessey, Drayton and Taverham. Consequently it is the shortest route at approximately 7km from the A47 to the A140.

The green route leaves the A47 at Longwater and follows the A1074 Dereham Road for 500m. It then heads northeast across the River Tud, the C162 Longwater Lane and continues eastwards to the C171 Town House Road between Old and New Costessey.

From Town House Road, the green route turns north-east and crosses Marriotts Way cycle track, the River Wensum and the C480 Low Road to meet the A1067 Drayton High Road between Drayton and Hellesdon. The route continues northeast to the C261 Reepham Road and carries on to the A140 Cromer Road adjacent to the airport.

3.2.2 Orange Route

The orange route is the closest western option to Norwich, which encompasses the outlying suburbs of Costessey, Drayton and Taverham. It is approximately 10 km from the A47 to the A140.

The orange route leaves the A47 at Longwater and heads north along William Frost Way. It then turns northwest, crossing over the River Tud, the C171 Costessey Lane, the River Wensum and the C172 Ringland Road, where it meets the western blue route. It then continues to the A1067 Fakenham Road, immediately west of Taverham.

The orange route continues in a north-easterly direction across the C262 Fir Covert Road, the U57168 Furze Lane and Marriotts Way cycle track where it

meets the red route and the brown and purple variations. From here, it crosses the C261 Reepham Road northwest of Thorpe Marriott. It then turns southeast, linking with the brown and purple options, and continues to A140 Cromer Road adjacent to the airport.

3.2.3 Blue Route

The blue route starts further west than the orange route but runs close to the built up area of Taverham. It is approximately 11 km from the A47 to the A140.

The blue route leaves the A47 to the west of Easton. From this junction, it heads northeast, crossing the River Tud, the U78215 Stony Lane and the U57321 Sandy Lane. It continues through Aves Gap and crosses the C171 Costessey Lane, the River Wensum and the C172 Ringland Lane and joins the orange route, which it follows to the A140 Cromer Road.

3.2.4 Red Route

The red route is the furthest west of the original 4 routes and consequently is the longest of these at approximately 12km in length.

The red route leaves the A47 to the west of Easton at the same location as the blue route. From this junction, it heads northwards, crossing over the River Tud and severing the U57215 Breck Lane, U57231 Sandy Lane, C174 Honingham Lane and U57217 Church Hill Lane. It then passes under the C172 Ringland Lane crosses the River Wensum and swings eastwards to a roundabout with the A1067 Fakenham Road at Attlebridge Hills. Here it meets the brown and purple variations.

The red route heads northeast, severing the C262 Fir Covert Road and the U57168 Furze Lane and crossing Marriotts Way cycle track. Here it meets the orange and blue routes which it then follows to the grade-separated junction with the A140 Cromer Road.

3.2.5 Brown Route

The brown route was suggested following the 2003 consultation as being the closest route to Norwich, which crosses the River Wensum in the vicinity of an existing river crossing. The route is approximately 15km long from the A47 to the A140.

The brown route leaves the A47 to the west of Easton at the same location as the blue and red routes. From this junction, it heads northwest over the River Tud, crosses the C174 Taverham Road and passes through Ringland Covert. It then crosses the U57214 Breck Lane and continues to the east of Weston Green, where it links up with the purple route. From this point, it continues northwards past Weston Longville, crossing the U57040 Church Lane and the C172 Ringland Lane. It then continues adjacent to the C167 Marl Hill Road to the A1067, east of Morton.

The brown route follows the existing A1067 Fakenham Road, crossing the River Wensum, to the C245 Fakenham Road, east of Attlebridge. The route then leaves the A1067 and continues northeast, to meet Marriotts Way cycle track and the C261 Reepham Road. It then heads southeast, following the C261 to a point south of Home Plantation.

From here the brown route leaves the C261 and continues south-eastwards towards Thorpe Marriott where it combines with the orange, blue, red, brown

variation and purple variation routes. It then follows the same path as these routes to the A140 Cromer Road.

3.2.6 Purple Route

The purple route was suggested following the 2003 consultation as being the closest route to Norwich which crosses the River Wensum in the vicinity of an existing river crossing and does not to cross the River Tud. The route is approximately 15km long from the A47 to the A140.

The purple route leaves the A47 at the C167 Berry Land/Wood Lane junction and heads northeast across the U57216 The Broadway, the U57214 Breck Lane and the U57217 Church Hill Lane. It links up with the brown route to the east of Weston Green. From this point, it follows the brown route the A140 Cromer Road.

3.2.7 Brown and Purple Variations

These two variations follow the brown and purple options from the A47 to the A1067 and on to the C245. However, from here, the variations continue along the existing A1067 Fakenham Road south-eastwards to Attlebridge Hills, where they meet the red route. From here, the variations follow the red route to the A140 Cromer Road.

3.3 Eastern Options

There are three eastern routes comprising the pink, yellow and blue. All three route corridors were consulted on in 2003 and amended slightly as a result of the consultation and the findings of the Stage 2 Environmental Assessment. All routes are described starting from the A140 Cromer Road to the A47 east of Postwick junction. All three options coincide at the A140 Cromer Road to C251 St Faiths Road and from the C442 Middle Road to the A47 at Postwick.

3.3.1 Pink Route

The pink route is the closest eastern option to Norwich, skirting the suburbs of Old Catton and Sprowston and running between Thorpe End and the main urban area of Thorpe St Andrew. Consequently it is the shortest route at approximately 12km from the A140 to the A47.

The route leaves the A140 Cromer Road and heads eastwards, skirting Norwich Airport to travel south-eastwards, crossing the C251 St Faiths Road southeast of Quaker Farm. Here, it splits from the blue route.

The pink route then crosses the C246 Buxton Road to the south of U57187 Beeston Lane and meets the B1150 North Walsham Road close to Norwich Rugby Football Club. Here, it splits from the yellow option.

The pink route then travels south-eastwards to the A1151 Wroxham Road, adjacent to the Sprowston Park and Ride site. It continues on the same bearing across the C283 Salhouse Road and the C874 Plumstead Road, passing through the eastern boundary of Racecourse Plantation. The route then swings eastwards across the C442 Green Lane North and the Norwich to Cromer railway line to the C442 Middle Road, west of Oaks Farm.

At Middle Road, the pink route meets the yellow and blue options. It heads southwards across the U59392 Low Road and U59400 Smee Lane, and meets the A47 at Postwick.

3.3.2 <u>Yellow Route</u>

The yellow route traverses the area between the pink and the blue routes and is approximately 13km in length from the A140 to the A47.

The yellow route follows the pink route between the A140 and the B1150 North Walsham Road. It then travels eastwards to the A1151 Wroxham Road, west of Tolshill Wood, then heads south-eastwards across Sprowston Manor Golf Course to the C283 Salhouse Road, northeast of Bulmer Coppice. From this point, it continues eastwards, crossing the Norwich to Cromer railway line to the C874 Plumstead Road.

At Plumstead Road, the yellow route joins the blue route and it heads southwards, across the C442 Middle Road and following the pink route to the A47 at Postwick.

3.3.3 <u>Blue Route</u>

The blue route is the furthest eastern option from Norwich, skirting the outlying villages of Spixworth and Rackheath. It is the longest route at approximately 14km from the A140 to the A47.

The blue route follows the pink and yellow routes between the A140 and the C251 St Faiths Road. It then swings eastwards, crosses the C246 Buxton Road and meets the B1150 North Walsham Road near Tithe Plantation. It continues eastwards and meets the A1151 Wroxham Road south of the U57095 Sloe Lane.

From this point, the blue route heads south-eastwards, running parallel to the C258 Green Lane West, crossing the C283 Salhouse Road and the Norwich to Cromer railway line to the C874 Plumstead Road. Here it joins once again with the yellow route, which it follows southwards to the A47 at Postwick.

3.4 **Preliminary Cost Estimates**

Cost estimates have been built up for each of options. The rates used in these estimates have been based on cost information from various schemes in Norfolk, factored to 2002 prices using The Road Construction Tender Price Index:

- A10/A134 Roundabout built 2002
- A10/A1122 Roundabout built 2002
- A140/B1149 Roundabout built 2001
- B1149 Corpusty Bypass a rural single-carriageway built 2001
- A149 Ormesby St Margaret Bypass a rural single-carriageway built 1995
- A143 Brockdish-Needham Bypass a rural single-carriageway built 1994
- A143 Scole-Stuston Bypass a rural dual-carriageway built 1993
- A11 Besthorpe to Wymondham Imp a rural dual-carriageway built 1993

Where rates were not available, the SPONS price book 2003 was used.

The local topography leads to significant cuttings and embankments and earthworks costs have been estimated on the basis cut and fill quantities, with appropriate rates for each. To meet sustainability and objectives minimise costs it has been assumed at this stage that all surplus material will be used within or adjacent to the site for essential landscaping mitigation. Works costs include an estimated allowance for public utility diversions. No consultation with utility companies has been undertaken as part of this scheme assessment.

The County Council's land surveyors, Norfolk Property Services, have provided Land and compensation cost estimates.

Option	Approx		timate (2002	02) (£,000)		
	Length	Works	Land	Total	Maintena	Total
	(km)			scheme	nce	Cost
				cost		
Western green route	6.9	63,003	10,706	73,709	3,190	76,899
Western Orange route	10.3	57,552	7,675	65,227	4,861	70,088
Western Blue route	10.5	51,795	9,939	61,734	4,805	66,539
Western Red route	12.1	61,085	4,597	65,682	6,355	72,036
Western Brown route	14.7	72,540	6,439	79,531	7,699	86,678
Western Purple route	14.3	69,116	5,773	74,889	7,274	82,163
Western Brown variation	15.3	73,092	6,439	78,979	7,665	87,196
Western Purple variation	14.9	69,669	5,773	75,442	7,240	82,682
Eastern Pink route	12.4	43,181	13,041	56,221	5,086	61,308
Eastern Yellow route	12.4	43,594	8,826	52,120	5,621	57,741
Eastern Blue route	13.7	43,504	6,702	50,206	5,994	56,200

A comparative order of costs is included in **Table 3.1**

 Table 3.1 Comparative Order of Costs

4.0 ENGINEERING DESCRIPTION OF ROUTE OPTIONS

4.1 **Generic Considerations**

4.1.1 Carriageway

All routes have been designed to a Design Speed of 120kph as a dual two-lane all-purpose road (D2AP) with 9.3 metre wide carriageways inclusive of 1.0m hard strips. A 2.5m central reserve would be provided along the route. In addition, it is envisaged that a 3.0m shared usage cycleway/footway could be provided within the route corridor for the whole of its length. This cycleway/footway would be continued, where practicable, across any structures on the route.

Pavements would be either flexible or flexible composite construction, with thickness to suit projected traffic flows. Surfacing materials to meet required standards of skidding resistance, reduced noise levels and ability to reduce spray would be specified. Rigid pavements would not be expected to meet all these standards and would not be specified.

A nominal 2.5m grass verge would be provided alongside each carriageway. Highway drainage would be designed using the principles of sustainable drainage. A variety of Sustainable Urban Drainage Systems (SUDS) features would be used depending on topography and environmental constraints. Features would include trenches and swales, in or beyond the verge. The width of the verges and swales would vary along the route. The aim would be to restrict the outfall of surface water from the highway, into existing watercourses in all but extreme circumstances. This would be done by providing ponds or lagoons at frequent locations, to contain run off from the road. The design of these would be based on agreed design storm return frequencies. The importance of the degree of containment is likely to vary in different parts on a route, so systems to contain more extreme events could be appropriate for example near the Tud and Wensum valleys.

4.1.2 Vertical Alignments

The provisional engineering layouts have been designed using Ordnance Survey 5m contour information with vertical alignments to meet the following criteria and assumptions.

- The maximum gradient used is 4% and all curves meet the requirements of a 120kph design speed.
- A basic assumption that earthworks should be minimised by following existing ground contours where possible, with any surplus material being used for adjacent landscaping to minimise the visual impact of the route, as well as keeping transportation of materials to a minimum.
- The requirements at road, river and rail crossings
- Consideration of sensitive locations such as communities where the road may need to be in a cutting or screened by earth bunds

The provisional alignments can be modified to take account of additional requirements for mitigation measures and other requirements identified in detailed development.

4.1.3 Junctions

Junctions would be provided at all major radial roads into the City. In practically all cases they are assumed to be of at-grade roundabout type. However, split level junctions are likely to be necessary at either end where the new road would meet the A47 Trunk Road, and also at the A140 Cromer Road. There are a number of minor roads crossed by the routes and these have been treated according to their situation. There are some cases where it is already clear that a road may be locally important, or where the vertical alignment of the distributor road would make it straightforward to provide a structure. In other cases where the situation is less clear, roads are described as being closed in this report. The provisional treatment for each road is outlined in the route descriptions. However, the eventual treatment would depend on detailed consultation during Stage 3 detailed design.

4.1.4 Other Criteria

For safety reasons, street lighting would be provided at all junctions along the route, with the links in-between the junctions being unlit.

Existing Public Rights of Way (PRoW) would be maintained where practicable. Any PRoW severed by the route could be linked to alternative crossing locations or PRoW by use of the proposed cycleway/footway.

Due to the provisional nature of the route alignment, it is not possible to determine whether any Departures from Standard would be required for any of the routes. However, Stage 3 detailed design would seek to minimise the requirements for Departures from Standard, where practicable.

4.1.5 <u>Structures</u>

All routes would require structures of some type, whether this is culverts for drainage, footbridges/underpasses for PRoW or major crossings of side roads or rivers. In principle, all structures would be designed to minimise their impact upon the surrounding landscape. In addition, the maintenance regime of each structure would be examined to ensure that there is minimal disruption to the environment and traffic during routine maintenance.

Any structures used by equestrians would have parapets or barriers of sufficient height to facilitate this usage.

(i) River Wensum Crossing

All western routes cross the Wensum floodplain at different locations along the Wensum valley between Costessey and Attlebridge. There are five different Wensum crossing options corresponding to the green, orange, blue, red and brown/purple (including purple and brown variation) routes. The length of crossing required varies from approximately 350m to 550m.

On any of the routes, the road would be above existing ground levels to cross the river and the flood plain. Whilst this could mean constructing an embankment, there has been a presumption that there would be a requirement not to obstruct the flood plain. Therefore the provisional designs assume that a structure would be constructed.

The most economical and practical form of construction for a crossing of this length would be a multi-span bridge or viaduct (the term viaduct is typically used for bridges with more than four spans and shall be used, where appropriate, from now on). Long span alternatives would be much more expensive than a multi-span viaduct and therefore long span construction bridge forms have not been considered during Stage 2 design.

For a multi-span viaduct, the geology, topography, and environmental factors (including aesthetics) peculiar to each route option site would affect the most appropriate construction and span configuration for each route option. The environmental factors (including aesthetics) are discussed in detail in Section 5; this section deals mainly with the engineering aspects.

The design philosophy of both steel and concrete forms of viaduct construction should emphasis lowest overall life cost rather than purely lowest initial capital cost, in accordance with, as far as possible, BD 57/01 and BA 57/01- Design for Durability. The choice of span configuration, i.e. the number of piers together with the extent of approach embankment, can significantly affect both the cost and appearance of the bridge crossing. In the following the overall length of the bridge would be taken as the total length of superstructure from abutment to abutment.

Bridge design codes advise that bridges with overall lengths not exceeding 60m and skews not exceeding 30° should be constructed with integral abutments. Other references indicate that integral bridges up to 120m total lengths have been built abroad, but not in the UK. However, due to the overall length of the viaducts for all options, significant thermal movements of the deck would be expected, that could not be accommodated by integral abutments or asphaltic plug joints. Therefore as a minimum, the use of mechanical movement joints at abutments would be required.

(ii) Steel v Concrete Superstructure – General considerations

A steel based superstructure would probably be slightly more expensive than a wholly concrete one, but for any foundation conditions its lower self-weight would generally result in a cheaper substructure. Clearly the poorer the foundation conditions and the greater the proportion of the total cost accounted for by the substructure, the more cost effective a steel superstructure is likely to become.

Steel can be used relatively economically to provide a smaller construction depth than concrete construction and this may be significant where there is a severe headroom restraint under the viaduct resulting in a restricted construction depth for the span considered. This may assist in the placement of structures over river crossing with headroom constraints, such as the rivers Tud and Wensum.

Steel has traditionally been considered to have greater maintenance costs (e.g. repainting) than concrete. However, the differential has been reduced in recent years by use of long life corrosion protection systems, or through the use of permanent enclosures in accordance with BD 67/96 "Enclosure of Bridges". Alternatively weathering steel may be used. However, permanent enclosures can have the additional benefit of providing internal access for inspection and future maintenance and therefore may be desirable where environmental designations may impose upon normal practice (see Section 5). Long life coatings, permanent enclosures and weathering steels all increase initial capital cost, but reduce whole life maintenance costs.

The main benefits of a concrete-based superstructure are that it may be slightly cheaper in certain circumstances (see comments above) and may have reduced maintenance costs compared to a steel-based option.

(iii) Concrete Superstructure Options

Possible concrete superstructure construction types to be considered include the following three main types:

- (i) Precast pre-tensioned beams acting compositely with insitu concrete slab deck.
- (ii) Insitu post tensioned voided deck.
- (iii) Precast post-tensioned glued segmental voided deck.

All three would comply with BD 57/01 and BA 57/01- Design for Durability. In relation to post-tensioned construction segmental structures, these would feature externally bonded tendons accommodated within the deck void. This would allow the tendons to be readily accessible for inspection and maintenance.

As for the steel superstructure options, the economics of these forms are dependent on site-specific span and construction depth constraints.

Type (i) construction whilst potentially very economical is limited to individual spans up to about 34m (standard U beams) or 40m (standard SY beams).

Type (ii) to (iii) are appropriate for spans in the range 30m to 100m (assuming construction depth not restricted).

(iv) Steel Superstructure Options

Some typical steel superstructure construction types are listed below. All these options utilise an in-situ composite slab acting compositely with the steel beams.

- (i) Longitudinal steel plate girders acting compositely with in-situ concrete slab.
- (ii) Longitudinal steel plate girders with transverse cross beams, all acting compositely with in-situ concrete slab ('ladder beam' construction).
- (iii) Steel composite box girders (single box beam under each carriageway or twin box beams under each carriageway).

The economics of these forms are dependent on site-specific span and construction depth constraints. It should be noted that ladder beam decks generally have a larger construction depth for a given span.

If it was desired to maximise the span, the aesthetic impact of the corresponding depth of the longitudinal plate girders could be reduced by employing a varied depth along their length. It is quite common to increase the girder depth over intermediate supports and this variation in depth is most readily achieved by straight haunching (tapered girders). For spans below 50m the choice of varying depth would attract a cost premium, above 50m it may however offer economy because of the weight savings possible in the midspan regions.

Steel composite box girders are generally more expensive for shorter spans, but for larger straight spans, in the range 45m to 100m, they may be considered. Steel composite box girders are particularly suited to bridges curved in plan and in this situation offer significant advantages over an equivalent steel girder

composite. Box girder bridges can offer the advantages of better appearance and reduced maintenance costs compared to plate girders

(v) Substructure Considerations

Foundations: No detailed consideration of the geological conditions for any of the crossing sites has been carried out, as this is usually carried out during Stage 3 detailed design. However, the ground conditions in the floodplain are almost certainly going to require piled foundations for both the intermediate supports and abutment foundations.

The most appropriate pile type would depend on the exact geological conditions for each site. However environmental constraints are likely to dictate the pile type, particularly for the intermediate supports adjacent to the River Wensum. It is considered that cast in-situ piles may not be appropriate due to the possible polluting effect on the watercourse and groundwater. Any piling option would be investigated with the Environment Agency during Stage 3 detailed design.

Intermediate Support Piers: For all the crossing sites, intermediate supports would generally be constructed in reinforced concrete. A number of pier configurations and surface finishes are possible, and these can have a very significant impact on aesthetics of the viaduct when viewed from a distance and close up. The intermediate supports can be made very slender with careful design. This does come with an increase in cost over a standard design.

Abutments: The abutments and wing-walls would also be constructed in reinforced concrete. The most appropriate abutment construction, from an aesthetic point of view, would be a bank seat type abutment. However, this may not be possible for some options due to physical and environmental constraints.

(vi) River Tud Crossing

At this stage it has been assumed that the River Tud will be crossed by a single span bridge, with the road on embankments across the flood plain either side of the bridge. This assumption is based on the requirements for the Tud crossing in relation to the link road for the new west of Costessey housing development, and the cost estimates for the western routes are based on such a layout.

4.2 Engineering Description of Routes

4.2.1 Western Green

The green route has a requirement for a new junction with the A1074 at Lodge Farm. The existing A1074 Dereham Road would be widened to dual carriageway standard from the existing A47(T) Longwater junction. From the new junction, the route then heads north-east, crossing the River Tud and severing Longwater Lane. It then proceeds east along the Tud valley on viaduct in the flood plain and cutting elsewhere. The route would then provide a roundabout on the C171 Town House Road. From here the route would head north-east in cutting across arable fields to the River Wensum.

The proposed horizontal bridge alignment at this location is a gentle reverse curve and the total bridge length that would be required to give minimum clearance to the floodplain is about 250m. If it was required to provide a more open aspect to the valley in elevation then the bridge could be extended to about 400m total length. The proposed highway alignment would be approximately 8m above the existing ground level where the bridge would cross

the River Wensum, reducing to about 6m at the northern extremity of the flood plain. This clearance would allow Marriotts Way to be continued under the structure.

From the edge of the floodplain the route would continue on embankment, severing the C480 Low Road, to a roundabout with the A1067 Fakenham Road. It would then continue in cutting through the existing woodland up to a new atgrade roundabout on the C26 Reepham Road. The route would then pass adjacent to Horsford Manor to a new split-grade junction with the A140 Cromer Road adjacent to Norwich International Airport. The B1149 Holt Road would be diverted to a new at-grade roundabout on the A140.

Five structures are currently envisaged:

- Underbridge over the A47(T) at Longwater Junction
- Dual-carriageway bridge over the River Tud at Longwater Lane
- Dual-carriageway viaduct over River Tud along the river valley (300m)
- Dual-carriageway viaduct over River Wensum floodplain (250m) with minimum clearance of 5m over the river. This would allow continuation of Marriotts Way and the existing bridleway underneath the viaduct.
- Dual-carriageway bridge over the A140 Cromer Road

The maximum cutting depth is approximately 8m (between Town House Road and the River Wensum) and the maximum embankment height is over 7m (split-grade junction with the A140 Cromer Road).

4.2.2 <u>Western Orange</u>

The orange route has a requirement to reconfigure the existing junction with the A47(T) at Longwater to a split-grade roundabout junction. From here the route would proceed through Longwater Business Park, along William Frost Way, which is already a dual carriageway, to the roundabout adjacent to Sainsbury's superstore. The orange route would head in a north-westerly direction crossing the River Tud by a bridge (minimum 3m clearance above water level) and looping to the west of the envisaged housing development at West Costessey. The route would then require a deep cutting through Ringland Hills to arrive at the River Wensum valley.

The proposed horizontal alignment of the viaduct at this location is approximately straight and the total bridge length that would be required to give minimum clearance to the floodplain and Costessey Lane is about 460m. If it was required to provide a more open aspect to the valley in elevation then the bridge could be extended to about 560m total length. The proposed highway alignment is approximately 10m above the existing ground level adjacent at the location where the bridge would cross the River Wensum reducing to about 1m at the northern extremity of the flood plain. This may require a height restriction on the C171 Costessey Lane. This would be determined during Stage 3 detailed design.

The route would then curve northwards, firstly on embankment, then passing in a cutting under C172 Ringland Road before proceeding in small cuttings and on embankments across the golf course to a new at-grade roundabout with the A1067 Fakenham Road. The route would then proceed north-east predominantly at-grade, severing Fir Covert Road, passing over Marriotts which is in cutting and severing Furze Lane to arrive at a new roundabout with C261 Reepham Road. From here the route would continue east, mostly in cutting and severing Drayton Lane. The proposed route would then pass over the B1149 Holt Road before finishing at a split-grade junction with the A140 Cromer Road.

Seven structures are currently envisaged: -

- Underbridge over the A47(T) at Longwater Junction
- Dual-carriageway bridge over River Tud
- Dual-carriageway viaduct over River Wensum floodplain (310m) with minimum clearance of 5m over the river.
- Single-carriageway bridge over the NDR at C172 Ringland Road
- Dual-carriageway bridge over Marriotts Way
- Dual carriageway bridge over the B1149 Holt Road
- Dual-carriageway bridge over the A140 Cromer Road

The maximum cutting depth is approximately 20m (Ringland Hills) and the maximum embankment height is over 7m (at the A140 Cromer Road).

4.2.3 Western Blue

The blue route leaves the A47(T) to the west of Easton. At this stage, uncertainty over trunk road programme and the topography of the area means an oval at-grade roundabout can be constructed which will replace the existing Easton roundabout and link in with the existing single carriageway section of the A47(T) while allowing for future grade separation when the A47(T) is dualled.

From this junction, the blue route would proceed north-eastwards to cross the River Tud on a bridge, giving a minimum clearance of 3m over the river level. The route would then rise to the east of Harman's Grove up over the Ringland ridge in cutting, severing the U78215 Stony Lane. The U57321 Sandy Lane could be continued by use of an overbridge as the route continues over Ringland Ridge to arrive at the Wensum floodplain.

The proposed horizontal bridge alignment at this location is on a very slight curve and the total bridge length that would be required to give minimum clearance to the floodplain is approximately 310m. If it was required to provide a more open aspect to the valley in elevation then the bridge could be extended to about 350m total length. The proposed highway alignment is approximately 5m above existing ground level on the east side of the River Wensum where the bridge would cross the river. This may give rise to a height restriction on the C171 Costessey Lane.

The route would then curve northwards, firstly on embankment, then passing in cutting to pass under C172 Ringland Road before proceeding in small cuttings and on embankments across the golf course to a new at-grade roundabout with the A1067 Fakenham Road. The route would then proceed north-east predominantly at-grade, severing Fir Covert Road, passing over Marriotts Way which is in cutting and severing Furze Lane to arrive at a new roundabout with C261 Reepham Road. From here the route would continue east, mostly in cutting and severing Drayton Lane. The proposed route would then pass over the B1149 Holt Road before finishing at a split-grade junction with the A140 Cromer Road.

Seven structures are currently envisaged: -

- Dual-carriageway bridge over River Tud
- Single-carriageway bridge over the NDR for the U57321 Sandy Lane
- Dual-carriageway viaduct over River Wensum floodplain (310m) with minimum clearance of 5m over the river

- Single-carriageway bridge over the NDR for the C172 Ringland Road
- Dual-carriageway bridge over Marriotts Way
- Dual carriageway bridge over the B1149 Holt Road
- Dual-carriageway bridge over the A140 Cromer Road

The maximum cutting depth is approximately 10m (Ringland Ridge) and the maximum embankment height is over 7m (at the A140 Cromer Road).

4.2.4 Western Red

The red route leaves the A47(T) to the west of Easton. At this stage, uncertainty over trunk road programme and the topography of the area means an oval atgrade roundabout can be constructed which will replace the existing Easton roundabout and link in with the existing single carriageway section of the A47(T) while allowing for future grade separation when the A47(T) is dualled.

From this junction, the red route would proceed northwards to cross the River Tud on a bridge, giving a minimum clearance of 3m over the river level. The route would then rise to the west of Harman's Grove up over the Ringland ridge in cutting and severing the U57215 Breck Lane, the U57231 Sandy Lane, the C174 Honingham Lane and the U57217 Church Hill Lane, before passing under the C172 Ringland Lane in cutting. Ringland Lane would be continued by use of an overbridge. The route would then continue in cutting through Primrose Grove to arrive at the Wensum floodplain.

The proposed horizontal bridge alignment at this location has a 1020m curve and the total bridge length that would be required to give minimum clearance to the flood plain is about 670m. If a more open aspect to the valley was required in elevation then the bridge could be extended to about 350m total length. The proposed highway alignment is approximately 6m above existing ground level adjacent to the River Wensum where the bridge would cross the river.

From the floodplain the route would continue east to a new at-grade junction with the A1067 Fakenham Road. The route would then again head east, predominantly at ground level, around the south of Deighton Hills to sever the C262 Fir Covet Road. The route would then continue eastwards, predominantly at-grade, passing over Marriotts Way which is in cutting and severing Furze Lane to arrive at a new roundabout with C261 Reepham Road. From here the route would continue east, mostly in cutting and severing Drayton Lane. The proposed route would then pass over the B1149 Holt Road before finishing at a split-grade junction with the A140 Cromer Road.

Six structures are currently envisaged: -

- Dual-carriageway bridge over River Tud
- Single carriageway bridge over the NDR for C172 Ringland Lane
- Dual-carriageway viaduct over River Wensum floodplain (670m) with minimum clearance of 5m over the river.
- Dual-carriageway bridge over Marriotts Way
- Dual carriageway bridge over the B1149 Holt Road
- Dual-carriageway bridge over the A140 Cromer Road

The maximum cutting depth is approximately 12m (Primrose Grove) and the maximum embankment height is over 7m (at the A140 Cromer Road).

4.2.5 <u>Western Brown</u>

The brown route leaves the A47(T) to the west of Easton. At this stage, uncertainty over trunk road programme and the topography of the area means an oval at-grade roundabout can be constructed which will replace the existing Easton roundabout and link in with the existing single carriageway section of the A47(T) while allowing for future grade separation when the A47(T) is dualled.

From this junction, the brown route would head northwest, across the River Tud on a bridge giving a minimum clearance of 3m above the river level. The route then continues in cutting, severing C174 Taverham Road, before proceeding through Ringland Covert (wood). The U57216 The Broadway, U57214 Breck Lane and U57217 Church Hill Lane would be severed. The route would then be placed in a cutting past Weston Longville, severing the U57040 Church Lane and passing under the C172 Ringland Lane to the east of Weston Longville. The C167 Marl Hill Road would be continued. Between the U57217 Church Hill Lane and the U57040 Church Lane the brown route crosses twice under the line of pylons.

A new at-grade roundabout would be provided to the west of the River Wensum floodplain, giving access to the proposed road from Morton. The route would then require the enlargement southwards of the existing A1067 road bridge over the River Wensum to accommodate the new road, necessitating the demolition of Morton Lodge. The route would then continue along the A1067 to a new at-grade roundabout with the C245 Fakenham Road. This roundabout would give access to Attlebridge from the proposed road.

The route then leaves the A1067 Fakenham Road north-eastwards to a new atgrade roundabout on C261 Reepham Road, adjacent to Marriotts Way. There would be a need for a local diversion of Marriotts Way to a segregated crossing. The route then follows Reepham Road more or less at grade. The C262 Taverham Lane could be continued by placement of an overbridge adjacent to Freeland Corner. The brown route would leave the C261 Reepham Road south of Home Plantation and a new at-grade roundabout would be placed here, giving access to the C261 Reepham Road. Drayton Lane would be severed by the new road. The proposed route would then pass over the B1149 Holt Road before finishing at a split-grade junction with the A140 Cromer Road.

Six structures are currently envisaged: -

- Single-carriageway bridge over the NDR for C172 Ringland Lane
- Modification of the existing River Wensum crossing to dual carriageway width
- Underpass for continuation of Marriotts Way for cyclist and pedestrians
- Single-carriageway bridge over the NDR for the C262 Taverham Lane
- Dual-carriageway -bridge over the B1149 Holt Road
- Dual-carriageway -bridge over the A140 Cromer Road

The maximum cutting depth is approximately 9m (where the C174 Taverham Road is severed) and the maximum embankment height is over 7m (at the A140 Cromer Road.

4.2.6 <u>Western Purple</u>

The purple route would leave the A47(T) at a junction with Wood Lane and Berry Lane. At this stage, uncertainty over trunk road programme and the topography

of the area means that the junction will need to be constructed at-grade, with the trunk road passing over the NDR when the A47(T) is dualled.

From this junction, the purple route would proceed northeast from the A47 crossing over Foxburrow Plantation on a high embankment. The U57216 The Broadway, the U57214 Breck Lane and the U57217 Church Hill Lane would be severed. The route would then be placed in a cutting past Weston Longville, severing the U57040 Church Lane and passing under the C172 Ringland Lane to the east of Weston Longville. The C167 Marl Hill Road would be continued. Between the U57214 Breck Lane and the U57040 Church Lane the brown route crosses three times under the line of pylons.

A new at-grade roundabout would be provided to the west of the River Wensum floodplain, giving access to the new road from Morton. The route would then require the enlargement southwards of the existing A1067 road bridge over the River Wensum to accommodate the new road, necessitating the demolition of Morton Lodge. The route would then continue along the A1067 to a new at-grade roundabout with the C245 Fakenham Road. This roundabout would give access to Attlebridge from the proposed road.

The route then leaves the A1067 Fakenham Road north-eastwards to a new atgrade roundabout on C261 Reepham Road, adjacent to Marriotts Way. There would be a need for a local diversion of Marriotts Way to a segregated crossing. The route then follows Reepham Road more or less at grade. The C262 Taverham Road could be continued by placement of an overbridge adjacent to Freeland Corner. The purple route would leave the C261 Reepham Road south of Home Plantation and a new at-grade roundabout would be placed here, giving access to the C261 Reepham Road. Drayton Lane would be severed by the new road. The proposed route would then pass over the B1149 Holt Road before finishing at a split-grade junction with the A140 Cromer Road.

Six structures are currently envisaged:-

- Single-carriageway bridge over the NDR for C172 Ringland Lane
- Modification of the existing River Wensum crossing to dual carriageway width
- Underpass for continuation of Marriotts Way for cyclist and pedestrians
- Single-carriageway bridge over the NDR for Taverham Lane
- Dual-carriageway bridge over the B1149 Holt Road
- Dual-carriageway bridge over the A140 Cromer Road

The maximum cutting depth is approximately 7m (under C172 Ringland Lane) and the maximum embankment height is over 7m (over Foxburrow Plantation and at the A140 Cromer Road).

4.2.7 <u>Western Brown/Purple Variation</u>

The western brown and purple variations follow the original routes from the A47(T) to the proposed roundabout on the A1067 Fakenham Road with the C245 old Fakenham Road. From here the alternative alignment for both routes follows the existing A1067 towards Norwich, dualling the existing road along its north-eastern side, rather than on the side nearest the Wensum floodplain. The route would then require an at-grade roundabout to allow it to divert from the A1067 east around the south of Deighton Hills and severing C262 Fir Covert Road. The route would then continue eastwards, passing over Marriotts Way which is in cutting and severing Furze Lane to arrive at a new roundabout with

C261 Reepham Road. From here the alternative alignment would rejoin the route of the original routes through to the A140 Cromer Road.

The purple/brown variation is predominantly at-grade, with minimal cutting or embankments

One structure would be required on the variant section: -

Dual-carriageway bridge over Marriotts Way

4.2.8 Eastern Pink

The pink route would start at a new split-grade junction where the NDR passes over the A140 Cromer Road. The route would then proceed in cutting across the northwest arm of Norwich International Airport before curving north to a new roundabout at the north-western tip of the airport. This roundabout will facilitate the road turning sharply southeast to follow the perimeter of the airport towards Quaker Farm. The route would then proceed at-grade south-eastwards, severing St Faith's Lane before rising on embankment and passing over the C246 Buxton Road to arrive at a new at-grade roundabout with the B1150 North Walsham Road. The vertical and horizontal alignment of the dual carriageway may require modification during Stage 3 detailed design in order to fully satisfy the operational requirements of Norwich Airport. This may involve placement of the route in cutting from the eastern end of the airport to the Buxton Road. This would give the additional benefit of reducing the visual impact of the currently proposed embankment.

From the junction with North Walsham road, the pink route would then progress south-east in cutting to a new at-grade roundabout with the A1151 Wroxham Road adjacent to the Park & Ride facility. This would necessitate realignment of the access to the Park & Ride site. From the Wroxham Road, the route would continue south-eastwards at ground level to a new roundabout on the C283 Salhouse Road. It would then pass into a shallow cutting through Racecourse Plantation to a new at-grade junction with the C874 Plumstead Road. From here the route would head east rising on embankment and severing the C442 Green Lane North, before passing over the Norwich to Cromer railway line to arrive at a new at-grade roundabout with the C442 Middle Road adjacent to Oaks Farm. The route would then head south, severing the U59392 Low Road and the U59400 Smee Lane before finishing at a reconfiguration of the existing junction with the A47(T) at Postwick to a new split-grade junction.

Three structures are currently envisaged:

- Dual-carriageway bridge over Buxton Road
- Dual-carriageway bridge over railway line
- Underbridge over the A47(T) at the Postwick junction

The maximum cutting depth is approximately 7m (split-grade junction with the A47(T)) and the maximum embankment height is over 7m (over railway line).

4.2.9 Eastern Yellow

The yellow route would start at a split-grade junction where the NDR passes over the A140 Cromer Road. The route would then proceed in cutting across the northwest arm of Norwich International Airport before curving north to a new roundabout at the north-western tip of the airport. This roundabout will facilitate the road turning sharply southeast to follow the perimeter of the airport towards Quaker Farm. The route would then proceed at-grade south-eastwards, severing St Faith's Lane before rising on embankment and passing over the C246 Buxton Road to arrive at a new at-grade roundabout with the B1150 North Walsham Road. The vertical and horizontal alignment of the dual carriageway may require modification during Stage 3 detailed design in order to fully satisfy the operational requirements of Norwich Airport. This may involve placement of the route in cutting from the eastern end of the airport to the Buxton Road. This would give the additional benefit of reducing the visual impact of the currently proposed embankment.

From the junction on B1150 North Walsham Road the route would head eastwards at grade to the A1151 Wroxham Road, the horizontal alignment minimising the impact on Foxburrow and Sprowston plantations. A new at-grade junction would be provided on the A1151. From here the route would head southeast on embankment across Sprowston Manor golf course, then through Paine's Yard Wood in cutting, before crossing the old landfill site to a new atgrade junction with C283 Salhouse Road. The route would be raised approximately 1m above existing ground level across the landfill site to ensure that the contaminated ground would not be disturbed.

The road would then continue east, rising on embankment to pass over the Norwich to Cromer railway line to a new at-grade roundabout with the C874 Plumstead Road. The proximity of the railway crossing would necessitate raising the Plumstead Road on its approaches to this new junction. The yellow route would then head south, severing C442 Middle Road, the U59392 Low Road and the U59400 Smee Lane before finishing at a reconfiguration of the existing junction with the A47(T) at Postwick to a new split-grade junction.

Three structures are currently envisaged:

- Dual-carriageway bridge over Buxton Road
- Dual-carriageway bridge over railway line
- Underbridge over the A47(T) at the Postwick junction

The maximum cutting depth is approximately 7m (split-grade junction with the A47(T) and the maximum embankment height is over 7m (over railway line).

4.2.10 Eastern Blue

The blue route would start at a split-grade junction where the NDR passes over the A140 Cromer Road. The route would the proceed in cutting across the northwest arm of Norwich International Airport before curving north to a new roundabout at the north-western tip of the airport. This roundabout will facilitate the road turning sharply southeast to follow the perimeter of the airport towards Quaker Farm. The route would then proceed at-grade south-eastwards, severing St Faith's Lane before swinging eastwards on embankment and passing over the C246 Buxton Road to arrive at a new at-grade roundabout with the B1150 North Walsham Road.

From the B1150, the blue route would pass through Beeston Park and then proceed predominantly on slight embankment to a new at-grade roundabout with the A1151 Wroxham Road. The route would then curve southeast, mostly in cutting, to arrive at a new at-grade junction with the C283 Salhouse Road. It would then continue southeast, passing over the Norwich to Cromer railway line to a new at-grade roundabout with the C874 Plumstead Road. The proximity of the railway crossing would necessitate raising the Plumstead Road on its approaches to this new junction. The blue route would then head south, severing C442 Middle Road, the U59392 Low Road and the U59400 Smee Lane

before finishing at a reconfiguration of the existing junction with the A47(T) at Postwick to a new split-grade junction.

Three structures are currently envisaged:

- Dual-carriageway bridge over Buxton Road
- Dual-carriageway bridge over railway line
- Underbridge over the A47(T) at the Postwick junction

The maximum cutting depth is approximately 7m (split-grade junction with the A47(T)) and the maximum embankment height is over 7m (over railway line).
5.0 ENVIRONMENTAL ASSESSMENT

5.1 Introduction

The information contained in the chapter would normally be a summary of that contained in the Stage 2 Environmental Assessment. However, since the issue of that report, further assessment has taken place based on updated engineering design for the consultation options and the consultation responses of statutory environmental bodies. This chapter therefore represents, in most cases, the full assessment of the options for a Northern Distributor route put forward for consultation in Autumn 2004.

5.1.1 Chapter Structure

This section comprises the environmental issues that are considered relevant to the scheme. The appraisal of each environmental topic is divided into five sections.

- **Introduction and Methodology** The objectives of the assessment and the methods of data collection and analysis are outlined.
- **Baseline Data** Description of the baseline condition.
- Assessment of Impacts or Effects The potential environmental impacts and their effects are identified. Both construction and operational effects of the scheme are considered, the latter being considered both in the opening year and the design year, to give an indication of the long-term impacts of the scheme. It is important to note that the assessment of effects is for a scheme with mitigation measures in place.
- **Mitigation Measures** Description of the measures to avoid, reduce or remedy significant predicted environmental effects.
- **Conclusions and Recommendations** A summary of environmental effects and nay recommended actions.

5.1.2 Evaluation and Assessment of Magnitude and Significance of Effects

The environmental effects of a new road scheme are either local or widespread. They may be adverse or beneficial, direct, indirect, permanent or temporary. Effects may occur immediately upon commencement of construction or at some time in the future. For each of the environmental topics considered, a statement as to the magnitude and significance of the effect is given.

The magnitude of the predicted effect is likely to be a combined measure of the total extent of the area affected and the volume or scale of these effects. Where possible the magnitude of the effect is quantified.

The evaluation of the significance of the effect is a matter of judgement. Significance criteria assess the scale of the potential effect as the resource or receptor. The criteria are measured against:

- the magnitude of the effect;
- the number of people affected;
- the level of importance of the impact in terms of environmental and planning policy/legislation;
- the sensitivity, uniqueness and rarity of location;
- whether the effect is permanent or reversible through mitigation.

The evaluation and assessment of magnitude and significance can, however, only be based on the level of information required for a Stage 2 Assessment.

5.2 Air Quality

5.2.1 Introduction and Methodology

A new road scheme may change traffic flows in a locality in a number of ways, with corresponding impacts on air quality. Road schemes are often perceived as having only negative effects. In some cases, however, the overall effect will be beneficial. If a scheme relieves congestion it can cause vehicles to operate in ways that produce fewer emissions, so reducing overall pollution levels. This occurs because vehicles operate most efficiently and produce least pollution when they are driven in freely flowing traffic at moderate speeds. If traffic is rerouted, the locations where pollution levels are highest will change, and may be transferred away from heavily populated areas where effects would be felt by most people. These effects may offset any increase in emissions caused by traffic using a longer new route. The impact of road schemes upon air pollution is assessed in terms of their effects upon local air quality and on total emissions across the region.

The objective at this stage is to undertake sufficient assessment to identify the likely impacts of the proposed scheme on air quality along each of the route options rather that the regional effect that the overall scheme would have. These potential impacts should be taken into account during the development and refinement of route options and Stage 3 detailed design.

This assessment has been made in accordance with the guidance provided by the Highways Agency, in the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3 Part 1. At Stage 2 this requires applying 0-50m, 50-100m, 100-150m and 150m-200m corridor bands on each side of the proposed routes and counting the number of sensitive receptors within each band

Sensitive receptors include schools, hospitals, houses and recreation areas. It is usual to show the Do-minimum case and the Do-something case to show the exact effects any route may have. However, it is difficult at this stage to calculate exactly how many sensitive locations within the northern suburbs would benefit, but it is estimated that they currently number well into the thousands. This assessment has therefore concentrated on the adverse impacts that any route option would have on the number of properties along its alignment to help in route selection, recognising that the overall impacts of the scheme would be beneficial in terms of local air quality.

5.2.2 Baseline Conditions

(i) Sources of Pollution

The main sources of air pollution in the study area are;

- Road traffic;
- The fire fighting training area at Norwich Airport (north-east end);
- Bayer CropScience chemical works on Sweet Briar Road (Outer Ring Road);
- Industrial Estates.

(ii) *Air quality constraints*

Norwich City Council has reviewed and assessed air quality in Norwich in three stages. This assessment concluded that Air Quality standards for one pollutant,

Nitrogen dioxide (NO₂), were unlikely to be achieved in certain areas of the city by 2005. Consequently, the City Council Cabinet has declared 3 Air Quality Management Areas. These are within or close to the inner-ring road and located at:

- St Augustines
- Grapes Hill
- Norwich Castle

A Stage 4 review and assessment was carried out under Part IV of the Environment Act 1995 Local Air Quality Management, and an Action Plan implemented during the summer of 2004.

5.2.3 Assessment of Impacts

(i) Western Green

This semi-urban route, with its proximity to Drayton, Taverham, Old Costessey and New Costessey would have the largest adverse effect on sensitive locations of any of the western routes. It has the potential to impact on 241 houses along its corridor, 73 of which lie inside the 100m band. In addition, sensitive receptor points identified, which could be affected by this route, are:

- St. Augustine's Primary School, Costessey
- Arden Grove First school, Hellesdon
- Benell Residential Care Home, Drayton
- The Limes, Drayton
- Woodland Nursing Home, Hellesdon
- Black Swan International Residential Home
- Recreation Ground, Costessey
- Drayton Wood
- Sports Field Aylsham Road
- Marriotts Way cycle path
- 1 Public Right of Way in Costessey
- RiverTud
- River Wensum SAC and SSSI
- County Wildlife Site Ref 2106 (Drayton Wood)

(ii) Western Orange

The orange option has the potential to impact upon 43 houses, of which 18 are inside the 100m band. The majority of these lie on the north west of Taverham and Thorpe Marriott. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Taverham High School
- Taverham Hall Preparatory School
- Taverham Golf Course
- Hinks Meadow (Thorpe Marriott)
- Bell Farm Riding School
- Sports Field (Aylsham Road)
- Marriotts Way cycle path
- 2 Public Rights of Way
- River Tud
- River Wensum SAC and SSSI

• County Wildlife Sites Ref 247 (Long Dale), 257 (Lord's Hills), 1339 (Blyth's Wood) and 1351 (Walsingham Plantation)

(iii) Western Blue

The blue option would have the potential to impact upon 33 houses, of which 13 are inside the 100m band. The majority of these lie on the north west of Taverham and Thorpe Marriott. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Taverham High School
- Taverham Hall Preparatory School
- Taverham Golf Course
- Hinks Meadow (Thorpe Marriott)
- Bell Farm Riding School
- Sports Field (Aylsham road)
- Marriotts Way cycle path
- 2 Public Rights of Way
- River Tud
- River Wensum SAC and SSSI
- County Wildlife Sites Ref 2128 ('Adjacent to the Tud'), 2104 (Harman's Grove) and 1351 (Walsingham Plantation)
- (iv) Western Red

The red option has the potential to impact on 11households, 6 of which lie inside the 100m band. The majority of these lie on the northern tip of Thorpe Marriott. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Sports Field (Aylsham Road)
- Bell Farm Riding School
- Marriotts Way Cycle path
- 4 Public Rights of Way
- River Tud
- River Wensum SAC and SSSI
- County Wildlife Sites Ref 2128 ('Adjacent to the Tud'), 2104 (Harman's Grove also Ancient Woodland), 2113 (Jennis Wood also Ancient Woodland), 1340 (Church Hill Common), 2070 (Wensum Pastures), 1343 (Attlebridge Hills) and 1351 (Walsingham Plantation)

(v) Western Brown

The brown option has the potential to impact on 42 properties, of which 17 lie inside the 100m band. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Bell Farm Riding School
- Felthorpe Flying Club
- Sports Field (Aylsham Road)
- Marriotts Way cycle path
- 3 Public Rights of Way
- River Tud
- River Wensum SAC and SSSI

 County Wildlife Sites Ref 2128 ('Adjacent to the Tud'), 2105 (Ringland Covert), 2070 (Wensum Pastures), 1343 (Attlebridge Hills) and 1344 (Mileplain, Triumph and Foxburrow Plantations)

(vi) Western Purple

The purple option has the potential to impact on 40 properties, of which 17 lie outside the 100m band. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Bell Farm Riding School
- Felthorpe Flying Club
- Sports Field (Aylsham Road)
- Marriotts Way cycle path
- 4 Public Rights of Way
- River Wensum SAC and SSSI
- County Wildlife Sites Ref 2116 (The Waterfence), 2070 (Wensum Pastures), 1343 (Attlebridge Hills) and 1344 (Mileplain, Triumph and Foxburrow Plantations)

(vii) Western Brown Variation

The brown variation would impact on 55 properties within 200m, of which 20 lie inside the 100m band. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Bell Farm Riding School
- Sports Field (Aylsham Road)
- Marriotts Way cycle path
- 4 Public Rights of Way
- River Tud
- River Wensum SAC and SSSI
- County Wildlife Sites Ref 2128 ('Adjacent to the Tud'), 2105 (Ringland Covert), 2070 (Wensum Pastures), 1343 (Attlebridge Hills) and 1351 (Walsingham Plantation)

(viii) Western Purple Variation

The purple variation would impact on 53 properties within 200m of the route, of which 20 lie inside the 100m band. These are mainly located along the existing A1067 and around the north west extent of Taverham and Thorpe Marriott. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Bell Farm Riding School
- Sports Field (Aylsham Road)
- Marriotts Way cycle path
- 5 Public Rights of Way
- River Wensum SAC and SSSI
- County Wildlife Sites Ref 2116 (The Waterfence), 2070 (Wensum Pastures), 1343 (Attlebridge Hills) and 1351 (Walsingham Plantation)

(ix) Eastern Pink

The pink route is the closest of the three eastern options to the urban fringe of Norwich. It has the potential to impact on 58 properties, of which 20 lie inside

the 100m band. Areas impacted upon may include some properties at the northern tip of Sprowston, along with some properties at the southern edge of Thorpe End. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Aviation Museum
- North Walsham Road Playing Field
- Norwich Rugby Football Club
- Sprowston Manor Hotel and Golf Course
- Cemetery, Sprowston
- Spixworth cycle path
- 2 Public Rights of Way
- County Wildlife Sites Ref 2041 (Racecourse Plantation) and 2042 (Belmore and Brown's Plantations)

(x) Eastern Yellow

The yellow route lies within open countryside to the north and east of Norwich. It has the potential to impact on 39 properties, of which 16 lie inside the 100m band. Areas impacted upon include Horsham St Faith and the northern tip of Thorpe End. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Aviation Museum
- Walsham Road Playing Field
- Norwich Rugby Football Club
- Sprowston Manor Hotel and Golf Course
- Spixworth cycle path
- 2 Public Rights of Way
- County Wildlife Sites Ref 2021 (Tolshill Wood also Ancient Woodland) and 1392 (March Covert)
- Ancient Woodland at Bulmer Coppice

(xi) Eastern Blue

The blue option lies the furthest out from the urban fringe of Norwich. However, this option would have the potential to have an impact on 62 properties, of which 20 lie inside the 100m band. This is mainly due to the proposed route's proximity to Rackheath, New Rackheath and Horsham St Faith. In addition, sensitive receptor points identified, which could be affected by this route, are:-

- Aviation Museum
- Beeston Park
- Spixworth cycle path
- 2 Public Rights of Way
- County Wildlife Sites Ref 1393 (Ladies Carr and Springs) and 1392 (March Covert)
- Ancient Woodland at Sprowston Wood and Ortolans' Grove

A summary of the routes is given in table 5.2.1. overleaf.

Route	Approximate Number of properties Distance from route			
	0 – 50	50 – 100	100 – 150	150 – 200
Western Green	4	69	56	112
Western Orange	6	12	0	25
Western Blue	3	10	3	17
Western Red	0	6	1	4
Western Brown	3	14	7	18
Western Purple	3	14	6	17
Western Brown Variation	7	13	14	21
Western Purple Variation	7	13	13	20
Eastern Pink	2	18	7	31
Eastern Yellow	2	14	8	15
Eastern Blue	1	19	12	30

Table 5.2.1 Summary of Properties

5.2.4 <u>Mitigation Measures</u>

It is difficult at this time to determine mitigation measures for air quality. The requirement for route alignments to be refined during Stage 3 detailed design would allow for any practicable mitigation measures required to be taken into account at that stage. These may include false cuttings road alignment cuttings and planting. However, there is little that can be done apart from realigning the route to mitigate the adverse impacts on air quality of road schemes.

5.2.5 Conclusions and Recommendations

The construction of the NDR will reduce traffic on residential roads in the suburbs and villages around the north of Norwich giving air quality benefits to a significant number of receptors. At this stage It is not thought that National Governments Air Quality Strategy Objectives for PM_{10} and NO_2 will be exceeded.

In terms of local air quality the western red route and the eastern yellow would have the least adverse air quality impact arising from placement of a new dual carriageway distributor road. If these routes were chosen to be taken forward the cumulative adverse impact would be felt at approximately 63 sensitive locations, of which 31 would lie outside the 100m band. The worst performing route options are the western green and eastern pink options. These are due to their proximities to populated areas.

5.3 Cultural Heritage

5.3.1 Introduction and Methodology

(i) Introduction

The cultural heritage resources that contribute to the overall character of the historic environment can be grouped into three broad categories for assessment:

- Historic buildings
- Historic landscapes
- Archaeological sites

Historic buildings include statutory listed buildings (Grade I, II* and II), locally listed buildings and other features identified by local authorities, interest groups and the Consultant as being of historical interest. This definition also encompasses structures of historic merit such as railway bridges, boundary stones, statues, etc.

Historic landscapes comprise visible elements of the landscape fashioned by human occupation such as field patterns, walls and hedgerows, drainage systems, lime kilns, barns, historic woodlands, village greens, etc. They also include sites of historical events such as battlefields.

Archaeological sites include a variety of features dating from Palaeolithic to modern times and include ruins, stone circles, standing stones, burial chambers, crop and soil marks and finds scatters, etc. They may be designated statutory sites such as Scheduled Ancient Monuments (SAMs) and local authority Archaeological Priority Areas. They also include palaeo-environmental geological features contained in gravels, drift, head material, alluvium and peat deposits.

(ii) Identification of Impacts and Effects

Potential impacts have been identified through a consideration of the construction, operational and maintenance requirements of the scheme, e.g. extent of landtake, level of traffic movements etc. Many impacts that occur during the construction phase are temporary in nature but others may be experienced throughout the operational phase, in which case they are long term. The following list comprises a range of impacts which may occur as a result of the scheme and which could result in effects on cultural heritage:

- temporary or permanent landtake;
- temporary or permanent severance;
- excavation and ground disturbance, including compaction;
- visual disruption during both construction and operation.

These impacts could lead to a set of effects on the archaeological and historic resources.

Such effects have been identified as:

- complete or partial loss of the archaeological feature or topographical evidence due to landtake;
- loss of the physical and visual integrity of the site owing to severance, such that key relationships are lost. This is particularly important where features are clustered together (i.e. group setting) or where the historic setting of an

archaeological monument or historic building or historic landscape/townscape feature is affected by visual intrusion;

- damage to resources as a result of change in water levels;
- direct damage caused by excavation;
- indirect damage as a result of point loading and compaction.

(iii) Evaluative Criteria

For Assessing the Importance of Historical Resource: The importance of archaeological sites, historic buildings and landscape features vary considerably. The starting point for evaluating the sensitivity of the cultural heritage features was to consider their legal or quasi-legal status (such as scheduled ancient monuments, conservation areas and listed buildings). The importance of cultural heritage features can be further defined by use of the non-statutory criteria for scheduling ancient monuments and listed buildings, as set out by English Heritage:

The criteria include:

- survival
- period
- rarity
- fragility
- diversity
- documentation
- group value
- potential
- amenity
- conservation value

For the Significance of Impacts and Effects: There is no standard scale of comparison against which the severity of impacts on cultural heritage may be judged because of the great variety of resources and receptors. Severity of impacts can be judged taking the following into account:

- The proportion of the feature affected and whether key characteristics would be affected, such as the setting of a listed building;
- Consideration of the type, survival/condition, fragility/vulnerability, potential and amenity value of the feature affected.

(iv) Significance Criteria

The significance of effects is determined by integrating the importance of the historic resources with the severity of impact to be judged there.

- Major: Effects which breach national statutory designations and policy and affect sites of national importance. The effects are likely to be of particular importance to national statutory agencies, local authorities, national and local interest groups and the general public. Examples may include demolition or significant landtake within a SAM or Grade I listed building or significant intrusion into the setting of a SAM or Grade I listed building.
- Moderate: Effects which conflict with national designations and local authority policies. They also include effects which do not technically conflict with national or local policy but which are significant in having a major impact on features, which are of particular importance at a

county and local level with local authorities and special interest groups. Examples could include the demolition of a Grade II listed building, extensive landtake in a poorly preserved archaeological site (ie a site of degraded archaeological value), significant visual intrusion to a Grade II* listed building.

Minor: Effects which, although not breaching national or local policies may be raised by local authorities and be of concern to local interest groups and the local public. These effects could be removed by incorporation of additional mitigation in the detailed design process. Examples may include the demolition or extensive intrusion of setting of unlisted historic buildings and loss of non-critical components of an archaeological site of local or county importance.

(v) *Methodology*

The assessment has been prepared in accordance with the principles set out in the Design Manual for Roads and Bridges Volume 11. Norfolk Archaeological Unit was commissioned to assess existing archaeological information relevant to the site; aspects of their report have been incorporated into this Stage 2 assessment. The study area for the cultural heritage assessment is a corridor along the route, is typically 200 metres either side of its centerline of the road.

A desk top assessment was undertaken to identify and evaluate all remains within the study area in the Norfolk Heritage Environment Record (NHER) and other published sources, and to assess the likely impacts of the route options. A preliminary walk over survey was also undertaken.

5.3.2 Baseline Conditions

Except for archeologically survey work and metal detector surveys, little formal archaeological work has previously taken place within the route corridors. However it is inevitable that the pattern of known finds must reflect metal detecting and other surface activity. An archeologically watching brief was undertaken for the Park and Ride site at Sprowston, and an evaluation at site 34170 in the Tud valley north of New Costessey. Informal metal detector surveys have also taken place at St Faiths Farstead, in two fields one north of the airport and second to the north east, a field to the north of Weston Longville, at the extension to Wensum Valley Golf Club and two sites close to Bull Farm one to the South and one to the west.

Archaeological and historical background

Cartographic evidence for the area begins with a map of 1585, depicting the great expanse of Mousehold Heath. This points to the area to the east of Norwich being mostly open heath and sheepwalks until enclosure around 1800; the place names Mousehold and Rackheath are reminders of this former heath. From 1800 to the present, the area has remained divided into regular fields and closes, typical of Parliamentary Enclosure, crossed by long straight roads laid out as part of this campaign.

However, more comprehensive cartographic evidence for this area begins with Faden's map of 1797 showing the landscape before enclosure, whilst Bryants map of 1826 and later maps, show the situation after enclosure and also show that since enclosure the landscape changed little, except for the gradual loss of hedges and the outward growth of Norwich. Archaeological features are shown on Figures in Part 3 of this report.

(i) Eastern Pink, Yellow and Blue – Pre Iron Age

The heavy clays of Norfolk saw little activity in the prehistoric period generally, with fewer flint axes found in this part of Norfolk and with few Bronze Age barrows or metal objects recorded (Lawson and Wymer 1993; Wymer 1993). Iron Age finds from this general area are few and suggest little activity or occupation here. Possibly the heath was beginning to become abandoned to occupation; the main Iron Age centres appear to have been in the west of the county (Green 1993).

The most notable archaeological monuments from this period are:

- Aerial Photograph cropmark evidence of undated enclosures etc Norfolk Heritage Environment Record (NHER) no's. 18152, 18901, 21126
- Excavated flint mounds NHER no. 31108
- Findspots, mostly casual losses rather than 'sites', except possibly NHER no's. 8153, 22047, 22223, 24240 where numbers of flints may indicate prehistoric activity even occupation.

(ii) Western Green, Orange, Blue, Red, Brown and Purple (and their variations) -Pre-Iron Age

On the western side of Norwich the major elements in the landscape are the Rivers Wensum and Tud, and finds along their valleys and slopes suggest past occupation and that many more finds and sites of this age lie in these locations. The evidence from finds of flints and flint tools across the landscape points to an especially significant activity of Late Glacial date, before the inception of the Neolithic and more permanent farming communities. Occupation and activity was particularly concentrated on river systems, along valley bottoms and on river terraces above the valley.

It is important to point out that an earlier find has been made; that of an Acheulian hand axe from high ground above the Wensum valley, close to Ringland Hills. It is the oldest find along any of the route options for a NDR.

High up on Royal Hill, Ringland, extensive finds of flint suggest a major prehistoric activity/occupation site, occupied at times over several Millennia, and includes a Mesolithic flint. Royal Hill continues to be a locus of intensive activity through the Neolithic and Bonze age periods.

Some cropmark evidence may also belong to this period, in particular nine ring ditches which could possibility be the ploughed flat remains of prehistoric burial mounds. The cropmark (ref. 18126) has been identified as a possible prehistoric 'henge' monument. If so this is one of a rare class of monument.

The most notable archaeological monuments from this period are:

- Aerial photographic evidence of undated enclosures, especially at ring ditch sites (7887-8, 11711, 17477, 17657, 21719, 25475, 32234 and new site 1).
- Aerial photographic cropmark at 18126 may be a 'henge'
- Finds of flints at Taverham Road, Honingham pointing to activity sites: 16390, 16391 and 17163 on a hilltop site (brown and brown variation)
- Finds from Royal Hill, Ringland, including 15027, 18046-9, 24021 (red)

(iii) Eastern Pink, Yellow and Blue - Iron Age and Roman

Iron Age activity is still poorly represented in some areas of central Norfolk and only one site is thought to have a possible Iron Age background, NHER no. 36451, although the undated enclosures (see previous) could be of this date.

Several monuments may be of Roman date and these include a Roman road, a possible marching camp NHER no.16451, and cropmarks at NHER no. 36451.

The most notable archaeological monuments from this period are:

- N-S road NHER no. 7598
- Aerial photographic evidence for a Roman marching camp NHER no. 16451
- Aerial photographic evidence for other enclosures NHER no's. 18152, 18901, 21126 and 36451

(iv) Western Green, Orange, Blue, Red, Brown and Purple (and their variations) -Iron Age and Roman

Iron Age activity is still poorly represented in some areas of central Norfolk and only one site is thought to have a possible Iron Age presence (besides 30 Neolithic flints), Site17163, although the undated enclosures could be of this date.

Apart from casual finds, there is little evidence of Roman activity, but several monuments may be of Roman date and these include the possible Roman 'villa' at 11711 on Royal Hill, Ringland, just beyond the edge of the corridor.

Small concentrations of Roman finds also come from:

- Felthorpe, sites 35252/33383
- East of Attlebridge at 20424/25137, 34873-4
- In the Tud valley, 34170 and 34873-4
- In the Wensum valley at Taverham 14870
- The most notable archaeological monuments from this period are:
- Aerial photographic evidence for a villa at 11711 (although outside the corridor)
- Aerial photographic evidence for other enclosures at 13225, 18126, 18131, 18192, 18907, 30315, and 36405 (although these are all of unknown date).

(v) Eastern Pink, Yellow and Blue - Saxon and Medieval

Saxon finds are few and almost certainly represent casual losses and not occupation monuments. Exceptions may be the site of Little Rackheath church NHER no. 12639 (and the possible site of Little Rackheath) and cropmark NHER no. 21127 (possibly sunken huts).

Medieval monuments may include NHER no. 30518, Rackheath Park, if it is medieval in origin.

The most notable archaeological monuments from this period are:

- Little Rackheath church NHER no. 12639 and burials NHER no. 31541.
- Little Rackheath former village site (?).
- Rackheath Park NHER no. 30518 (possibly of medieval origin)
- Aerial Photographic evidence for enclosures etc, NHER no's. 18152, 18901, 21126, 21127.

- Tracks across Mousehold Heath NHER no's. 8127, 8128, 8152, 8166.
- Parish boundary NHER no. 31018.
- (vi) Western Green, Orange, Blue, Red, Brown and Purple (and their variations) -Saxon and Medieval

Saxon finds are few and almost certainly represent casual losses and not occupation monuments.

Medieval monuments may include St Walstan's Well (or its remains), Church Hill Common, Ringland, and Costessey Park. Site 7727, the findspot of a piece of medieval carved stone, may represent the existence of a medieval hermitage site nearby.

Important buildings include St Andrew's Church, Attlebridge, the site of St Mary's Church at Morton on the Hill and the remains of St Walstan's Well, Costessey.

(vii) Eastern Pink, Yellow and Blue - Post medieval

Post medieval sites and monuments are mostly landscapes and buildings, many of which follow on from earlier periods.

The most notable archaeological monuments from this period are:

- Roads NHER no's. 8127, 8128, 8152 and 8166.
- Entrenchments NHER no. 9687-8.
- Landscape parks at Beeston Old Hall (Red Hall Farm), Beeston New Hall NHER no. 30495, Sprowston NHER no. 30522, Rackheath NHER no. 30518.
- Linear features NHER no's.19016 and 31018.
- Pits and postholes (excavated) NHER no. 36799.
- Post-medieval buildings at Quaker Farm/Spixworth Farm, Red Hall Farm/Beeston Old Hall, Oaks Farm, Laurel Farm.

(viii) Western Green, Orange, Blue, Red, Brown and Purple (and their variations) -Post medieval

Again as for the eastern routes the post –medieval sites and monuments on the western side of Norwich are mostly landscapes and buildings, with many entries also found under Saxon and Medieval, but continuing into the later period.

The important archaeological monuments are:

- Taverham Park
- Honingham Hall Park
- Costessey Park
- Breck Farm, Taverham
- Brick Farm/Model Farm, Costessey
- Taverham Hall Farm, Taverham
- Upper Farm/Horsford Manor, Horsford
- West Farm, Horsham St Faith
- 8-10 The Street, Attlebridge
- The Street, Attlebridge
- Bull Farm, Felthorpe
- Brand Farm, Felthorpe
- White Horse Farm, Morton-on-the Hill

A full gazetteer of sites is contained within part 2 of this report.

(ix) Eastern Pink, Yellow and Blue - Listed Buildings and Conservation Areas:

There are no listed buildings within the study area; however two listed features would receive fairly open views of the pink route.

The first is the Parish Church of St Mary and St Margaret, Church Lane, Sprowston, a grade I listed building. The building originates from the 14th Century, and was restored in 1889. It is built of brick and flint, with brick and stone dressings, and lead and copper roofs. The churchyard wall and gates of the same church are grade II listed structures dating back to 1857. Built of knapped flint, gault brick and wrought iron, they contribute to the overall value. Figures 3a and 3b in Section 3 identify locations of listed buildings within the study area.

The second is Rackheath Hall, a grade II listed building dating from the 19th Century. It has recently been restored and converted into flats, with additional properties built adjacent to the original Hall.

There are however other buildings that are important in the context of the historic landscape.

- <u>Spixworth, Quaker Farm (Spixworth Farm 1907)</u> An 18th century farm complex with house, thatched barn and attached stables, and 20th century cottages on the road frontage. All within a compact curtilage.
- <u>Sprowston, Sprowston Manor (Hall) and Park</u> The original hall built in 1559, replaced by present hall in 1872-6. Parkland existed here by 1797 but may be early 18th century in origin, with the Park to the south and southwest of the Hall.
- <u>Beeston St Andrew, Red Hall Farm (site of Beeston Old Hall)</u> The original Beeston Hall stood at this site however it was moved at an unknown date to its present site to the east. The present 19th Century villa is of red brick with a farm complex and a small Park attached to the south.
- <u>Beeston St Andrew, New Hall and Park</u> The Park existed by 1797 with a north South Avenue laid out by 1842. The present hall is 1890 in date, replacing a house of early 19th Century.
- <u>Gt and Lt Plumstead, Laurel Farm (or The Laurels)</u> Post enclosure farm. Red brick house
- <u>Gt and Lt Plumstead, Oaks Farm, Tukes Green</u> An early 19th Century farm house and complex set on the former edge of Tukes Green. The Green has been enclosed but its line is fossilised in a wide ditch within the gardens of The Oaks. Large trees also mark the extent of the former triangular garden.
- <u>Rackheath Hall and Park</u> The known origins of the Park go back to the 18th Century but the south west corner of the Park with pale and leapgate is shown on the map of 1585 and is therefore most likely to be in origin a medieval deer park and not a later landscape park. The Park was extended to the south in 1984, following enclosure, over former heath land.

There are no Conservation Areas within the study area.

(x) Eastern Pink, Yellow and Blue - Scheduled Ancient Monuments:

There are no scheduled ancient monuments located within any of the route corridor on the eastern side of Norwich.

(xi) Eastern Pink, Yellow and Blue - Historic Parklands:

Three historic parklands have been identified through Norfolk County Council's inventory of parks, Rackheath Hall, Sprowston Manor Park and Beeston Park, all of which remain intact today. A fourth minor Park not on the NCC inventory due to its size is Red Hall Farm (the site of Old Beeston Hall)

(xii) Western Green, Orange, Blue, Red, Brown and Purple (and their variations) -Listed Buildings and Conservation Areas:

Nine listed buildings lie within the study area's of the routes on the western side of Norwich:

- <u>Beehive Lodge</u> is a Grade II listed building, formerly the lodge at Costessey Park, dated from the early 19th Century.
- <u>Hill Farm House is a Grade II listed building</u>, a 17th Century house.
- <u>Taverham Hall</u> is a Grade II listed building.
- <u>Low Farm</u> is a Grade II listed building with an additional 17th Century threshing barn.
- <u>The Church of St Peter in Easton</u> is a Grade I listed building, built in the late 12th Century with later additions in the 13th and 15th Centuries. It lies 100m east of the A47 and is built from partially rendered flint with stone dressings. Roofs are pantile and slate.
- <u>The Church of St Andrew, Attlebridge,</u> grade II* listed building, built during the 13th Century with 15th Century additions.
- <u>Church Farm House Attlebridge</u>, grade II listed building dated from the 18th Century constructed from colour washed bricks, pantile roof with gabled ends.
- <u>Model Farm in Costessey</u> is a Grade II listed building c. 1840. The building is red brick with slate roofs and is situated approximately 150m west of the proposed route.
- <u>Morton Lodge, Morton on the Hill</u> is a grade II listed building c. 1830.
- <u>Berry Hall, Honingham is a grade II listed building.</u>

The listed buildings within the study area are shown on two figures in part 3 of this report. The following list is of other buildings that are important in the context of the historic landscape;

- Breck Farm, Taverham
- Brick Farm/Model Farm, Costessey
- Taverham Hall Farm, Taverham
- Upper Farm/Horsford Manor, Horsford
- West Farm, Horsham St Faith
- 8-10 The Street, Attlebridge
- 7 The Street, Attlebridge
- Bull Farm, Felthorpe
- Brand Farm, Felthorpe
- White Horse Farm, Morton-on-the Hill

There are no Conservation Areas within the study area.

(xiii) Western Green, Orange, Blue, Red, Brown and Purple (and their variations) -Scheduled Ancient Monuments: There are no scheduled ancient monuments located with are located within any of the route corridors on the western side of Norwich.

(xiv) Western Green, Orange, Blue, Red, Brown and Purple (and their variations) -Historic Parklands:

Taverham Hall (grade II) and Park are important historic features dating from the eighteenth century. Most of the original area of parkland is now in agricultural production and many of the trees have been removed, however part of the historic parkland is retained surrounding the Hall. The original Hall was replaced in the 1860s by the one found there today. The Hall is currently a school. The peripheral tree belts survive so the overall structure of the parkland still remains.

Costessey Park dates from before the conquest, as and was mentioned in the Domesday Book as 'a park for beasts of chase'. A Hall was built or rebuilt within the Park in1564; this was demolished between 1919 and 1922. Formal disparking had already taken place in the 17th century.

Honingham Hall Park is an area of historic parkland although very little of it remains today, it is not listed on NCC Inventory of Historic Parkland.

5.3.3 Assessment of Impacts

(i) Western Green

Aerial photographs have revealed six ring ditches NHER ref. 7887, 7888, 17477, 18192, 36405 and a new site of a cropmark at grid ref TG165109. Only one of the cropmarks would be adversely affected as they are likely to fall within the alignment of the road. These cropmarks are sites of high significance and would possibility merit preservation or excavation giving rise to a major significant effect. The remaining sites are out side the alignment of the road but remain within the corridor. Depending on the final alignment of the road and associated earthworks these may also be adversely affected.

Land would be required from within the grounds of the remains of Costessey Park; this area is importance in archaeological terms and has high potential for buried sites of archaeological interest. Due to the alignment of the road severance of any remaining park features could occur.

Upper Farm is an important feature in the historic landscape. Its setting is likely to be adversely affected, and the significance of this is considered to be moderate. This property would be subject to visual intrusion due to its proximity to the route.

With the current data the overall impact from this route can therefore be considered major. However with mitigation measures in place the level of impact is likely to reduce to one that is either minor or moderate.

(ii) Western Orange

Four cropmarks fall within the route corridor although none not be subject to excavation based on the current road design. The impacts on these are therefore considered to be less, although the features remain of national concern.

Due to the importance of the river valleys as locations for earlier settlements during excavations finds of archaeological importance are likely to be found.

The impact on historic parkland associated with Taverham Hall, is likely to be in terms of noise and visual intrusion; these impacts are likely to be minor to moderate. However due to the original extent of the parkland any excavation through this area is likely to reveal new features of archaeological significance.

Costessey Park and the remains of the old Hall would experience severance from its remaining features. This parkland is not listed as historic parkland and as such does not merit the same protection; there remains high potential for the identification of features of archaeological significance.

Beehive Lodge is located within 20m of the route alignment. The construction of a road in this location would generate significant adverse effects on the grade II listed building. Due to the proximity of the route to this property it is unlikely that the impacts can be adequately mitigated. A major adverse impact is predicted.

The overall impact of this route is considered to be minor with the exception of the listed building where the significance is increased to major.

(iii) Western Blue

All the cropmarks identified through aerial photography are outside of the route alignment but within the wider study area. Although they are of major significance they are not currently directly affected by the blue route.

A number of finds have also been recorded in the study area. These are usually single objects, and their significance is only considered to be minor. However any excavation work is likely to lead to the identification of further finds.

The blue route does not require any land-take from the existing boundaries for the historic parkland at Taverham Hall but would still fall within the original boundaries, which extended much further than today. Due to this there is the high potential for the identification of new archaeological features or finds. The addition of a dual carriageway road in this location is likely to adverse affect the setting of Taverham Hall.

The significance of the impact at the Church of St Peter is reduced by the fact that the A47 is situated between the building and the proposed route. However, bearing in mind the grade I status of the building and the requirement for a new junction from the A47, the impact on the church is considered minor to moderate.

Hill Farm House is located approximately 150m from the route. The property is likely to suffer from visual intrusion, and the road may detract from the historical setting.

Breck Farm is an important feature in the historic landscape, its setting is likely to be adversely affected. The significance of this is considered to be moderate. This property would also experience visual intrusion due to its proximity to the route alignment.

The overall impact of this route is considered to be minor to moderate.

(iv) Western Red

Within the study area a number of finds have also been recorded. These are usually single objects, and their significance is only considered to be minor. However any excavation work is likely to lead to the identification of further finds. It is impossible to assess the significance of unknown finds. Church Hill Common, Ringland is the only area of common land close to any route alignments. It will not experience land loss however due to its importance as a landscape feature the severance effects are likely to be minor to moderate.

NHER ref 11711 denotes the possible location of a Roman Villa, Roman coins, shards and other objects have been found here. In addition this is the location of the Mesolithic flint, the oldest find on the database. Since the route is over 300m from the position of the possible Roman villa site, the impact is considered to be minor, although there is a high potential to identify further presently unknown archaeological finds.

The significance of the impact at the Church of St Peter is reduced by the fact that the A47 is situated between the building and the proposed route. However, bearing in mind the Grade I status of the building and the requirement for a new junction from the A47, the impact on the church is considered minor to moderate.

The overall impact of this route is considered to be minor.

(v) Western Brown

Sites of the remains of St Mary's Church, St Andrews Church and Church Farm House are within the study area. However, due to their location within Attlebridge the setting or character of these features would not be altered by the brown route.

Cropmark NHER ref. 25475 lies within the road alignment. With the current road alignment it is likely that the whole feature would be permanently affected due to necessary excavations. The cropmark is important as it is a site of high significance of national concern. A major significant effect would result on this feature, however the full impact of the route can be completely assessed as finds associated with the cropmark remain buried.

The remaining cropmarks would at this stage not be affected by landtake or excavation. However they are features of national significance.

Morton Lodge is likely to be adversely affected due to its proximity to the existing A1067. The significance of this impact is considered to be major as the property will require demolition.

Pump Farm, Field Farm, The Old Rectory, Church Farm House, Bull Farm and Brand Farm have all been identified as features of importance in the historic landscape. None of the buildings would be demolished. However their setting is the wider landscape would be altered. The significance of the impact on these buildings is considered to be moderate.

The brown route also goes through the eastern side of Honingham Park. This impact is less significant as the parkland is not listed on NCC inventory of historic parkland, however there remains high potential for the identification of features of archaeological significance. Severance of the remaining features and land take effects are likely to arise through the construction of this route option.

The overall impact of this route is considered to be minor with the exception of the impact on the cropmark and the listed building where the significance is increased to major. The impact on the cropmark is however the same for all the routes that pass through Attlebridge.

(vi) Western Purple

The remains of St Mary's Church, St Andrews Church and Church Farm House are within the study area. However, due to their location within Attlebridge the setting and character of these features it is unlikely that they would be altered by the purple route.

Cropmark NHER ref. 25475 lies within the road alignment. With the current road alignment it is likely that the whole feature would be permanently affected due to necessary excavations. The cropmark is important as it is a site of high significance of national concern. A major significant effect would result on this feature, however the full impact of the route can be completely assessed as finds associated with the cropmark remain buried.

The remaining cropmarks would at this stage not be affected by landtake or excavation. However they are features of national significance.

Morton Lodge is likely to be adversely affected due to its proximity to the existing A1067. The significance of this impact is considered to be major as the property would be demolished.

Pump Farm, Field Farm, The Old Rectory, Church Farm House, Bull Farm and Brand Farm have all been identified as features of importance in the historic landscape. None of the buildings would be demolished. However their setting is the wider landscape would be altered and possibly severed. The significance impact on these buildings is considered to be moderate.

The purple route also goes through the western side of Honingham Park. This impact is less significant as the parkland is not listed on NCC inventory of historic parkland, however there remains high potential for the identification of features of archaeological significance. Severance of the remaining features and land take effects are likely to arise through the construction of this route option.

The overall impact of this route is considered to be minor with the exception of the impact on the cropmark and the listed building where the significance is increased to major. The impact on the cropmark is however the same for all the routes that pass through Attlebridge.

(vii) Western Brown Variation

The remains of St Mary's Church, St Andrews Church and Church Farm House are within the study area. However, due to their location within Attlebridge the setting or character of these features would not be altered by the brown route variation.

Cropmark NHER ref. 25475 lies within the road alignment. With the current road alignment it is likely that the whole feature would be permanently affected due to necessary excavations. The cropmark is important as it is a site of high significance of national concern. A major significant effect would result on this feature, however the full impact of the route can be completely assessed as finds associated with the cropmark remain buried.

The remaining cropmarks would at this stage not be affected by landtake or excavation. However they are features of national significance.

Morton Lodge is likely to be adversely affected due to its proximity to the existing A1067. The significance of this impact is considered to be major as the property would be demolished.

Pump Farm, Field Farm, The Old Rectory and Church Farm House have all been identified as features of importance in the historic landscape. None of the buildings would be demolished. However their setting is the wider landscape would be altered and possibly severed. The significance impact on these buildings is considered to be moderate.

The brown route variation also goes through the eastern side of Honingham Park. This impact is less significant as the parkland is not listed on NCC inventory of historic parkland, however there remains high potential for the identification of features of archaeological significance. Severance of the remaining features and land take effects are likely to arise through the construction of this route option.

The overall impact of this route is considered to be minor with the exception of the impact on the cropmark and the listed building where the significance is increased to major. The impact on the cropmark is however the same for all routes that pass through Attlebridge.

(viii) Western Purple Variation

The remains of St Mary's Church, St Andrews Church and Church Farm House are within the study area. However, due to their location within Attlebridge the setting and character of these features would not be altered by the purple route variation. Similarly Berry Hall is within the study area, its setting is likely to be adversely affected due to the proposed new roundabout on the A47 (West).

Cropmark NHER ref. 25475 lies within the road alignment. With the current road alignment it is likely that the whole feature would be permanently affected due to necessary excavations. The cropmark is important as it is a site of high significance of national concern. A major significant effect would result on this feature, however the full impact of the route can be completely assessed as finds associated with the cropmark remain buried.

The remaining cropmarks would at this stage not be affected by landtake or excavation. However they are features of national significance.

Morton Lodge is likely to be adversely affected due to its proximity to the existing A1067. The significance of this impact is considered to be major as the property would be demolished.

Pump Farm, Field Farm, The Old Rectory and Church Farm House have all been identified as features of importance in the historic landscape. None of the buildings would be demolished. However their setting is the wider landscape would be altered and possibly severed. The significance impact on these buildings is considered to be moderate.

The purple route variation also goes through the western side of Honingham Park. This impact is less significant as the parkland is not listed on NCC inventory of historic parkland, however there remains high potential for the identification of features of archaeological significance. Severance of the remaining features and land take effects are likely to arise through the construction of this route option.

The overall impact of this route is considered to be minor with the exception of the impact on the cropmark and the listed building where the significance is increased to major. The impact on the cropmark is however the same for all the routes that pass through Attlebridge.

(ix) Eastern Pink

Of the archaeological monuments listed in the gazetteer several have been identified as of particular interest.

Four cropmarks are within the study area however they are outside the road layout. At this stage they are unlikely to be affected, however this should be readdressed if the route is realigned.

Sprowston Manor Park is important. Historically it covered an area much larger than that defined in the Broadland Local Plan. The area of land to the south, which falls outside of the classified historic parkland, is now in regular agricultural production. In recent time the historic parkland has been converted to a golf course, although many of the ancient trees remain.

The pink route skirts around the southern edge of the historic parkland. A small section of the parkland will be directly affected, as necessary land-take for construction of the route. This would also result in the loss of part of the boundary features; a moderate to minor impact is predicted.

The likelihood of finding artifacts during excavation is high where the route passes through the historic parkland.

The Grade I listed Parish Church of St Mary and St Margaret, Church Lane, Sprowston may be indirectly affected by the scheme. Although not subject to land-take, visual intrusion and noise impact are predicted due to the proximity of the road, this is considered to be minor.

West Farm is an important feature in the historic landscape and its setting is likely to be adversely affected. The significance of this is considered to be moderate. In addition the property is likely to experience some visual intrusion due to its proximity to the route alignment.

With current information the overall significance of the impact of the pink route is considered to be minor to moderate.

(x) Eastern Yellow

Of the archaeological features to the north of Norwich, the yellow route has the potential to affect a number of features contributing to the historic landscape and associated buildings. The most important of these features is the cropmark NHER no. 18901, although the route is currently 100m away from this site.

The yellow route goes through the historic boundaries of Rackheath Park, which result in the severance and loss of the historic parkland. Due to the history of the site there is a high possibility that features of national significance or concern would be identified during excavation with the parkland. In addition Rackheath Hall, a grade II listed building is situated with the historic parkland. A minor to moderate impact is predicted on the setting of the listed building.

The southern edge of Beeston Park historic parkland would be directly affected by the yellow option, as land would be required for the road. The Park is of national significance; however, parts of the parkland have been turned into agricultural production. Even when taking this into consideration, the impacts are still likely to be moderate.

West Farm is an important feature in the historic landscape and its setting is likely to be adversely affected. The significance of this is considered to be moderate. In addition the property is likely to experience some visual intrusion due to its proximity to the route alignment.

Quaker Farm/Spixworth Farm, Oaks Farm and Laurel Farm are all moderately important as post-medieval buildings that contribute to historic landscape. Land surrounding all these properties would be subject to landtake with this option and the blue and pink routes.

Overall the yellow route would have moderate impacts on the archaeological and historic landscape features within its study area.

(xi) Eastern Blue

Three cropmarks are located within the study area; an iron age/Roman enclosure identified through aerial photographs as a cropmark HNER no.36451, a second cropmark NHER no. 18152 and the third are burials, possibly outliers of Rackheath Church, NHER no. 31541. All three features are at least 100m from the centre of the road but they do offer a high potential for buried sites of archaeological interest.

The blue route runs along the eastern margins of Rackheath Park, and would result in the historic boundary of the site being lost within the landtake for this route. Severance may also occur but would depend on the exact positioning of the road. Rackheath Park is an area of national significance. As the selection of this option would merit the preservation or eventual excavation of this site prior to construction, a moderate adverse effect is likely.

In addition Rackheath Hall, a grade II listed building is situated with the historic parkland. A minor to moderate impact is predicted on the setting of the listed building.

Beeston Park would experience both severance and landtake and is considered to be of national importance. A moderate to major significant impact is predicted. The significance of the impacts remains relatively high, although a large proportion of the historic parkland has been converted to agricultural production. There remains a high potential for the recovery of unknown buried archaeological finds. These may be significant.

West Farm is an important feature in the historic landscape and its setting is likely to be adversely affected. The significance of this is considered to be moderate. In addition the property is likely to experience some visual intrusion due to its proximity to the route alignment.

The overall impact of the blue route is considered to be moderate.

5.3.4 <u>Mitigation Measures</u>

The routes that have been taken forward to the public consultation have already been through a preliminary process of route optimisation to try to minimise the impacts, most notability the red route, and all the routes as they pass to the north of the airport.

Where possible, localised vertical and horizontal realignment should be considered as the primary method of mitigation. This could potentially reduce or eliminate effects on listed buildings, historic parklands etc. Further localised realignment would occur during the detailed design stage.

Where realignment would not completely eliminate negative effects of the route, or where it is not a feasible option, additional mitigation measures should be employed.

Where features such as listed buildings would suffer from significant visual intrusion, physical screening could be considered in order to reduce the magnitude of the impacts. This could be in the form of earth bunding or strategic planting of vegetation, or ideally a combination of both.

Where historic parklands are subject to landtake and severance, mitigation cannot compensate effectively for the loss. The appearance of the park and its inherent integrity, which is a product of centuries of existence, could not be recreated by even the most comprehensive mitigation strategy. Therefore any measures would have to be implemented with a view to disguising the detrimental effects, and not compensating for the loss that would occur. These could take the form of careful landscaping, bunding and planting. Thought should be given to the species mix employed, and where possible, semi-mature trees should be heavily favoured over the immature hedgerow species which are the norm, taking into account the sensitive surroundings.

It may be appropriate during the scheme development to undertake a number of preliminary investigative excavation digs along the alignment of the selected route, particularly if the route goes through areas of historic parkland or cropmarks. Further advice on this would be sought from the County Archaeologist at the appropriate stage.

It is important to note that where its feasible precedence is always given to preserving the remains *in situ* (i.e. through alteration the vertical and horizontal alignment of the route). It is only when this is not feasible that excavation and recording should take place prior to the start of construction.

During construction, a watching brief would be required following the guidance set out in PPG 16, the aim of which would be to identify and record any archaeological finds.

5.3.5 Conclusions and Recommendations

All of the route options have some affect on cultural heritage aspects.

There are relatively small differences between impacts of the western options. The routes on the west show differences that are less apparent. All the routes and alternatives raise significant impacts, However on balance it is the red route that is the least damaging western option.

It important to note that if the purple or brown route or variation is selected as a preferred route, a grade II listed building at Morton would require demolition.

Of the routes to the east, there is little to choose between them, although none are without detrimental effects on the surrounding features of cultural heritage. However it is worth stating that none of the cultural heritage features of any of the eastern routes are of international importance.

The implementation of sensitive mitigation to reduce the impacts must be included in the detailed design for this scheme, as without them even the recommended least damaging routes may not be acceptable.

The assessment of the archaeological impacts is for guidance only since the nature and physical extent of all the archaeological sites has not been fully quantified at this stage. A significant proportion of the archaeological interest is likely to be in the ground and hence an unknown factor. Should consideration be given to progressing a route option which could affect one or more sites identified as of national significance, then the possibility of preliminary

investigative excavations should be considered in conjunction with the County Archaeologist.

Based on the information and assessment currently available it is recommended for cultural heritage resources that the yellow and red routes are taken forward for further consideration to form the Northern Distributor Road around Norwich.

5.4 **Disruption due to Construction**

5.4.1 Introduction and Methodology

As DMRB Volume 11 states, 'disruption due to construction' is a term which covers the effects on people and on the natural environment which can occur between the start of pre-construction works and the end of the contract maintenance period. Disruption due to construction need not be as a result of work directly on the road scheme itself, but can also arise from advance works by utilities, which may extend well beyond the highway construction site.

The construction effects are temporary but may be significant. Typical construction impacts might include a localised increase in noise, vibration, dust and dirt and a loss of amenity due to the presence of heavy construction traffic. Those affected can include people in their homes or places of work; people visiting shopping centres or community facilities and pedestrians, cyclists or vehicle travellers.

Construction work can potentially also affect the natural environment. Possible impacts are:

- Sediment and materials entering the river
- Physical disturbance to habitat
- Direct loss of habitat
- Disruption to local hydrological conditions and adverse change in the hydrological status of habitats
- Temporary severance and fragmentation of habitat
- Pollution and leachate from road construction materials and construction activities, including dewatering
- Disturbance to wildlife during construction by noise, vibration, lighting and movement
- Obstructions in the river channel
- Shading
- Decrease in water quality

Operational impacts are:

- Loss of habitat
- Severance and fragmentation of habitats
- Change in river channel cross-section profile which alters flow conditions
- Obstructions in the river channel
- Reduction air quality particularly hydrocarbons and heavy metals.
- Changes to environment caused by shading and other microclimatic changes created by structures
- Changes in management of vegetation as a result of severance
- Reduction in water quality due to highway discharge
- Siltation due to highway run off
- Risk of collision between fauna and road traffic
- Disruption to local hydrological conditions and adverse change in the hydrological status of habitats
- Disturbance from lighting at junctions

Details on specific ecological impacts of each route option are given in the Ecology and Nature Conservation chapter of this report.

Detailed impacts on ecology resulting from disruption due to construction (for example, haul routes, locations of borrow pits or surplus material for each route option) would be addressed at Stage 3, when more detailed engineering information would be available.

Disruption due to construction is generally a more localised phenomenon than the impacts of a scheme once it has opened to traffic and will impact most on those people living within 100m of a new route.

Where material needs to be transported to or from the highway construction site, the impacts along construction access routes should also be assessed.

The assessment of disruption at a stage 2 level involves:

- Estimating the number of properties within100m of each route option, highlighting any particularly sensitive locations such as schools and hospitals.
- Identifying ecological, archaeological or historic features near the route.
- Identifying any likely differences in the magnitude of disruption for each route option
- Broadly assessing the types of earthworks

5.4.2 <u>Baseline Conditions</u>

There will be a degree of disturbance wherever options follow existing roads, but disturbance will be greater at the following locations:

- junctions where the construction area can be extensive,
- bridges where piling may occur,
- cuttings and embankments where extensive earthworks may occur,
- locations where existing roads will need to be broken up by the use of pneumatic breakers to allow widening to take place.

The number of people disturbed will obviously be higher where the road passes close to housing, employment areas, and sensitive community uses such as hospitals, schools, library's etc. Experience elsewhere shows that significant disturbance normally only occurs within 100m of major construction activities.

5.4.3 Assessment of Impacts

(i) Western Green

There are 73 properties within 100m of the green route. The route also passes close to Costessey Recreation Ground, St. Augustine's RC Primary School and Benell Residential Care Home. The green route also crosses the River Tud and the River Wensum which are environmentally sensitive wildlife areas. Wildlife habitat at Wensum Mount Farm and Drayton Wood county wildlife sites, Turnpike Belts, and The Wilderness is also impacted on.

(ii) Western Orange

There are 18 properties within 100m of the orange route. The route also passes close to Taverham Golf Course, Taverham High School and Hinks Meadow. The orange route also crosses the River Tud and the River Wensum which are environmentally sensitive wildlife areas. Wildlife habitat at Lord's Hills, Easton Reeds, Blyth's Wood and Walsingham Plantation county wildlife sites, Longdell Hills, Blackhill Wood and Drayton Drewray is also impacted on.

(iii) Western Blue

There are 13 properties within 100m of the blue route. The route also passes close to Taverham Golf Course, Taverham High School and Hinks Meadow. The blue route also crosses the River Tud and the River Wensum which are environmentally sensitive wildlife areas. Wildlife habitat at "Adjacent to the Tud" and Walsingham Plantation county wildlife sites, Aves Gap and Drayton Drewray is also impacted on.

(iv) Western Red

There are 6 properties identified within 100m of the red route. The red route crosses the River Tud and the River Wensum which are environmentally sensitive wildlife areas. Wildlife habitat at "Adjacent to the Tud" county wildlife site, Aves Gap, Primrose Grove, Deighton Hills and Drayton Drewray is also impacted on.

(v) Western Brown

There are 17 properties within 100m of the brown route but no particularly sensitive properties have been identified. The brown route also crosses the River Wensum at an existing crossing and the River Tud which are environmentally sensitive wildlife areas. Wildlife habitat at "Adjacent to the Tud" and Mileplain Plantation county wildlife sites, Ringland Covert and Drayton Drewray is also impacted on.

(vi) Western Purple

There are 17 properties within 100m of the purple route but no particularly sensitive locations have been identified. The purple route also crosses the River Wensum at an existing crossing which is an environmentally sensitive wildlife area. Wildlife habitat at Foxburrow Plantation and Mileplain Plantation county wildlife sites and Drayton Drewray is also impacted on.

(vii) Western Brown Variation

There are 20 properties within 100m of the brown variation but no particularly sensitive locations have been identified. The brown variation also crosses the River Wensum at an existing crossing and the River Tud which are environmentally sensitive wildlife areas. Wildlife habitat at "Adjacent to the Tud" county wildlife site, Ringland Covert, Deighton Hills and Drayton Drewray is also impacted on.

(viii) Western Purple Variation

There are 20 properties within 100m of the purple variation but no particularly sensitive locations have been identified. The purple variation also crosses the River Wensum at an existing crossing which is an environmentally sensitive wildlife area. Wildlife habitat at Foxburrow Plantation county wildlife site, Deighton Hills and Drayton Drewray is also impacted on.

(ix) Eastern Pink

There are 20 properties within 100m of the pink route. The route also passes close to Walsham Road playing field, Norwich Rugby Football Club, Sprowston Manor Hotel and Golf Course, Horsham Bowling Green and Norwich Aviation Museum. Wildlife habitat at Racecourse Plantation county wildlife site is also impacted on.

(x) Eastern Yellow

There are 16 properties within 100m of the yellow route. The route also passes close to North Walsham Road playing field, Norwich Rugby Football Club, Sprowston Manor Hotel and Golf Course, Horsham Bowling Green and Norwich Aviation Museum. Wildlife habitat at Paine's Yard Wood county wildlife site is also impacted on.

(xi) Eastern Blue

There are 20 properties within 100m of the blue route. The route also passes close to Rackheath Park, Beeston Park, Horsham Bowling Green and Norwich Aviation Museum. Wildlife habitat at Heath Wood is also impacted on.

5.4.4 <u>Mitigation Measures</u>

Disruption due to construction can be mitigated to a certain extent both under powers conferred by the Land Compensation Act 1973 which allows for temporary rehousing or insulation of eligible buildings against construction noise if certain criteria are met.

Contractual working restraints can also be used to protect the natural environment, for example by placing restrictions on where the Contractor can store borrow or surplus material. Contract conditions can also be used to limit noise from the construction site, to control working hours, to prevent access to sensitive areas, to restrict construction traffic to suitable haul routes, and to ensure that such routes are cleaned or swept regularly.

Monitoring of conditions regarding noise, vibration and dust may be necessary during construction.

It is anticipated that each route will be designed so that the earthworks will be balanced; that is so that the amount of earth excavated for cuttings will equal the amount of fill required for areas where the road will be in embankment. However, for all the routes, the areas of cut and fill will not be adjacent to each other and so a significant amount of haulage and temporary storage would be required.

In considering possible methods of mitigating adverse impacts during the construction period, it will be necessary to balance the severity of an impact with its duration. For example, it may be better to cause greater disruption over a short period than less disruption over an extended period.

Some typical mitigation measures for protected species are outlined below and may have implications during construction:

- <u>Great crested newts</u> –, exclusion fencing would be required as a minimum but any mitigation measures are likely to include trapping and translocation of species, the provision of tunnels, new ponds and terrestrial habitat.
- <u>Badgers</u> exclusion fencing (both permanent and temporary), tunnels/underpasses and the construction of artificial setts.
- <u>Bats</u> construction of artificial roost sites and/or bat boxes and provision of foraging habitat.
- <u>Birds</u> ensuring vegetation is cut and cleared outside of the bird nesting season and the provision of replacement habitat.
- <u>Otter</u> provision of passage way sand ledges under bridges or other structures over the river, replacement habitat including the provision of holts, if necessary.

- <u>Water vole</u> exclusion, trapping and translocation of species and the provision of replacement habitat.
- <u>Reptiles</u> exclusion, trapping and translocation of species and the provision of replacement habitat.

An Environmental Management Plan would be required to provide environmental protection during the construction phase.

5.4.5 <u>Conclusions and Recommendations</u>

In terms of disruption to properties, the western red and the eastern yellow routes affect the least number of properties. It is the western green and eastern pink and blue that would have the most affect on properties during their construction. In terms of disruption to wildlife habitat, consideration should be given during Stage 3 detailed design to minimise the construction impact of any route taken forward. Detailed phasing of site clearance, placement of temporary habitats and new habitat creation should be considered before the start of the main construction phase.

5.5 Ecology and Nature Conservation

5.5.1 Introduction and Methodology

The identification of a preferred route for the NDR, in ecology and nature conservation terms, is to minimise the potential adverse effects and to maximise the beneficial effects of the proposals upon the ecological resource and to ensure that any remaining adverse effects are identified and mitigated. The construction of the scheme may potentially generate impacts on the ecology of the surrounding area. DMRB Volume 11 identifies a number of areas of concern, depending on the nature of the site. These can include direct loss of wildlife habitats, severance of existing habitats, disruption to local hydrology and increased pollution from road run-off.

The objective at Stage 2, according to DMRB Volume 11, is to undertake sufficient assessment to identify the nature conservation factors, and the significance of effects upon them, to develop and refine route options. The assessment has been prepared in accordance with the principles of the ecology and nature conservation chapter of DMRB. However, as DMRB does not define how the significance of possible ecological impacts should be defined, an approach has been taken in this assessment to use significance criteria based on Transport Analysis Guidance (TAG).

Where possible the issues raised by statutory bodies during the 2004 consultation have been addressed and relevant information included. As a result the amount of information and assessment in this section is greater than would normally be expected in a stage2 scheme assessment report.

(i) Significance Criteria

The significance of any impacts will be based on consideration of the nature conservation value of the features and the magnitude of the impact. These will be combined to give an overall appraisal category.

Value	Criteria	Examples
Very High	High importance and rarity, international scale and limited potential for substitution	Internationally designated sites
High	High importance & rarity, national scale, or regional scale with limited potential for substitution	Nationally designated sites Regionally important sites with limited potential for substitution
Medium	High or medium importance and rarity, local or regional scale, and limited potential for substitution	Locally designated sites Regionally important sites with potential for substitution
Lower	Low or medium importance and rarity, local scale	Undesignated sites of some local biodiversity and earth heritage interest
Negligible	Very low importance and rarity, local scale	Other sites with little or no local biodiversity and earth heritage interest

Criteria for Determining Nature Conservation Value of Features

Magnitude	Criteria
Major negative	The proposal (either on its own or with other proposals) may adversely affect the integrity of the site, in terms of the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the population levels of species of interest
Intermediate negative	The site's integrity will not be adversely affected, but the effect on the site is likely to be significant in terms of its ecological objectives. If, in the light of full information, it cannot be clearly demonstrated that the proposal will not have an adverse effect on integrity, then the impact should be assessed as major negative.
Minor negative	Neither of the above apply, but some minor negative impact is evident. (In the case of Natura 2000 sites a further appropriate assessment may be necessary if detailed plans are not yet available).
Neutral	No observable impact in either direction.
Positive	Impacts which provide a net gain for wildlife overall.

Criteria for Determining the Magnitude of Impact

Estimating the Overall Appraisal Category

Magnitude of Potential Impact	Nature Conservation Value of Sites Damaged or Improved				
	Very high	High	Medium	Lower	Negligible
Major negative	Very large adverse	Very large adverse	Moderate adverse	Slight adverse	Neutral
Intermediate negative	Large adverse	Large adverse	Moderate adverse	Slight adverse	Neutral
Minor negative	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Neutral
Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Positive	Large beneficial	Large beneficial	Moderate beneficial	Slight beneficial	Neutral

(ii) Sources of information

The information for this section has been obtained from a number of sources:

- English Nature
- Environment Agency
- Norfolk County Council
- Broadland District Council
- South Norfolk Council
- Norfolk Wildlife Trust

- National Ancient Woodland register
- UK Biodiversity website
- OS Landranger Maps 133, 134 and 144
- Aerial photographs

In addition, a number of specialist ecological surveys have been completed for this study:

Phase 1 Habitat Surveys

A Phase 1 Habitat Survey, covering the route corridors extending as far west as the red route, was conducted by Richard Kilshaw Ecological Services. The purpose of this survey was to determine the major habitat types along the proposed route corridors, to gauge the ecological value of the route corridors, and to identify habitat types deemed as important. The survey was carried out following the standard techniques set out in 'The Handbook for Phase One Habitat Survey – A technique for Environmental Audit', published by the Joint Nature Conservation Committee (JNCC). Two surveys were undertaken during Autumn 2002 (30 September to 22 October) and Spring 2003 (15 March to 15 April). The results of these surveys were combined in a final report.

A second Phase 1 Habitat Survey was conducted by Mott MacDonald to complement that carried out by Richard Kilshaw Ecological Services, covering the north-south sections of the newly proposed western brown and purple routes. This comprised a field survey carried out in July 2004, using the standard methodology as detailed in JNCC (1993).

• Breeding birds, bats, badger and reptiles surveys

Philip Parker Associates were commissioned to conduct species surveys for breeding birds, badger, bats and reptiles. The objective of these surveys was to identify the presence and abundance of the species/groups within the proposed route corridors.

The work firstly identified likely potential habitats for the named species/groups, and the recommendation of areas that should be targeted for more detailed survey. This was done through a review of the Phase 1 Habitat Survey report provided by Richard Kilshaw Ecological Services followed by site walkovers. The additional Phase 1 survey covering the north-south sections of the brown and purple routes was not available at the time of the surveys, and it is possible that some potential habitats along these routes may have been missed. Field surveys were then conducted for the species/groups within the habitats identified, and the results collated for each route corridor.

Breeding bird surveys were conducted between 30 April and 27 June 2004. Where possible each site was visited twice, once in the morning and once in the afternoon. At each site an appropriate transect was selected and walked slowly, with the number and activity of each species observed being recorded.

Badger surveys were conducted between 27 June and 3 September 2004. Each identified habitat feature offering the potential for badgers was thoroughly searched for the following badger signs: setts, latrines, dung, badger hair, footprints and pathways. Where setts were identified, an assessment of the likely status and levels of activity was made. Bat surveys were conducted between 27 June and 3 September 2004. Each of the identified habitat features was visited, and an assessment made of their potential as bat roosts and foraging areas. Evidence of bats was recorded where observed at the sites, but time did not allow inspection of any holes or cavities. Bat roost potential was graded as 'high', 'medium' or 'some', and bat foraging potential was graded as 'good' or 'poor'. Records of bat roosts held by English Nature were also inspected.

Reptile surveys were conducted in June and September 2004. Sites offering good potential for reptiles were surveyed using two techniques: the searching of favoured habitats (direct observation) and, where access could be agreed with the landowner, the use of artificial refuges to supplement the survey effort. The survey involved slowly walking a transect and checking the ground for basking reptiles or movements, and the checking of refuges for the presence of reptiles. Each site was visited on several occasions at different times of the day.

Great Crested Newt Survey

A Great Crested Newt survey was undertaken by Norfolk Wildlife Trust during spring/summer 2004. The objectives were to establish the distribution of great crested newt populations within the proposed route corridors, and to assess the likely impact of route options on newt populations. A desktop study was conducted to identify existing newt records and map all ponds within the route corridors, following which an assessment of the current status of each pond was made using aerial photography and a site walkover. Each pond was subject to a single daytime survey using three different survey techniques. A second visit was conducted at night if none were detected during the day and if it was felt there was a reasonable likelihood that newts could be present, torching was the survey technique used. In addition all the ponds were scored for Habitat Suitability Index factors.

Hedgerow Assessment

A hedgerow assessment was conducted by Norfolk County Council in 2004. The purpose of this was to determine the status of hedges within the proposed route corridors, and to identify those classified as 'important' under the Hedgerow Regulations 1997. Hedgerows identified as being crossed by the proposed route corridors were surveyed during site visits, and the findings used to assess them against the specifications of the Hedgerow Regulations.

Otter and water vole surveys

A joint otter and water vole survey was undertaken during August 2004. The rivers Tud and Wensum were surveyed, up two 200m either side of the proposed crossings. The aim of the survey was to identify the presence of both species through the identification of field signs.

Invertebrates

An assessment of the potential for terrestrial invertebrates has also been completed. The assessment was desk based to highlight areas that offer the highest potential for different invertebrate groups.

The specialist surveys have covered extensive areas affected by the route options. Where they have not directly covered particular sections of route

corridors, inferences have been made about the likely ecology from comparison with adjacent areas, casual observations, and discussions with landowners and others with knowledge of the area. Detailed surveys would take place for a Stage 3 assessment of any route options selected for progression.

The study area for this chapter is a corridor along each route, 200 metres either side of its centreline, a band of 400 metres total width. Impacts are assessed as being direct if a feature is affected by the actual route and indirect if a feature falls within a route corridor. Figures which identify important ecological and nature conservation features are included in Part 3 of this report.

The ecological baseline conditions and impact assessment are considered for each route from east to west. This differs from the engineering assessment, which is considered from west to east for each route.

5.5.2 Baseline Conditions

For the topic of ecology, the routes are descriptions go from east to west i.e. from the A47 to Postwick to the A47 west of Norwich.

(i) Western Green

Designated sites

The western green route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) under the EC Habitats Directive (92/43/EEC), as it contains habitats and / or species which are rare or threatened in a European context. For the River Wensum these habitats and species are:

- White-clawed crayfish (*Austropotamobius pallipes*) for which the River Wensum is considered to be one of the best areas in the UK.
- Bullhead (*Cottus gobio*) for which the area is considered to support a significant presence
- Brook lamprey (*Lampetra planeri*) for which the area is considered to support a significant presence
- Desmoulin's whorl snail (*Vertigo moulinsiana*) for which the area is considered to support a significant presence
- Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho –Batrachion* vegetation (water-crowfoot) for which this is considered to be one of the best areas in the UK.

The EC Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora has been transposed into UK law through the Conservation (Natural Habitats &c.) Regulations 1994 (it is more commonly known and referred to as the Habitats Regulations).

The Habitats Regulations provides for the protection of internationally designated conservation sites. Regulation 48 restricts the granting of planning permission for development that is likely to significantly affect a European nature conservation site by requiring an appropriate assessment to be undertaken assessing the implications of the development of the site. The only exception to this is if the development is connected to or necessary for the nature conservation management of the site.

The River Wensum is also a Site of Special Scientific Interest (SSSI). It is an enriched calcareous lowland river with over 100 species of plants, a rich invertebrate fauna and a relatively natural corridor. The adjacent mosaic of meadow and marsh areas provides a rich habitat for a wide variety of specialised plants and animals. The Wensum is also a good mixed fishery and has an abundant and diverse mollusc fauna. The adjacent floodplains, which are also crossed by this route, are included within the Broads Environmentally Sensitive Area (ESA). The River Tud floodplain, which the corridor runs along for some distance, is also included in the Broads ESA.

The corridor crosses three County Wildlife Sites's, Low Road Meadow (ref. no. 255), Wensum Mount Farm (ref. no. 2106), and Drayton Wood (ref. no. 2022), which is also covered by TPO. Three other TPO's are crossed by the corridor, one around the Hellesdon hospital, one south of Horsham St Faith and one to the south west of Drayton Wood.

Protected Species

Great crested newts

Based on the current survey information Great Crested Newts are not present in any ponds along this route. In addition only one pond had a relatively high habitat index, suggesting that a relative low/small population exists in the route corridor.

Badgers

Three badger setts each with numerous holes are located within the route corridor. These setts were active at the time of the survey. In addition, there may be areas used for foraging as the extent of their territories is not known.

• <u>Bats</u>

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings provide potential roost sites. The bat survey identified 48% of the suitable habitats surveyed offers high potential to support bat roosts and 95% offers high potential for foraging areas.

• <u>Birds</u>

Barn Owls tend to nest in old, dilapidated buildings and barns, so are likely to be present in the corridor where potential nesting sites co-exist with suitable hunting ground. However during the bird survey none were recorded. No other Schedule 1 breeding birds were recorded within the route corridor during the survey.

Otters

Evidence of otter on the river Tud was recorded during the survey. A spraint was identified next to a bridge. Due to the extensive territories that otters at known to occupy is likely that otters would also be found with in this section of the Wensum valley as they are recorded further west, although no evidence was recorded during the survey.

Water voles

No evidence of water voles was recorded in the route corridor during the survey however records do show that water voles are present further west of the route along the river Wensum.

Reptiles

There is a 3rd party record of adder being present in an area of semiimproved grassland adjacent to the west of Drayton Wood, bordering the A1067, although none were identified during the survey. Adders are protected under the Wildlife and Countryside Act 1981.

White-Clawed Crayfish

Records show that Freshwater White-Clawed Crayfish are present in the River Wensum and the River Tud. Crayfish have previously been recorded where the River Wensum runs parallel to Marriott's Way, at Costessey Park and at Costessey Fish Farm. They are mostly likely to be found in fast-running water with a stony substrate, commonly this is around bridges and other structures in the river. The historical presence of white-clawed crayfish in the River Wensum is one of a number of factors that have lead to the designation of the river as a SAC under the European Habitats Directive. White-clawed crayfish are listed under Annexes II and V of the EU Habitats Directive, Appendix 3 of the Bern Convention and are protected under Schedule 5 of the Wildlife & Countryside Act (1981), which makes it illegal to take native crayfish from the wild or to attempt to sell them in Britain.

Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the green route crosses the river Wensum.

• Ranunclion fluitantis and Callitricho-Batrachion vegetation

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Green		
	1	2	3
Ranunculus saniculifolius			
-------------------------------------	---	---	
R. trichophyllus			
R. fluitans			
R. pelatus			
R. penicillatus ssp. penicillatus			
R. penicillatus ssp. pseudofluitans			
R. aquatilis			
Myriophyllum spp.			
Callitriche spp.	*	*	
Berula erecta			
Zannichellia palustris			
Potamogeton spp.			
Fontinalis antipyretica			

Invertebrates

The invertebrate assessment suggests that there is one prime location that is highly likely to support dead wood invertebrates within the route corridor. In addition the River Wensum has an abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Priority Habitats and Species

Within the green route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan. Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marshes are located along both the Wensum and Tud valleys, and areas of fen, reedbeds and mesotrophic lakes are likely to be associated with these areas too.

The breeding bird survey identified 50 different species breeding during the survey period. 5 of these are national BAP species and 2 are local BAP species, including Turtle Dove, Skylark, Song Thrush, Linnet and Reed Bunting.

The UK BAP and Norfolk BAP also include Great Crested Newts, Freshwater White-Clawed Crayfish, Otters and Water Voles, which are described in the Protected Species section above.

Habitat

• A140 Cromer Road to C261 Reepham Road

The route corridor crosses a species poor hedgerow with mature Oak, next to Harts Hill Farm and bordering Holt Road. The hedge consists entirely of Hawthorn. A mature Oak in a poor Hawthorn hedge, with potential for roosting bats and nesting birds would be close to the centreline of the western green route. This may provide a valuable habitat link with the surrounding countryside. There is an adjacent new pond in poor grassland. The majority of the rest of the area crossed in this section is arable land, some of which is within the boundary of Horsford Manor. There is a tree belt with mature Ash and ancient Oak, along with Sycamore and Hawthorn bordering Reepham Road.

<u>C261 Reepham Road to A1067 Drayton High Road</u>

The corridor crosses a tree belt dominated by mature Scots Pine and Sycamore, with occasional Lime and a poor ground flora. The corridor then crosses Drayton Wood, which is a CWS and is also covered by a TPO. This is a mixed woodland dominated by Scots Pine and Sycamore with many ancient and mature trees and a dense undergrowth of Elder, Sycamore and Birch. Some Hazel coppice exists in places and mature Beech. There are also areas of open woodland and boundary habitats to paths and fallen tree sites.

A1067 Drayton High Road to C171 Town House Road:

From Drayton High Road the green route corridor crosses arable land and part of some species rich, semi-improved grassland associated with the hospital. Between Drayton High Road and the C489 Low Road it runs parallel to a species rich hedgerow, with mature Oak, Ash and Chestnut trees and Privet, Buckthorn, Elm and Hawthorn below.

The green route corridor then crosses the River Wensum. There are a number of habitats associated with the river, including species rich, semiimproved fen meadow grassland, dominated by Reed Sweet Grass with Pond Sedges, Angelica, Marsh Thistle, Water Mint, Marsh Bedstraw and Rushes (Juncus spp.) A ditch network and mature Poplars are also present in this area. On the eastern bank of the river, the corridor also crosses a broadleaf carr woodland of Willow, Alder and Oak, with Elder, Hawthorn and Bramble below. The woodland borders the river with a fringe of tall emergent aquatic macrophytes. On the west bank of the river, the corridor crosses Marriott's Way, which is a combined National Trail and Cycle Route. There are a range of mixed habitats along the route, including woodland, scrub, grass banks, ponds and wetland habitats. Within this area, two CWS are crossed; Wensum Mount Farm, which is low-lying river valley floodplain, wet grassland and fen and the adjoining Low Road Meadow, which is a grazed species-rich meadow with several ditches.

<u>C171 Town House Road to A1074 Dereham Road:</u>

From Town House Road the green route corridor passes between Costessey and New Costessey, following the floodplain of the River Tud. The corridor crosses a series of fishing lakes and associated mixed habitats, including ditches, river and woodland with ancient trees and scrub. Remnants of carr woodland and scrub surround the lakes, adjoining mature Alder carr woodland with occasional ancient Oak and Ash. The shallow lake margins have discontinuous emergent vegetation of Reedmace, Pond Sedge and Yellow Flag, with abundant Alder saplings. The short grass margin around much of the lakes is potentially species-rich. The corridor continues to run parallel to the River Tud and crosses an area of wet grassland and scrub. The site appears to be potentially speciesrich, semi-improved grassland, with small carr woodlands dominated by Alder and Ash.

The corridor then crosses a line of Poplars and an area of improved grassland bordering the River Tud, before crossing the river itself near the existing road bridge. Adjacent to the road bridge is a small copse of mature trees with Willow, Ash and Alder and high potential for otter activity. The site leads into a grassland area and riverside walk. On the west side of the River Tud, the corridor crosses improved grassland and then a band comprising of broadleaved woodland, scrub, a farmyard and a plantation. The woodland is dominated by Sycamore and has an extensive coppice Hazel grove, which has matured to form a dense canopy over a ground flora containing abundant bryophyte flora. Bluebells are present within the woodland. Adjacent to the woodland is an area of improved grassland with encroaching Hawthorn scrub and a farmyard with a number of buildings and debris piles. The improved grassland area leads into a semi-mature plantation (approximately 10+ years old) of Oak, Chestnut, Field Maple, Ash, Silver Birch and Hawthorn. The corridor crosses part of a landfill site and an area of woodland bordering the A1074. This mature woodland contains broadleaved mixed species, with locally dominant Beech, Sycamore and Chestnut. Oak, Ash and Hornbeam are occasional, with a species-poor understorey.

A1074 Dereham Road to A47

The green route corridor follows the existing A1074 until its junction with the A47. An area of mature woodland borders the north of the A1074, containing broadleaved mixed species, with locally dominant Beech, Sycamore and Chestnut. Oak, Ash and Hornbeam are occasional, with a species-poor understorey. Arable land borders the south of the A1074, with patches of Hawthorn and English Elm immediately next to the road.

(ii) Western Orange

Designated sites

The orange route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). The adjacent floodplains are also crossed, and these are included within the Broads ESA. The River Tud floodplain, which the corridor also crosses, is also included in the Broads ESA. The corridor crosses six CWS's, Long Dale (ref. no. 247), Lord's Hill and Easton Reeds (ref. no. 257), Ringland Pits (ref. no. 1339), Taverham Meadows (ref. no. 2115), Blyth's Wood (ref. no. 2112) and Walsingham Plantation (ref. no. 1351). Part of CWS 257 is ancient woodland and is covered by a TPO. Three additional areas of TPO are crossed by the corridor, Snake Wood, Beech Avenue in Taverham and one to the south of Horsham St Faith.

Protected Species

Great crested newts

The orange route corridor is likely to affect a number of protected species. Great Crested Newts are present in two ponds to the north of Thorpe Marriott. The orange route corridor passes to the south of this location.

Badgers

Two badger setts are located within the orange route corridor. These setts were active at the time of the survey. In addition, there may be areas used for foraging as the extent of their territories is not known at this stage.

• <u>Bats</u>

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings provide potential roost sites. The Bat survey revealed that 31% of the

suitable habitat surveyed offers high potential to support roosting sites and 89% offers high potential for foraging areas.

Birds

Barn Owls tend to nest in old, dilapidated buildings and barns, so are likely to be present in the corridor where potential nesting sites co-exist with suitable hunting ground, although none were recorded during the breeding bird survey.

Otters

Historical records state that otters are known to be present within both the river Tud and the River Wensum, this is expected as their territories extent several kilometres. However evidence of otter activity was only recorded on the river Tud within the route corridor during the field survey.

Water voles

Water voles are known to be present in the Tud and Wensum valleys, where suitable small drains, dykes and vegetative habitats exist. However, when surveyed no evidence of water vole activity was recorded on the River Tud or the River Wensum.

Reptiles

An important reptile site is present in the scrubby margin to woodland and a clearing at Lords Hills, where there is a good population of grass snakes and an exceptional population of slow worms. An adder has also been reported here. This area is considered to be a key reptile site due to its population of slow worms. Also within the corridor common lizards are present in Ringland Woodland and Lakes. Grass snakes, adders, slow worms and common lizards are all protected under the Wildlife and Countryside Act 1981.

White-Clawed Crayfish

Historic records of White-Clawed Crayfish show that they may be present in both the Tud and Wensum where there are fast-running flow conditions and a stony substrate. The most recent record for the River Tud is at the RMC bridge crossing in 2003.

Invertebrates

The River Wensum supports abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the orange route crosses the river Wensum.

Ranunclion fluitantis and Callitricho-Batrachion vegetation

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Orange		
	1	2	3
Ranunculus saniculifolius			
R. trichophyllus			
R. fluitans			
R. pelatus			
R. penicillatus ssp. penicillatus			
R. penicillatus ssp. pseudofluitans			
R. aquatilis			
<i>Myriophyllum</i> spp.	*	*	*
Callitriche spp.			*
Berula erecta			
Zannichellia palustris			
Potamogeton spp.	*		*
Fontinalis antipyretica			

Priority Habitats and Species

Within the orange route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan. Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marsh is located along both the Wensum and Tud valleys, and areas of fen, reedbeds and mesotrophic lakes are likely to be associated with these areas too.

The breeding bird survey recorded 60 different species with the route corridor. 4 of these species are national BAP species and 2 are local BAP species, including Song Thrush and Skylark.

The Norfolk BAP also includes Great Crested Newts, Freshwater White-Clawed Crayfish, Otters and Water Voles, which are described in the Protected Species section above.

Invertebrate species of significant interest are likely to be present in at least 15 locations covering 5 different habitat types. One of the species known to be present in the Wensum valley is the Desmoulin's Whorl Snail, this species has a BAP. The EA records for the River Wensum at Taverham Mill shows that the river has an invertebrate population of excellent quality with a score of 5.5 according to the Lincoln Quality Index (LQI is a single quality applicable to East Anglian rivers).

Habitat

A140 Cromer Road to C261 Reepham Road

To the west of the A140 the corridor crosses an arable field until it reaches the B1149 Holt Road, which has a species-rich hedge, containing

Blackthorn (*Prunus spinosa*) predominantly but also with abundant Elder (*Sambucus nigra*), Oak (*Quercus robur*), Ash (*Fraxinus excelsior*) and occasional Field Maple (*Acer campestre*). The ground flora is dominated by Bramble (*Rubus fruticosus* agg) and Ivy (*Hedera helix*), and appears low in species diversity.

To the north the field is bordered by a cycle track, lined on both sides by a generally species-poor hedge with trees, mostly standard oak with a lot of dead material, providing ideal roost sites for bats. English elm and hawthorn are also present, with bracken (*Pteridium aquilinum*) dominating the herb layer. To the south of this field is a mature Oak with standing dead wood, which could provide an opportunity for roosting bats and nesting birds. It stands in a species poor hawthorn hedge adjacent to a new pond.

Beyond the B1149 the corridor crosses arable land, with a network of several species-rich hedges with trees, mostly semi-mature oak and elm, with elder, hawthorn and field maple present in the shrub layer. The herb layer is consistently poor throughout these hedges, being almost exclusively composed of common nettle (*Urtica dioica*). The corridor then crosses Drayton Lane, bordered by defunct species poor hawthorn hedges, with a small area of amenity grassland on the northern edge of the corridor.

From Drayton Lane, the corridor then runs parallel with the C261 Reepham Road, crossing very large arable fields with few boundaries, passing close to a field of improved grassland dominated by perennial ryegrass, and an area of amenity grassland. Two species-rich belts of trees are crossed, both of which contain abundant mature oaks, and occasional ash, elder, hawthorn, hazel, field maple and elm. Adjacent to these belts lies an area of amenity grassland of perennial ryegrass, edged by a defunct speciespoor hedge dominated by hawthorn. More arable land is then crossed; separated by species-poor hedges with trees, mostly field maple, blackthorn and hawthorn. A field of improved grassland is also crossed.

The corridor then continues further west through an area of mixed seminatural woodland. The canopy is dominated by scots pine (*Pinus sylvestris*), with locally abundant oak and silver birch (*Betula pendula*), and the shrub layer contains occasional elder, holly (*Ilex aquifolium*), honeysuckle (*Lonicera periclymenum*) and gorse (*Ulex spp*), along with non-natives including rhododendron. The herb layer is species-poor, dominated by bracken and bramble. The edges of the woodland have a scrubby community of gorse and broom (*Cytisus scoparius*). Seasonal ponds are evident within the wood, dominated by soft rush (*Juncus effusus*).

Beyond this woodland, the corridor crosses more improved grassland, with a number of standard oak, an area of scattered bramble and willow scrub, and runs close to an area of broadleaved plantation, of young oak, hazel, field maple and lime (*Tilia* spp).

<u>C261 Reepham Road to A1067 Fakenham Road</u>

The route corridor here crosses fairly large arable fields with defunct species-poor hedgerows to the boundaries. The exception to this generalisation is the hedge bordering Thorpe Marriott, which is speciesrich, containing hawthorn, hazel and dog rose. This arable land is bisected by Marriott's Way, which at the point of crossing is edged by a speciespoor hedgerow. The corridor then crosses Fir Covert Road, and then areas of improved grassland, some of which are grazed, the remainder used as a playing field. Walsingham Plantation CWS (ref. no. 1351) is also crossed. This is an area of broadleaved semi-natural woodland.

A1067 Fakenham Road to C172 Ringland Road:

The orange route corridor crosses a golf course and an area of Sycamore dominated woodland, with frequent Ash and occasional Oak. The woodland contains many mature trees, some ancient, and has a ground flora which is seasonally dominated by Bluebell. Snake Wood, which is also covered by a TPO, falls within the route corridor in this section, as does the TPO along Beech Avenue in Taverham. Within the golf course, the corridor crosses areas of tall, tussocky semi-improved grassland, which appears to be developing into a diverse sward. There are also areas of wet semi-improved grassland with a diverse sward.

<u>C172 Ringland Road to Longwater Business Park:</u>

A species-rich hedgerow is present along the Ringland Road close to the crossing point, which contains frequent Oak, Ash and Buckthorn. This hedge is considered to be important under the Hedgerow Regulations. The corridor crosses arable land and then Blyth's Wood CWS ref. no. 2112, an area of woodland and ponds. The woodland contains Oak, Ash and Alder and is dominated by a Hazel understorey. There is a large wet grassland ride, with ponds nearby. These ponds contain Yellow Flag (*Iris pseudacorus*), Water Cress (*Rorippa nasturtium-aquaticum*), Great Yellow Cress (*Rorippa amphibia*), Pond Sedge (*Carex* spp) and Rush species (*Juncus* spp). A species-rich ground flora is also found in wet areas in the wood.

Prior to crossing the River Wensum, the corridor passes through Ringland woodland and lakes, CWS ref. no. 1339, which is linked to the woodland mentioned above. This is a mixed broadleaved woodland with large lakes, small ponds and ditch networks which links to Blyth Wood, creating a massive habitat area. The woodland is dominated by Alder, Oak and Willow, with some ancient trees and Hazel coppice. There are also open areas and dense Willow and Alder scrub and carr woodland. Some of the lakes are very large, with areas of emergent Common Reed and Reed Sweet Grass and surface areas dominated with Broad-leaved Pond Weed (Potamogeton natans) and White Water Lily (Nymphaea alba). There are overhanging Alder and Willow trees, but also areas of open water with shallow margins. To the east of the woodland is an area of semi-improved grassland with a mix of grasses and rushes and low-lying wet areas dominated by beds of Pond Sedge (Carex spp) and Reed Sweet Grass (Glyceria maxima). The ditch at the woodland boundary and the ditch network within the meadows are relatively species-rich with Flote Grass (Glyceria fluitans), Amphibious Bistort (Persicaria amphibia) and Brooklime (Veronica beccabunga).

The orange route corridor then crosses the River Wensum at this location before passing through Lord's Hills Woodland. This is an open Oak dominated broadleaved woodland, with occasional Hornbeam and Birch. There are some massive and ancient trees within the woodland. A track runs through the woodland where heath-like vegetation predominates and there is also an area of conifer plantation. This site is part of a large group of interlinked woodlands. To the east of this woodland, a mixed habitat area of woodland, ponds, ditches and flood grassland bordering the River Tud also falls within the route corridor. The woodland includes former coppiced Alder carr, Oak, Ash and Birch, with mature trees, mature coppice and occasional large ancient trees. The route corridor then crosses the River Tud at this location and swings eastwards towards Longwater Business Park. At this point, it crosses a large area of sparselyvegetated heath-like habitat, containing potentially diverse flora, dense and scattered scrub and small water bodies. The habitat is recently colonised sandy soil with Gorse (*Ulex* spp), Broom (*Cytisus scoparius*) and Birch and a diverse ground flora, including Orchids (*Ophrys* spp). Long Dale CWS also falls within the route corridor. The corridor then enters Longwater Business Park.

(iii) Western Blue

Designated sites

The blue route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). It also crosses the adjacent floodplains, and these are included within the Broads ESA. The River Tud floodplain, which the route corridor also crosses, is also included in the Broads ESA. In addition, the route corridor crosses three CWS's, Walsingham Plantation (ref. no. 1351), Harman's Grove (ref. no. 2104), which is also on the ancient woodland register, and Adjacent to River Tud (ref. no. 2128). The corridor also crosses TPOs along Beech Avenue, Taverham, Snake Wood and to the south of Horsham St Faith.

Protected Species

• <u>Great crested newts</u>

Great crested newts are present in two ponds to the north of Thorpe Marriott. The blue route corridor passes to the south of this location.

Badgers

Four badger setts are located within the blue route corridor. All but one of the setts was active at the time of the survey. In addition, there may be areas used for foraging, although the extent of territories is not known at this stage.

Bats

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings provide potential roost sites. The Bat survey revealed that 31% of the suitable habitat surveyed offered high potential to support bats and 92% was of high potential for foraging.

• <u>Birds</u>

Barn Owls tend to nest in old, dilapidated buildings and barns, so are likely to be present in the corridor where potential nesting sites co-exist with suitable hunting ground, although none were recorded during the bird survey. The survey did however record Hobby (a Schedule 1 species) as breeding within the route corridor.

Otters

Records show that Otters were present in the corridor in 1996/97 at Ringland. The field survey recorded otter's spraints on the River Wensum.

Water voles

No evidence of water voles was recorded during the field survey along the River Tud or Wensum within the route corridor.

<u>Reptiles</u>

No reptiles have been recorded along the western blue route corridor.

<u>White-Clawed Crayfish</u>

Freshwater White-Clawed Crayfish are known to be in both the Rivers Tud and Wensum where there are fast-running flow conditions and a stony substrate. Records show that crayfish have been recorded in 2003 at Ringland Bridge; older records also show that crayfish have been observed at Low Common, Ringland. There are also records dating from 1981, and more recently 1996, of crayfish in the River Tud at Easton.

Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the blue route crosses the river Wensum.

Ranunclion fluitantis and Callitricho-Batrachion vegetation

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Blue		
	1	2	3
Ranunculus saniculifolius			
R. trichophyllus			
R. fluitans			
R. pelatus			
R. penicillatus ssp. penicillatus			
R. penicillatus ssp. pseudofluitans			*
R. aquatilis			
Myriophyllum spp.	*	*	*
Callitriche spp.	*	*	*
Berula erecta	*		
Zannichellia palustris			
Potamogeton spp.		*	*
Fontinalis antipyretica	*	*	

Invertebrates

The River Wensum supports abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Priority Habitats and Species

Within the blue route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan. Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marshes are located along both the Wensum and Tud valleys, and areas of fen and reedbeds are likely to be associated with these areas too.

Turtle Dove, Skylark, Song Thrush, Linnet, Bullfinch and Reed Bunting were all recorded during the breeding bird survey and are covered by the national BAP.

Invertebrate species of significant interest are likely to be present in at least 6 locations covering 5 different habitat types. One of the species known to be present in the Wensum valley is the Desmoulin's Whorl Snail, this species has a BAP. The EA records for the River Wensum at Taverham Mill shows that the river has an invertebrate population of excellent quality with a score of 5.5 according to the Lincoln Quality Index (LQI is a single quality applicable to East Anglian rivers).

The Norfolk BAP also includes Great Crested Newts, Freshwater White-Clawed Crayfish, Otters and Water Voles, which are described in the Protected Species section above.

Habitat

• A140 Cromer Road to C261 Reepham Road

This section is similar to the western orange route, therefore the same comments apply.

<u>C261 Reepham Road to A1067 Fakenham Road</u>

This section is similar to the western orange route, therefore the same comments apply.

• <u>A1067 Fakenham Road to C172 Ringland Road:</u>

This section is similar to the western orange route, therefore the same comments apply.

<u>C172 Ringland Road to A47</u>

A species-rich hedgerow is present along the Ringland Road close to the crossing point, which contains frequent Oak, Ash and Buckthorn. This hedge is considered to be important under the Hedgerow Regulations. A broadleaved Oak, Sycamore and Chestnut dominated woodland with occasional Ash and Elm also falls within the route corridor. Conifers are present in the interior of the wood. The surrounding area is arable, until the route corridor crosses improved grassland close to the river. Immediately before the improved grassland, the corridor crosses a planted broadleaved woodland with Poplar dominant and Alder, Ash and Oak. Mature and ancient trees are present and there is a wet ditch bordering the wet flood meadows near the river. The ancient trees may have interesting saproxylic invertebrate assemblages. The improved grassland adjacent to

the River Wensum has potentially species-rich semi-improved areas and a wet ditch network mostly dominated by Reed Sweet Grass with small areas of Pond Sedge and Common Reed. The blue route corridor crosses the Wensum at this location. The western riverbank comprises flood grassland with water bodies and diverse flora locally dominated by Reed Sweet Grass and Reed Canary Grass. The ditches contain Water Starwort, Pond Sedge and Duckweed. Fish fry, frogspawn and Otter spraints are present in this area. This site adjoins other potentially species-rich grassland habitat along the floodplain. The ditch network in this area is potentially of high significance for a range of wetland and aquatic fauna. A species-rich hedgerow is also crosses on the western side of the river lining the road, which contains massive ancient Oaks.

Continuing southwards from the River Wensum, the route corridor crosses Ringland Hills, which at this location is a broadleaved mature woodland dominated by Oak, with abundant Ash and Bluebells present. This site is linked to a broad band of woodland. South of the woodland, the corridor crosses a species-rich hedgerow with mature Ash, Hawthorn and Blackthorn, with occasional Oak and Spindle. Another block of mature woodland also falls within the route corridor at this location, with frequent Ash, Sycamore and Beech. Hazel and Hawthorn are locally frequent in the understorey, while Bramble and Nettle dominate the ground flora, with Dogs Mercury also present, indicating ancient status. The corridor then crosses arable land and two more species-rich hedges. North of the River Tud, a mature mixed woodland block also falls within the route corridor, dominated by Scots Pine and other conifer species, with occasional Chestnut and Oak. Harman's Grove is CWS and an ancient woodland and falls within the route corridor.

The River Tud at the western blue route corridor crossing location has mature Poplars, Alders and Oaks bordering the banks. Reed Sweet Grass and Nettle dominate the banks, with Pond Sedge and Reed Canary Grass. The southern side of the river is a species-rich grassland and ditch network in the valley floor of the River Tud. Large areas are dominated by Pond Sedge with a mix of Reed Sweet Grass and Rushes (*Juncus* spp.) and broadleaved herbs, including Angelica, Water Figwort, Water Mint and Common Fleabane. The open water and ditches contain Canadian Pondweed and Water Violet, with frogs, frogspawn and Otter spraints present. This site links to the adjacent river corridor and habitats. The river channel itself contains frequent Water Crowfoot (*Ranunculus* spp.).

South of the River Tud, the route corridor crosses a species-rich hedgerow. Semi-mature Poplars have been felled recently to promote the native rich hedge below. The hedge contains frequent Hazel, with occasional Maple, Elm and Hawthorn. The corridor then crosses an area of improved grassland and arable land, before reaching the A47. Prior to reaching the A47, the route corridor crosses a hedge which is considered to be important under the Hedgerow Regulations.

On the southern side of the A47 where the blue route corridor joins is a broadleaved tree belt dominated by mature Oak (*Quercus, robur*) and ash (*Fraxinus excelsior*) with a sparse understorey. Next to this is semi-mature plantation of mixed broadleaved species, including Field maple, Cherry, hazel, Hawthorn and Ash, with a dense Bramble providing good scrub habitat for bird nesting and foraging.

(iv) Western Red

Designated sites

The red route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). It also crosses the adjacent floodplains, and these are included within the Broads Environmentally Sensitive Area (ESA). In addition, the red route corridor crossed the River Tud floodplain, which is also included in the Broads ESA. The corridor crosses seven County Wildlife Sites (CWS); Walsingham Plantation (ref. no. 1351), Attlebridge Hills (ref. no. 1343), River Wensum Pastures, Morton Hall, (ref. no. 2070), Church Hill Common (ref. no. 1340), Harman's Grove (ref. no. 2104), which is also ancient woodland register, Jennis' Wood (ref. no. 2113, which is also ancient woodland and adjacent to the River Tud (ref. no. 2128). An area covered by a Tree Preservation Order (TPO), to the south of Horsham St Faith, is also crossed, as is a Roadside nature Reserve bordering the A1067 Fakenham Road.

Protected Species

Great crested newts

Great Crested Newts are present in two ponds to the north of Thorpe Marriott. The red route corridor passes to the south of this location.

Badgers

Thirteen badger setts are located within the red route corridor. Four of the setts were not active at the time of the survey and it is not thought that any of the setts are main setts. The territories of the badgers are unknown at this stage.

<u>Bats</u>

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings provide potential roost sites. The bat survey suggests that 37% of the suitable habitat present offers high potential to support bat roosts and 90% of the habitats offer high foraging potential.

Birds

Barn Owls were recorded during the bird survey as roosting in the route corridor. They tend to nest in old, dilapidated buildings and barns, where potential nesting sites co-exist with suitable hunting ground. The Hobby was also recorded during the bird survey, both are Schedule 1 species.

Otters

Otters are known to be present in the route corridor with the Wensum valley and the field survey identified evidence of otter. However the survey of the River Tud did not identify any signs of activity.

Water voles

Water voles were recorded during the field survey in the ditches along side the River Wensum and in the River Tud. Historical records support the present of water voles in the River Tud.

<u>Reptiles</u>

Common lizards are present at two sites along the corridor: a small disused quarry adjoining the south of Primrose Grove, and an area of woodland with an open clearing immediately to the west of Ringland. It is probable that adders are also present at the second of these sites.

<u>White-Clawed Crayfish</u>

Freshwater White-Clawed Crayfish are known to be in both the Rivers Tud and Wensum where there are fast-running flow conditions and a stony substrate. Records show that crayfish have been recorded in 2003 at Ringland Bridge, older records also show that crayfish have been observed at Low Common, Ringland and at Attlebridge Hall. There are also records dating from 1981 and more recently in 1996 of crayfish in the River Tud at Easton and Honingham.

• Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the red route crosses the river Wensum.

• Ranunclion fluitantis and Callitricho-Batrachion vegetation

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Red		
	1	2	3
Ranunculus saniculifolius			
R. trichophyllus			
R. fluitans			
R. pelatus			
R. penicillatus ssp. penicillatus			
R. penicillatus ssp. pseudofluitans			*
R. aquatilis		*	
Myriophyllum spp.	*	*	*
Callitriche spp.			*
Berula erecta			
Zannichellia palustris	*	*	*
Potamogeton spp.	*	*	*
Fontinalis antipyretica			

Invertebrates

The River Wensum supports abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Priority Habitats and Species

Within the red route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan (BAP). Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marshes are located along both the Wensum and Tud valleys, and areas of fen and reedbeds are likely to be associated with these areas too.

Turtle Dove, Skylark, Song Thrush, Linnet, Bullfinch and Reed Bunting were all recorded during the breeding bird survey and are all covered by the national BAP.

Invertebrate species of significant interest are likely to be present in at least 6 locations covering 5 different habitat types. One of the species known to be present in the Wensum valley is the Desmoulin's Whorl Snail, this species has a BAP. The EA records for the River Wensum at Taverham Mill shows that the river has an invertebrate population of excellent quality with a score of 5.5 according to the Lincoln Quality Index (LQI is a single quality applicable to East Anglian rivers). The survey point is approximately 6km from the red route corridor however it still gives an indication of the potential for this stretch of the River Wensum to support important invertebrates.

The Norfolk BAP also includes great crested newts, freshwater white-clawed crayfish, otters and water voles, which are described in the Protected Species section above.

Habitat

A140 Cromer Road to C261 Reepham Road

This section is the same as the western orange route, therefore the same comments apply.

• C261 Reepham Road to A1067 Fakenham Road

Beyond the C261 Reepham Road the route corridor crosses more large arable fields, bordered generally by defunct species-poor hedges dominated usually by hawthorn, with trees occasionally present, either scots pine or oak. The exception to this generalisation is the hedge bordering Thorpe Marriott, which is species-rich, containing hawthorn, hazel and dog rose. The route then crosses Marriott's Way cycle path, which is bordered by species-poor hedges, and then a mixture of arable fields and improved grassland of perennial ryegrass, again bordered by defunct hedges, dominated by blackthorn, elm and hawthorn, occasionally with standard oaks, in different locations. A row of scots pine is also crossed at this location.

The corridor then crosses Fir Covert Road, which has hedges on either side, mostly species-poor blackthorn hedges, but species-rich locally. A combination of arable and improved grassland is then crossed, with a species-poor hawthorn hedge, a defunct hedge of hawthorn with occasional mature ash, and a thin belt of silver birch. County Wildlife Site, ref. no.1351 (Walsingham Plantation) falls within the route corridor. This is a broadleaved woodland with a canopy dominated by pedunculate oak, with frequent silver birch, beech (*Fagus sylvatica*) and sycamore, and a thin shrub layer of elder. The herb layer contains bracken, bramble and ivy, but also less common plants including moschatel (*Adoxa moschatellina*), climbing corydalis (*Corydalis claviculata*), red campion (*Silene dioica*) and wood avens (*Geum urbanum*). On the opposite side, the corridor crosses another area of woodland, part of which is Wildlife Site ref. no. 1343, Attlebridge Hills, a mixed mature woodland dominated by coniferous species, with frequent ash and sweet chestnut (Castanea sativa), a shrub layer of locally abundant holly, and a species-poor herb layer mainly of bramble. Between these two areas of woodland lies arable land with species-poor, hawthorn-dominated hedges.

• A1067 Fakenham Road to C172 Ringland Road:

The route corridor first crosses a species-rich hedge that runs along the edge of the A1067 Fakenham Road, a short section of which also contains Ash. This area is also a Roadside Nature Reserve (RNR No. 59), due to the presence of Hoary Mullein. It then crosses part of an arable field, and Taverham Golf Course, an area of amenity grassland dominated by perennial ryegrass. Three species-poor hawthorn hedges with trees, mostly standard oak, are crossed within this area.

Beyond the Golf Course the corridor enters the Broads ESA, which covers the Wensum valley. The habitat is a mosaic of improved and semiimproved grassland, the latter having much greater species diversity, separated by ditches and watercourses, including the Wensum itself, which is designated as SAC and SSSI.

The improved grasslands are dominated by perennial ryegrass, whereas species found in the semi-improved grassland are much more numerous, and include grasses like tufted hair-grass (*Deschampsia cespitosa*), false oat-grass (*Arrhenatherum elatius*) and reed sweet-grass (*Glyceria maxima*), terrestrial herbs like ragged robin (*Lychnis flos-cuculi*) and blinks (*Montia fontana*), and aquatic/semi-aquatic herbs like water forget-me-not (*Myosotis scorpioides*), marsh marigold (*Caltha palustris*), watercress (*Rorippa nasturtium-aquaticum*), fool's watercress (*Apium nodiflorum*) and brooklime (*Veronica beccabunga*). Scrubby areas of hawthorn and oak are also present within this mosaic. The river itself contains both branched and unbranched burweed (*Sparganium erectum* and *emersum* respectively), rush species (*Juncus* spp), and reed species (*Carex* spp), with alder (*Alnus glutinosa*) and willow species (*Salix* spp) occasionally located along the banks.

Leaving the river valley the corridor then crosses more arable fields, with both species-rich and species-poor hedges with trees to the boundaries, dominated by hawthorn, with frequent bramble, spindle (*Euonymus europaeus*) and dog rose, and with numerous standard oak, ash and elm. A row of mature poplars is also close to the route corridor.

The corridor then crosses Primrose Grove, an area of mixed mature woodland of abundant oak, ash, sweet chestnut and sycamore, with frequent scots pine. The shrub layer here contains locally dominant hazel coppice, and other areas contain frequent elder and holly and the herb layer, whilst generally low in diversity, dominated by nettles and bracken, also contains locally abundant bluebell, dog's mercury, with frequent dog's mercury and lords and ladies (*Arum maculatum*). There is a significant amount of dead material distributed across the woodland floor, providing an excellent source of food and shelter for numerous invertebrate species.

Beyond the woodland, the corridor crosses an arable field and speciespoor hawthorn hedge, and an area of escarpment/vegetated cliff, close to numerous mature ash, hazel coppice, gorse scrub and open grassland. There is a house and outbuildings, and the area is evidently used as a farm dump. Between this area and the C172 Ringland Road, is a defunct hedgerow with occasional ancient trees, mostly oak and ash. These ancient trees are potentially of high significance for invertebrate assemblages.

<u>C172 Ringland Road to A47</u>

The route corridor crosses a species-rich hedgerow with trees adjacent to Ringland Lane. The trees are mostly standard oak, with elm and ash also present, and the hedge itself is comprised of abundant hawthorn, spindle and dog rose. This hedge is considered to be important under the Hedgerow Regulations. The corridor then crosses arable fields and an area of mature mixed woodland, with a canopy of frequent oak, sycamore, beech, scots pine and other conifer species, and a generally species-poor herb layer dominated by bracken and bramble, with frequent ivy and ground ivy. Locally the herb layer is more diverse, containing species like dog's mercury and lords and ladies.

More arable land is then crossed, with defunct species-poor hedges to the boundaries, some of which contain trees, predominantly oak. The corridor then crosses a small area of mixed woodland, of oak, scots pine, sycamore and beech, with a species-poor ground flora, and CWS ref. no. 1340, Church Hill Common. This diverse site is a mixture of semi-improved acidic grassland and scrub succeeding to woodland. To the northwest is an area of birch woodland, mostly of semi-mature specimens, although some mature examples are present, with gorse and bracken scattered underneath. The majority of the rest of the site is continuous bracken, with young field maple and sweet chestnut trees, gorse, dog rose and bramble dominating. Other herbs such as climbing corydalis, rosebay willowherb (Chamerion angustifolium) and occasional bluebell are also present. Sheep's sorrel (Rumex acetosella) dominates the area of acid grassland, with frequent heath bedstraw (Galium saxatile) red fescue (Festuca rubra), sweet vernal-grass (Anthoxanthum odoratum) yorkshire fog and bent species (Agrostis spp). A small area of oak woodland is also present, with abundant hazel in the understorey.

The route corridor then crosses further areas of arable land, bisected by two defunct hedges with trees, predominantly oak. It then crosses three similar areas of mixed mature woodland, one of which is CWS ref. no. 2113, Jennis Wood, also registered as ancient woodland. They each have a canopy dominated by scots pine, with abundant oak, sycamore, ash and occasional sweet chestnut and beech, and a shrub layer of frequent elder and occasional hawthorn and blackthorn. The herb layer is generally species-poor, being dominated by bramble, nettles and bracken, although locally the diversity and value is higher, with bluebell, red campion, herb robert and dog's mercury present. After crossing another strip of arable land, more woodland is crossed, some of which is similar to that described above, fronted with standard oak, with a herb layer including bluebell and lords and ladies. However, the majority of woodland crossed by the corridor at this point is broadleaved, dominated by sycamore, with abundant beech and oak, frequent sweet chestnut and occasional silver birch. The species-poor shrub layer is comprised mainly of elder, and the herb layer contains locally abundant bluebell and lords and ladies. At Weston Road the route corridor crosses a species-rich hedge which is considered to be important under the Hedgerow Regulations, further arable land, and then Harman's Grove CWS ref. no. 2104, which is also registered as ancient woodland. Its canopy is dominated by sweet chestnut (*Castanea sativa*), and oak (*Quercus robur*), with frequent beech (*Fagus sylvatica*) and sycamore (*Acer pseudoplatanus*). Bluebell seasonally dominates the ground flora.

Prior to reaching the A47, the route also crosses the River Tud and its adjacent floodplains, part of which are a CWS ref. no. 2128 and are also covered by the Broads ESA. It also crosses a species-rich hedge, which is considered to be important under the Hedgerow Regulations.

On the southern side of the A47 where the red route corridor joins is a broadleaved tree belt dominated by mature Oak (*Quercus, robur*) and ash (*Fraxinus excelsior*) with a sparse understorey. Next to this is semi-mature plantation of mixed broadleaved species, including Field maple, Cherry, hazel, Hawthorn and Ash, with a dense Bramble providing good scrub habitat for bird nesting and foraging.

(v) Western Brown

Designated sites

The brown route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). It also crosses the adjacent floodplains, and these are included within the Broads Environmentally Sensitive Area (ESA). In addition, the brown route corridor crossed the River Tud floodplain, which is also included in the Broads ESA. The route corridor crosses four County Wildlife Sites (CWS); Triumph and Foxburrow Plantations (ref. no. 1344), Attlebridge Hills (ref. no. 1343), Hall Hills (ref. no.2105) and River Wensum Pastures, Morton Hall (ref. no. 2070). An area covered by a Tree Preservation Order (TPO), to the south of Horsham St Faith) is also crossed by the brown route corridor.

Protected Species

Great crested newts

Great Crested Newts are present in two ponds to the north of Thorpe Marriott. The brown route corridor passes to the south of this location.

Badgers

The brown route was not covered by the ecological surveys. However, nine badger setts can be identified as being consistent with the purple route. Additional setts may also be present in Hall Hills and the Broom woodlands.

<u>Bats</u>

Bats are likely to be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings may provide potential roost sites.

• <u>Birds</u>

Similarly barn owls are likely to be present in the corridor where potential nesting sites co-exist with suitable hunting ground.

• <u>Otters</u>

Evidence of Otters was recorded along the River Tud during the survey. No evidence was identified along the River Wensum, although the existing bridge is a site where otter marking would be highly probable.

Water voles

Evidence of water vole was recorded during the field survey. Historical records of water vole along this section of the River Tud exist.

Reptiles

No reptiles have been recorded along this route corridor. However it is possible that potential reptile sites may have been missed as the Phase 1 habitat survey for this area had not been completed at the time of the reptile survey.

White-Clawed Crayfish

Records of white crayfish at Attlebridge show the habitat is suitable to support the species.

• Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the brown route crosses the river Wensum.

Ranunclion fluitantis and Callitricho-Batrachion vegetation

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Purple		
	1	2	3
Ranunculus saniculifolius			
R. trichophyllus			*
R. fluitans			
R. pelatus			
R. penicillatus ssp. penicillatus			
R. penicillatus ssp. pseudofluitans	*	*	
R. aquatilis			
Myriophyllum spp.	*	*	
Callitriche spp.	*	*	*
Berula erecta			
Zannichellia palustris	*	*	*
Potamogeton spp.	*	*	*
Fontinalis antipyretica	*	*	

Invertebrates

The River Wensum supports abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Priority Habitats and Species

Within the brown route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan (BAP). Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marshes are located along both the Wensum and Tud valleys, and areas of fen and reedbeds are likely to be associated with these areas too.

Brown Hares, Skylark and Grey Partridge are species listed in the Norfolk BAP, and all are likely to be found across the arable landscape that the corridor crosses. Song Thrushes are also covered by the Norfolk BAP, and are likely to be found in any farmland and woodland areas that the corridor crosses although the breeding bird survey did not cover this area.

The Norfolk BAP also includes great crested newts, freshwater white-clawed crayfish, otters and water voles, which are described in the Protected Species section above.

Habitat

A140 Cromer Road to C261 Reepham Road

This section is similar to the western orange route, except that it crosses the C261 slightly further north at its junction with Breck Farm Lane. The same comments apply until the corridor reaches the area of the mixed semi-natural woodland to the northeast of the C261. From here the corridor crosses through the edge of the mixed semi-natural woodland, encroaching further into it then the western red route. Beyond this woodland the corridor crosses an area of scattered bramble and willow scrub, with a number of standard oak, and then more improved grassland of perennial ryegrass. <u>C261 Reepham Road to A1067 Fakenham Road</u>

Where the corridor meets the C261 Reepham Road, it crosses a defunct hedge, within which there are ancient and mature Oaks. It then follows the C261across arable land until meeting the Marriott's Way at Freeland Corner. At Freeland Corner there is a small copse providing good bird nesting habitats. To the west of the road it is formed of a mature Ash, semi-mature Oaks and Hawthorn, with ground flora dominated by nettles. To the east of the road the copse is formed of predominantly Blackthorn and semi-mature Oaks with ground flora dominated by Ivy. From this point the corridor follows the C261 passing through Mileplain Plantation, CWS ref. no. 1344, which contains Oak, Ash and Sycamore with some planted Scots Pine and other conifers. There are also areas of Hazel coppice with Field Maple and Beech, including some ancient trees. Having left the woodland the route corridor continues in a southwesterly direction, crossing arable fields and improved grassland to meet the A1067, crossing the River Wensum at, or close to, the location of the existing road bridge at Attlebridge. A species-rich hedge, considered to be important under the Hedgerow Regulations, lines the Fakenham Road to the east of the crossing location. Prior to crossing the River Wensum, CWS 1343 falls within the route corridor

• A1067 Fakenham Road to A47

South of the A1067, the brown route follows the route of the existing road towards Weston Longville. The corridor crosses mostly arable land, and a couple of small broadleaved copses. It then crosses an area of coniferous plantation that backs onto broadleaved oak/sycamore/beech woodland, which itself backs onto the existing road. The broadleaved woodland has a rich community, including a shrub layer of field maple (*Acer campestre*) and silver birch (*Betula pendula*). The ground is mostly bare with Common Nettle the most frequent plant. Bramble and Red Campion (*Silene dioica*)) are occasional to frequent with Herb Robert (*Geranium robertianum*), Wood Avens (*Geum urbanum*) and Foxglove (*Digitalis purpurea*) all occasional. A second, similar area of broadleaved woodland is also crossed by the route, also with a coniferous plantation adjacent.

To the north of Weston Longville the brown route leaves the existing road. The existing road at this location has wide, banked, species-rich verges containing Common Poppy (*Papaver rhoeas*), Yarrow (*Achillea millefolium*), Vetches (*Vicia* spp), Buttercups (*Ranunculus* spp), Bladder Campion (*Silene vulgaris*) and ferns, as well as a moderate diversity of coarse grasses. The corridor then crosses a mature broadleaved woodland strip, close to the Ringland Road. Pedunculate Oak is dominant, with frequent Beech and Ash and occasional Scots Pine. There is also a dense shrub layer.

The route corridor continues southwards across large arable fields. It crosses a species-rich hedgerow with Ash, Holly, Elder and Hawthorn and a path lined on one side by a species-rich hedgerow with trees on an earth bank, and on the other by a series of standard trees (mainly Oak and Ash), also on an earth bank. The path in between is covered with lush growth of coarse grasses and herbs. Within this section of the route, there are two hedges which are considered to be important under the Hedgerow Regulations. The corridor also crosses three small fields used for grazing horses, which are separated from the adjacent road by a species-rich hedge.

After crossing further arable land, the corridor then crosses a wide band of mixed semi-natural woodland of scots pine, sycamore and silver birch, and the corner of broadleaved sycamore/birch woodland. Both have a poor shrub layer, and a herb layer dominated by bramble and bracken. More arable land is crossed, and then a large swathe of diverse broadleaved woodland of oak, sycamore, beech and birch. This woodland is the Hall Hills CWS ref. no. 2105.

The route corridor then crosses arable land edged with grassland (presumably under the Countryside Stewardship Scheme) and areas of scots pine. It then crosses Taverham Road, and then neglected fields of ruderal herbs and semi-improved grassland. It crosses the River Tud and associated floodplains, of improved and poor-semi-improved grassland used for grazing horses, and then climbs towards the A47, crossing arable land with species-rich hedges with trees, mostly oak and ash, and a small area of broadleaved woodland with a canopy dominated by poplars, with occasional oak, ash and sycamore.

On the southern side of the A47 where the brown route corridor joins is a broadleaved tree belt dominated by mature Oak (*Quercus, robur*) and ash (*Fraxinus excelsior*) with a sparse understorey. Next to this is semi-mature plantation of mixed broadleaved species, including Field maple, Cherry, hazel, Hawthorn and Ash, with a dense Bramble providing good scrub habitat for bird nesting and foraging.

(vi) Western Brown Variation

Designated sites

The brown variation route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). It also crosses the adjacent floodplains, and these are included within the Broads Environmentally Sensitive Area (ESA). In addition, the brown variation route corridor crossed the River Tud floodplain, which is also included in the Broads ESA. The route corridor crosses four County Wildlife Sites (CWS); Walsingham Plantation (ref. no. 1351), Attlebridge Hills (ref. no. 1343), Hall Hills (ref. no.2105) and River Wensum Pastures, Morton Hall (ref. no. 2070). An area covered by a Tree Preservation Order (TPO), to the south of Horsham St Faith) is also crossed by the brown variation route corridor.

Protected Species

Great crested newts

Great crested newts are present in two ponds to the north of Thorpe Marriott. The brown variation route corridor passes to the south of this location.

Badgers

The brown route was not fully covered by the ecological surveys. Nine badger setts can be identified as being consistent with the purple route. Additional setts may also be present in Hall Hills and the Broom woodlands.

<u>Bats</u>

Bats are likely to be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings may provide potential roost sites.

• <u>Birds</u>

Similarly barn owls are likely to be present in the corridor where potential nesting sites co-exist with suitable hunting ground.

• <u>Otters</u>

Evidence of Otters was recorded along the River Tud during the survey. No evidence was identified along the River Wensum, although the existing bridge is a site where otter marking would be highly probable.

Water voles

Evidence of water vole was recorded during the field survey. Historical records of water vole along this section of the River Tud exist.

Reptiles

No reptiles have been recorded along this route corridor. However it is possible that potential reptile sites may have been missed as the Phase 1 habitat survey for this area had not been completed at the time of the reptile survey.

White-Clawed Crayfish

Records of white crayfish at Attlebridge show the habitat is suitable to support the species.

• Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the brown variation crosses the river Wensum.

Ranunclion fluitantis and Callitricho-Batrachion vegetation

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Purple		
	1	2	3
Ranunculus saniculifolius			
R. trichophyllus			*
R. fluitans			
R. pelatus			
R. penicillatus ssp. penicillatus			
R. penicillatus ssp. pseudofluitans	*	*	
R. aquatilis			
Myriophyllum spp.	*	*	
Callitriche spp.	*	*	*
Berula erecta			
Zannichellia palustris	*	*	*
Potamogeton spp.	*	*	*
Fontinalis antipyretica	*	*	

Invertebrates

The River Wensum supports abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Priority Habitats and Species

Within the brown route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan (BAP). Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marshes are located along both the Wensum and Tud valleys, and areas of fen and reedbeds are likely to be associated with these areas too.

Brown Hares, Skylark and Grey Partridge are species listed in the Norfolk BAP, and all are likely to be found across the arable landscape that the corridor crosses. Song Thrushes are also covered by the Norfolk BAP, and are likely to be found in any farmland and woodland areas that the corridor crosses although the breeding bird survey did not cover this area.

The Norfolk BAP also includes great crested newts, freshwater white-clawed crayfish, otters and water voles, which are described in the Protected Species section above.

Habitat

A140 Cromer Road to C261 Reepham Road

This section is similar to the western orange route, therefore the same comments apply.

<u>C261 Reepham Road to A1067 Fakenham Road</u>

This section is similar to the western red route, therefore the same comments apply. The brown variation route corridor then follows the existing A1067 westwards, which is generally bordered by species-poor hawthorn hedges with trees including Oak and English Elm, and areas of scattered scrub. Approaching Attlebridge an area of Attlebridge Hills abuts the A1067, and beyond this a species-rich hedge, considered to be important under the Hedgerow Regulations, lines the Fakenham Road.

This area is also a Roadside Nature Reserve (RNR No. 59), due to the presence of Hoary Mullein. Behind these boundaries are arable fields. The route crosses the River Wensum at, or close to, the location of the existing road bridge at Attlebridge. To the west of Attlebridge, the route corridor leaves the A1067 and runs in a southwards direction.

A1067 Fakenham Road to A47

This section is the same as the western brown route, therefore the same comments apply.

(vii) Western Purple

Designated sites

The purple route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). It also crosses the adjacent floodplains, and these are included within the Broads Environmentally Sensitive Area (ESA). The route corridor crosses six County Wildlife Sites; Attlebridge Hills (ref. no. 1343), Triumph and Foxburrow Plantations (ref no. 1344), Walsingham Plantation (ref. no. 1351), River Wensum Pastures, Morton Hall (ref. no. 2070), The Waterfence (ref. no. 2116) and Old Covert, Wood Lane (ref. no. 2109). An area covered by a Tree Preservation Order (TPO), to the south of Horsham St Faith) is also crossed by the purple route corridor.

Protected Species

Great crested newts

Great Crested Newts are present in two ponds to the north of Thorpe Marriott. The purple route corridor passes to the south of this location.

Badgers

Ten badger setts were identified as part of the survey, none appear to be main setts and at least one has holes that are disused. The extent of badger territories is not known at this stage.

• <u>Bats</u>

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings provide potential roost sites. From the bat survey 33% of the suitable habitat surveyed offers high potential to support roosting sites and 83% offers high potential as foraging areas.

• <u>Birds</u>

Barn Owls tend to nest in old, dilapidated buildings and barns, so are likely to be present in the corridor where potential nesting sites co-exist with suitable hunting ground.

• <u>Otters</u>

No evidence of Otter was identified along the River Wensum, although the existing bridge is a site where otter marking would be highly probable.

Water voles

Evidence of water vole was not recorded during the field survey.

Reptiles

No reptiles have been recorded along this route corridor. However it is possible that potential reptile sites may have been missed as the Phase 1 habitat survey for this area had not been completed at the time of the reptile survey.

• White-Clawed Crayfish

Records of white crayfish at Attlebridge show the habitat is suitable to support the species.

Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the purple route crosses the river Wensum.

• Ranunclion fluitantis and Callitricho-Batrachion vegetation

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Purp	Purple	
	1	2	3
Ranunculus saniculifolius			
R. trichophyllus			*
R. fluitans			
R. pelatus			
R. penicillatus ssp. Penicillatus			
R. penicillatus ssp. Pseudofluitans	*	*	
R. aquatilis			
<i>Myriophyllum</i> spp.	*	*	
Callitriche spp.	*	*	*
Berula erecta			
Zannichellia palustris	*	*	*
Potamogeton spp.	*	*	*
Fontinalis antipyretica	*	*	

Invertebrates

The River Wensum supports abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Priority Habitats and Species

Within the purple route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan (BAP). Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marshes are located along both the Wensum and Tud valleys, and areas of fen and reedbeds are likely to be associated with these areas too.

Brown Hares, Skylark and Grey Partridge are species listed in the Norfolk BAP, and all are likely to be found across the arable landscape that the corridor crosses. Song Thrushes are also covered by the Norfolk BAP, and are likely to be found in any farmland and woodland areas that the corridor crosses.

Also covered is the Desmoulin's whorl snail, which is known to be present in the Wensum valley where the habitat is suitable.

The Norfolk BAP also includes great crested newts, freshwater white-clawed crayfish, otters and water voles, which are described in the Protected Species section above.

Habitat

• A140 Cromer Road to C261 Reepham Road

This section is similar to the western brown route, therefore the same comments apply.

<u>C261 Reepham Road to A1067 Fakenham Road</u>

This section is similar to the western brown route, therefore the same comments apply.

A1067 Fakenham Road to A47

South of the A1067, the purple route follows the same route as the brown route as far as the area to the north-east of Weston Green, where there is a species-rich hedgerow with Ash, Holly, Elder and Hawthorn and a path lined on one side by a species-rich hedgerow with trees on an earth bank, and on the other by regular standard trees (mainly Oak and Ash) also on an earth bank. The path in between is covered with lush growth of coarse grasses and herbs. Within this section of the route, there are three hedges which are considered to be important under the Hedgerow Regulations.

At this point the purple route continues to the west of the brown route and crosses a species-rich hedgerow with Oak trees. The hedgerow lines the road to Weston Green (Breck Road) and contains Hawthorn, Blackthorn, Field Maple, Ash and Bramble. This hedge is considered to be important under the Hedgerow Regulations. The route corridor continues in a southwesterly direction and crosses an area of broadleaved woodland with a fairly open canopy of Oak and Sycamore. This is CWS 2116 (The Waterfence) and CWS 2109 (Old Covert, Wood Lane) also falls within the route corridor. Adjacent to this woodland is a band of coniferous plantation, which is almost exclusively Scots Pine. The corridor then crosses an area of damp grassland, which follows the course of a stream through the centre of a field grazed by cattle. More arable land is then crossed. Immediately prior to joining the A47, the route corridor runs close to a well-vegetated grassy track between fields and a wooded area with a species-rich hedgerow with trees either side of it. Both contain abundant Field Maple, Ash and Hawthorn and occasional Oak, Blackthorn and

Hazel. Both hedgerows are on earth banks with soft grasses and herbs, including Dogs Mercury.

(viii) Western Purple Variation

Designated sites

The purple variation route corridor crosses the River Wensum, which is designated as a candidate Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). It also crosses the adjacent floodplains, and these are included within the Broads Environmentally Sensitive Area (ESA). The route corridor crosses five County Wildlife Sites; Attlebridge Hills (ref. no. 1343), Walsingham Plantation (ref. no. 1351), River Wensum Pastures, Morton Hall (ref. no. 2070), The Waterfence (ref. no. 2116) and Old Covert, Wood Lane (ref. no. 2109. An area covered by a Tree Preservation Order (TPO), to the south of Horsham St Faith) is also crossed by the purple variation route corridor.

Protected Species

Great crested newts

Great Crested Newts are present in two ponds to the north of Thorpe Marriott. The purple route corridor passes to the south of this location.

Badgers

Ten badger setts were identified as part of the survey, none appear to be main setts and at least one has holes that are disused. The extent of badger territories is not known at this stage.

• <u>Bats</u>

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, or in buildings with access to the roof space. All areas of woodland, standard trees and suitable buildings provide potential roost sites. From the bat survey 33% of the suitable habitat surveyed offers high potential to support roosting sites and 83% offers high potential as foraging areas.

• <u>Birds</u>

Barn Owls tend to nest in old, dilapidated buildings and barns, so are likely to be present in the corridor where potential nesting sites co-exist with suitable hunting ground.

Otters

No evidence of Otter was identified along the River Wensum, although the existing bridge is a site where otter marking would be highly probable.

Water voles

Evidence of water vole was not recorded during the field survey.

Reptiles

No reptiles have been recorded along this route corridor. However it is possible that potential reptile sites may have been missed as the Phase 1 habitat survey for this area had not been completed at the time of the reptile survey.

White-Clawed Crayfish

Records of white crayfish at Attlebridge show the habitat is suitable to support the species.

Bullhead and Lamprey

No existing records have identified bullhead or lamprey present where the routes crosses the River Wensum, however they are known to be throughout the river system including where the purple variation crosses the river Wensum.

• <u>Ranunclion fluitantis and Callitricho-Batrachion vegetation</u>

The River Wensum River Corridor Survey (1995) has been examined at the crossing points for the western NDR routes and 500m upstream and downstream of each crossing point.

Using the EUNIS habitat classification, the following table shows the presence of the relevant species for the classification.

- 1 = upstream of crossing point
- 2 = at crossing point
- 3 = downstream of crossing point

Plant Species	Purple		
	1	2	3
Ranunculus saniculifolius			
R. trichophyllus			*
R. fluitans			
R. pelatus			
R. penicillatus ssp. penicillatus			
R. penicillatus ssp. pseudofluitans	*	*	
R. aquatilis			
Myriophyllum spp.	*	*	
Callitriche spp.	*	*	*
Berula erecta			
Zannichellia palustris	*	*	*
Potamogeton spp.	*	*	*
Fontinalis antipyretica	*	*	

Invertebrates

The River Wensum supports abundant and diverse mollusc fauna which includes the Desmoulin's whorl snail (*Vertigo moulonsiana*), water beetles and mayflies.

Priority Habitats and Species

Within the purple route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan (BAP). Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins. Floodplain grazing marshes are located along both the Wensum and Tud valleys, and areas of fen and reedbeds are likely to be associated with these areas too.

Brown Hares, Skylark and Grey Partridge are species listed in the Norfolk BAP, and all are likely to be found across the arable landscape that the corridor crosses. Song Thrushes are also covered by the Norfolk BAP, and are likely to be found in any farmland and woodland areas that the corridor crosses.

Also covered is the Desmoulin's whorl snail, which is known to be present in the Wensum valley where the habitat is suitable.

The Norfolk BAP also includes great crested newts, freshwater white-clawed crayfish, otters and water voles, which are described in the Protected Species section above.

Habitat

A140 Cromer Road to C261 Reepham Road

This section is similar to the western orange route, therefore the same comments apply.

• C261 Reepham Road to A1067 Fakenham Road

This section is similar to the brown variation, therefore the same comments apply. As for the brown variation, the purple variation route corridor then follows the existing A1067 westwards, crossing the River Wensum at, or close to, the location of the existing road bridge at Attlebridge. At the A1067, the route corridor crosses a Roadside Nature Reserve (RNR No. 59). To the west of Attlebridge, the route corridor leaves the A1067 and runs in a southwards direction.

• A1067 Fakenham Road to A47

This section is the same as the western purple route, therefore the same comments apply.

(ix) Eastern Pink

Designated sites

The pink route corridor runs through two County Wildlife Sites (CWS); Racecourse Plantation (reference no. 2041), and Belmore and Brown's Plantations (reference no. 2042). Several Tree Preservation Orders are also located within the corridor, which cover both areas and individual trees, along the frontage of Sprowston Manor on the Wroxham Road, and to the south of Thorpe End. These are all described in the habitat section below.

Protected Species

<u>Great crested newts</u>

Great Crested Newts are present in the ponds within Racecourse Plantation and also in the pond at Quaker Farm at the western end of the pink route.

Badgers

A Badger sett with approximately 5 holes is present within the eastern pink route corridor, however this sett was not in use at the time of the survey.

<u>Bats</u>

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, so all standard trees and areas of woodland may provide scope for roost sites. The bat survey suggests that

48% of the suitable habitat surveyed offers high potential to support bats while 93% has high foraging potential.

<u>Birds</u>

Barn Owls may be present where the opportunity to roost co-exists with an undisturbed hunting ground. Old derelict or dilapidated farm buildings are favourite roost sites. However none were recorded during the Bird survey. No Schedule 1 bird species were recorded.

Reptiles

Grass snakes are present in two locations along the pink route; in a clearing around Heath Farm bordering the edge of Racecourse Plantation, and in a woodland clearing and rides within Round Hill Plantation and The Breck.

Priority Habitats and Species

Within the pink route corridor, a number of species and habitats are likely to be encountered and are included within the Norfolk Biodiversity Action Plan. Ancient and/or species-rich hedges are located across much of the corridor, as are cereal field margins.

Six locations have been identified from the Phase 1 habitat survey as offering the likely hood of supporting a significant number of invertebrates. The invertebrate species would be associated with woodland habitats and those of mature/ancient trees.

Forty nine species of breeding bird were recorded during the survey. Of these, 4 were national BAP species and 2 were local BAP species, including Song Thrush and Skylark.

Great Crested Newts are also a BAP species and are mentioned above.

Habitat

A47 to C874 Plumstead Road

From A47 the corridor runs North between The Grange and Heath Farm, across large arable fields. The corridor then crosses several hedges, the majority of which are species-poor with trees, dominated by hawthorn (*Crataegus monogyna*), with occasional standard pedunculate oak (*Quercus robur*). An unmanaged pond, with a large amount of fallen timber in it, but with no aquatic vegetation, is located adjacent to Low Road. The corridor runs close to an area of amenity grassland, dominated by perennial ryegrass with scattered broad-leaved trees, and a mature tree belt consisting of Lime (*Tilia vulgaris*), Beech (*Fagus sylvatica*), Poplar (*Populus* spp), Chestnut (*Castanea sativa*), Oak (*Quercus robur*) and Elm (*Ulmus procera*), before reaching Middle Road.

The corridor follows the line of Middle Road for a short distance, bordered on both sides by species-poor hedges comprising predominantly of Hawthorn and Oak. The route corridor crosses trees and arable land, up to and across the Norwich to Cromer railway line, and then through more arable land, followed by fields of improved grassland dominated by perennial ryegrass (*Lolium perenne*), that are bordered by planted belts of tall lombardy poplar (*Populus nigra* cv. *Italica*). The poplar here are growing adjacent to silver birch (*Betula pendula*), scots pine (*Pinus sylvestris*), oak and beech (*Fagus sylvatica*), and there are also traces of the original hawthorn hedge that the above belts were planted to replace. The corridor also runs close to the southern half of Triangle Wood, an area of semi-mature replanted woodland, protected by a Tree Preservation Order (TPO). The developing canopy is dominated by sweet chestnut (*Castanea sativa*), oak, sycamore (*Acer pseudoplatanus*) and birch, with occasional standard oak near the boundaries, and a species-poor herb layer.

<u>C874 Plumstead Road to C283 Salhouse Road</u>

The corridor crosses Racecourse Plantation CWS, which is a mosaic of coniferous plantation and semi-natural broadleaved woodland, with a network of rides and paths dividing up the area. To the south, the broadleaved woodland is fairly young, with silver birch, european larch (Larix deciduas) and western hemlock-spruce (Tsuga heterophylla) the main features of the canopy layer. To the north, the woodland is older and better established, dominated by oak, birch and hazel (Corylus avellana). The herb layer contains a diverse herb community, with numerous grass species also present. The rides and footpaths are perhaps the most important areas, as they provide areas for diverse and valuable ecological communities to thrive. Of particular note are areas of heath and damp grassland communities. A set of ponds also exists within the site. Adjacent to this CWS lies an area of semi-improved grassland and scrub, dominated by perennial ryegrass and bent species (Agrostis spp), with bramble (*Rubus fruticosa* agg.) and bracken (*Pteridium aquilinum*) locally dominant, and occasional semi-mature birch, hawthorn and english elm (Ulmus procera).

Part of Belmore and Brown's Plantations CWS also lies within the route corridor. It is similar in appearance and ecological status to Racecourse Plantation, made up of a mosaic of coniferous and broadleaved woodland over a sandy acidic soil. As above, footways and rides criss-cross the site, and provide locations for diverse grass and sedge communities to thrive. Closer to the route, the woodland gives way to scrub, and then poor semi-improved grassland.

Within the corridor are two areas of semi-improved grassland, dominated by mixed swathes of perennial ryegrass, common bent (*Agrostis capilaris*), yorkshire fog (*Holcus lanatus*) and timothy grass (*Phleum pratense*). Between these is a belt of planted coniferous trees, predominantly scots pine, with occasional ash (*Fraxinus excelsior*), beech, with a shrub layer of sweet chestnut and hawthorn, which separates it from a second area of grassland, similar to that described above. An area of derelict land also lies adjacent to the grassland, with scrubby vegetation including giant hogweed (*Heracleum mantegazzianum*), bramble, common nettle (*Urtica dioica*) and elder saplings, in between rubble, wood, sheet tin and an old shed.

<u>C283 Salhouse Road to A1151 Wroxham Road</u>

The corridor crosses arable land and numerous hedges with trees, most of which are species-poor, and two adjacent areas of semi-natural mixed woodland, Round Hill Plantation and the Breck. Round Hill Plantation has a canopy made up of abundant scots pine, with occasional broadleaved constituents including oak, ash and beech. The herb layer is species-poor, dominated by bracken (*Pteridium aquilinum*), with frequent bramble and

hawthorn, with occasional oak saplings. The Breck is very similar in most respects, but with a canopy dominated locally by pine and beech. The corridor then runs through a species-poor hedge with trees, dominated by oak, poplar species (*Populus* spp) and bramble, and along the course of two defunct (no longer continuous and stock-proof) species-poor hedges with trees, dominated by hawthorn, which are bordered on both sides by arable land. It then runs along the edge of Sprowston Manor Golf Course, an area of amenity grassland dominated by perennial ryegrass. On the south-east side of Wroxham Road is a belt of mature sycamore in a parkland setting, separating the road from the golf course which lies behind it. These are covered by TPOs, some covering a large area, and some covering specific trees.

A1151 Wroxham Road to B1150 North Walsham Road

The corridor here crosses large areas of arable land, with numerous hedges, some of which are defunct. They are generally dominated by hawthorn, with standard oak and occasional elm, which have a great deal of dead material, cracks and crevices that would provide roost sites for bats and birds. It also crosses a road edged on both sides by a defunct species-rich hedge with intermittent trees. As well as oak, sycamore and hawthorn, dog rose (*Rosa canina*), field maple (*Acer campestre*) and blackthorn are present.

B1150 North Walsham Road to Norwich Airport

The corridor runs across the large areas of amenity grassland of perennial ryegrass of the local rugby club. The pitches and surrounding land is a species-poor grass community dominated by perennial ryegrass. Further small arable fields are then crossed, with an area of scrub woodland and rich hedges and banks and a boundary containing mature trees, particularly Maple and Oak. The ground flora is poor. There is a pond near the woodland boundary which, although overshadowed by trees, may provide a suitable amphibian breeding site. Adjacent to the woodland is an area of allotments. The corridor would also cross a species rich hedgerow, which borders Buxton Road and comprises dominant Oak with Hawthorn, Blackthorn and Field Maple, with a species rich understorey. The route then crosses more arable land, including two species-rich hedges with trees, one of which contains ancient trees including Oak and occasional Beech.

Around Quaker Lane are a number of species-rich hedges with trees, all with numerous standard trees, mostly oak, but occasionally beech and sycamore. Two hedges in the location are considered to be important under the Hedgerow Regulations. The majority of these have dead material in situ, holes and crevices, which are likely to provide roost sites for bats, bird nesting habitat and shelter for invertebrates. The corridor crosses an area of mixed broadleaved and deciduous saplings, and one more species-poor hedge with trees, dominated by hawthorn and pedunculate oak.

On the Northern edge of the route corridor close to the airport runway lies Bunker's Hill, a small area of mature broadleaved woodland of oak, sycamore, sweet chestnut and beech making up the canopy, with a shrub layer of holly and elder. Although the herb layer is dominated by bracken, bluebells (*Hyacinthoides non-scripta*) are locally abundant. Norwich Airport to A140 Cromer Road

From the north-east of Norwich Airport, the corridor runs parallel with the airport boundary crossing arable land. Some field boundaries have been removed or are marked by ditches, with only a few marked by hedgerows. Those that do exist tend to be defunct (no longer stock-proof) species-poor hedges, dominated by hawthorn (*Crataegus monogyna*). The corridor crosses a road with species-rich grass verges, including yorkshire fog (*Holcus lanatus*), red fescue (*Festuca rubra*) and various bent species (*Agrostis* spp), with herbs including field scabious (*Knautia arvensis*) and toadflax (*Linaria vulgaris*)(*Populus* spp). It then runs adjacent to two rows of Poplars (*Populus* spp) along the airport boundary.

The corridor then crosses a species-rich hedge with trees, defunct in places, mostly mature pedunculate oak (*Quercus robur*) and ash (*Fraxinus excelsior*), with a mixed shrub layer of blackthorn (Prunus spinosa), hawthorn, english elm (*Ulmus procera*) and dog rose (*Rosa canina*), and a species-poor herb layer of bramble (*Rubus fruticosa* agg) and ivy (Hedera helix). Close to this hedge are others that the corridor crosses, mostly defunct species-poor hedges dominated by hawthorn.

The corridor passes through the north-west section of the airport grounds, crossing some improved grassland dominated by perennial ryegrass (*Lolium perenne*). From here to the A140 the corridor runs parallel to a species poor hedgerow with mature oak trees, with the hedge being unmanaged and consisting exclusively of hawthorn. The A140 at this point is bordered by a defunct species-poor hedge dominated by hawthorn.

(x) Eastern Yellow

Designated sites

The yellow route corridor crosses two County Wildlife Sites. The first is Tollshill Wood (reference no. 2021), a site that is also on the ancient woodland register and is covered by a Tree Preservation Order. The second is March Covert (reference no. 1392). An additional area designated as ancient woodland, Bulmer Coppice, on Salhouse Road, lies within the corridor.

Several other TPOs are contained in the route corridor, covering both areas and individual trees, along the frontage of Sprowston Manor on the Wroxham Road. These are all described in the appropriate parts of the habitat section below.

Protected Species

Great crested newts

Great Crested Newts are known to be present in the pond at Quaker Farm, which lies immediately south of the route corridor at its western end.

Badgers

Two Badger setts with numerous holes are present within the yellow route corridor. An additional sett was also identified however it was not in use at the time of the survey. The extent of territories is not known at this stage.

Bats

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, so all standard trees and areas of woodland may provide scope for roost sites. The bat survey shows that

55% of the suitable habitat surveyed offers high potential to contain bat roosts while all (100%) offers high potential for foraging areas.

<u>Birds</u>

Barn Owls may be present where the opportunity to roost co-exists with an undisturbed hunting ground. Likely places of shelter include any old dilapidated buildings around Red Hall farm, as well as the numerous farms between the A47 and Plumstead Road East, although none were recorded during the bird survey. The only Schedule 1 (Wildlife and Countryside Act 1981) breeding bird recorded in the yellow route corridor was the Eurasian Hobby.

<u>Reptiles</u>

Grass snakes, adders and slow worms are present in the area of semiimproved grassland north of Salhouse Road between Pig's Park and Bulmer Coppice, and also in Paine's Yard Wood immediately adjacent to this grassland. Grass snakes, adders and slow worms are protected under the Wildlife and Countryside Act 1981.

Priority Habitats and Species

Within the yellow route corridor, a number of species and habitats may be encountered, which are covered by the Norfolk Biodiversity Action Plan. As is the case for the pink corridor, numerous ancient and/or species-rich hedges, and cereal field margins are located across the study area.

Great Crested Newts are described in the protected species section above.

Fifty four breeding birds were recorded during the survey. Of these, 4 were national BAP species and 2 local BAP species including Song Thrush and Skylark.

Seven locations have been identified from the Phase 1 habitat survey as offering the likely hood of supporting a significant number of invertebrates. The invertebrate species would be associated with woodland habitats and those of mature/ancient trees.

Habitat

A47 to C874 Plumstead Road

In common with the pink route, the yellow route runs through arable land interspersed mostly with species-poor hedges with trees. It carries on northwards parallel with the railway for a kilometre more than the pink route crossing large arable fields, a species-rich hedge with trees dominated by hawthorn, ash and oak, and an improved grassland field of perennial ryegrass. Plumstead Road is edged by species poor hedges of hawthorn and some hazel.

<u>C874 Plumstead Road to C283 Salhouse Road</u>

This section is dominated by large arable fields. The route crosses the railway bordered by scattered scrub, and also crosses two small fields of improved grassland of perennial ryegrass.

<u>C283 Salhouse Road to A1151 Wroxham Road</u>

At this point the corridor crosses part of the March Covert CWS. This site has a dense canopy mainly of oak, with occasional horse chestnut (*Aesculus hippocastanum*), ash and sycamore, and a shrub layer of abundant coppiced hazel and occasional blackthorn and holly. The herb layer is dominated by bramble, where primrose (*Primula vulgaris*) are a notable feature. The CWS represents part of a larger area of birch/ash woodland, with occasional scots pine, sycamore and oak, with a shrub layer of field maple and hazel, which has been coppiced in the past. The species-poor herb layer is dominated locally by ground ivy (*Glechoma hederacea*), bracken and bramble.

Also within the corridor here is Bulmer Coppice, an area of ancient woodland. The canopy is mixed and mature, dominated by scots pine, with occasional oak and silver birch, with hawthorn dominating the shrub layer. The bracken-dominated herb layer has bank and ditch structures within it, and evidence of badger habitation has was observed during the survey.

In between March Covert and Bulmer Coppice is an area of semi-improved grassland dominated locally by Yorkshire fog. Diverse herb communities are also present, with white clover (*Trifolium palustre*), common centaury (*Centaurium erythraea*) and birds' foot trefoil (*Lotus corniculatus*) being notable constituents, along with many grass and rush species. A newly planted hedge crosses this area, with gorse (*Ulex* sp.) and bracken alongside the hawthorn.

The corridor then crosses through Paine's Yard Wood, an additional area of mixed woodland, into arable land with few boundary hedges, and then runs through the middle of Sprowston Manor Golf Course, a large area of amenity grassland of perennial ryegrass. A species-rich tree belt adjacent to Wroxham Road is severed, that contains hazel, sycamore, birch, ash, spindle (*Euonymus europaeus*), holly, hawthorn and blackthorn, and lies next to an area of tall ruderal herbs, with frequent rosebay willowherb (*Chamerion angustifolium*), cow parsley (*Anthriscus sylvestris*) and common ragwort (*Senecio jacobaea*).

As the corridor meets Wroxham Road it crosses a second County Wildlife Site, Tollshill Wood, which is also covered by a TPO. This ancient woodland is well-managed, with a canopy dominated by sycamore and sweet chestnut, with frequent oak and beech. Large hornbeam (*Carpinus betulus*) and small-leaved lime (*Tilia cordata*) are notable on the western boundary, close to the route. The diverse herb layer includes bluebell, wood anemone (*Anemone nemorosa*), wood avens (*Geum urbanum*), red campion (*Silene dioica*) and hedge woundwort (*Stachys sylvatica*).

A1151 Wroxham Road to B1150 North Walsham Road

Adjacent to Wroxham Road, the corridor crosses the edge of an area of oak dominated broadleaved woodland covered by TPOs, and then crosses arable land with occasional species-poor hedges, dominated by hawthorn. The corridor touches the southern edge of Spanish Plantation, a broadleaved mixed woodland with a canopy dominated by sweet chestnut and occasional birch, and a species-rich herb layer including bluebells.

It then crosses a road edged on both sides with a species-rich hedgerow with trees, considered to be important under the Hedgerow Regulations . The hedgerow contains oak, dog rose, hawthorn, sycamore, field maple blackthorn and holly, and includes mature Oak and Sycamore trees within it. Beyond this it crosses a further area of arable land before reaching North Walsham Road. B1150 North Walsham Road to Norwich Airport

This section is similar to the eastern pink route, and therefore the same comments apply.

Norwich Airport to A140 Cromer Road

This section is similar to the eastern pink route, and therefore the same comments apply.

(xi) Eastern Blue

Designated sites

The corridor of the blue route runs through the southern half of Church Wood, Ladies Carr and Springs County Wildlife Site (CWS reference no. 1393), which consists of woodland, grassland and standing water habitats. Part of the site is also ancient woodland. It also crosses part of March Covert CWS (reference no. 1392). Two more areas of ancient woodland lie within the corridor, namely Sprowston Wood and Ortolans' Grove. Trees covered by a Tree Preservation Order (TPO) also fall within the route corridor, bordering the A1151 Wroxham Road. These are all described in the appropriate parts of the habitat section below.

Protected Species

Great crested newts

Great Crested Newts, protected by the Wildlife and Countryside Act 1981, and the Conservation (Natural Habitats &c.) Regulations 1994, are present in a pond at Quaker Farm at the western end of the blue route.

Badgers

No Badger setts are located along the eastern blue route corridor, although there may be areas used for foraging. Badgers are protected under the Protection of Badgers Act 1992.

• <u>Bats</u>

Bats may be present wherever there are mature trees, with cracks, crevices and dead material in situ, so all standard trees and areas of woodland may provide scope for roost sites. Of the suitable habitat surveyed 38% offers high potential for roost sites while 97% offers high potential for foraging. All species of bat are protected under the Wildlife and Countryside Act 1981, and the Conservation (Natural Habitats &c.) Regulations 1994.

Birds

Barn Owls may be present where the opportunity to roost co-exists with an undisturbed hunting ground. Likely places of shelter include any old dilapidated buildings around the numerous farms between the A47 and Plumstead Road East, as well as any suitable buildings east of Rackheath Hall. The breeding bird survey did not record Barn owls or other Schedule 1 species however 55 species of breeding bird were recorded. All breeding birds are protected under the Wildlife and Countryside Act 1981 and Barn Owls are given additional protection under Schedule 1.
Reptiles

Grass snakes are present in an area of semi-improved grassland to the north of Heath Wood, and there is also a record of adder being present in this area.

Priority Habitats and Species

Within the blue route corridor, a number of species and habitats may be encountered, which are covered by the UK Biodiversity Action Plan (BAP) and/or Norfolk BAP. Ancient and/or species-rich hedges and cereal field margins, are spread across most of the corridor.

Grazing marsh may be present close to the Church Wood, Ladies Carr and Springs CWS. Reedbeds and mesotrophic lakes are also likely to be found at this location.

Great Crested Newts are described in the section above.

The breeding birds survey identified 5 national BAP species and 2 local BAP species, including Skylark and Grey Partridge.

From the invertebrate habitat assessment at least 5 locations offer high potential to support species, mainly those associated with wetland and dead wood environments.

Habitat

A47 to C874 Plumstead Road

This section is similar to the eastern yellow route, and therefore the same comments apply.

<u>C874 Plumstead Road to C283 Salhouse Road</u>

The corridor crosses a small field of improved grassland comprised of perennial ryegrass, and then the railway line which is edged by scattered scrub. It then runs across large arable fields with no hedges. Prior to reaching Salhouse Road the corridor runs parallel to a belt of mixed seminatural woodland, dominated by Birch species, with frequent Oak, Wild Cherry (*Prunus avium*) and Hawthorn. Salhouse road is bordered by a defunct species-poor hedge and screen on the south side.

<u>C283 Salhouse Road to A1151 Wroxham Road</u>

On crossing Salhouse Road, the corridor crosses a species-rich hedgerow with trees, predominantly standard oak. It then passes across arable fields and three small improved grassland fields, bordered by species-rich hedges with trees, mostly Oak, with occasional Elm, Ash and Sycamore, all providing significant potential for bat roost sites. The hedges themselves are made up mostly of Hawthorn, with frequent Blackthorn and occasional Dog Rose, over a species-poor herb layer.

This section of the corridor also runs parallel with the eastern edge of March Covert CWS. This site has a dense canopy mainly of oak, with occasional horse chestnut (*Aesculus hippocastanum*), ash and sycamore, and a shrub layer of abundant coppiced hazel and occasional blackthorn and holly. The herb layer is dominated by bramble, where primrose (*Primula vulgaris*) are a notable feature.

The corridor then crosses through Heath Wood, an area of mixed speciesrich mature woodland. Oak, Sweet Chestnut, Elm, Sycamore and Scots Pine constitute the canopy layer, with numerous glades dominated by colonising Birch and Sycamore. In some locations, the herb layer contains Bluebell, Broad Buckler Fern (*Dryopteris dilatata*), Primrose and Honeysuckle (*Lonicera periclymenum*). Also within the corridor is part of the adjacent woodland area, which has a canopy dominated by Sycamore, with abundant Ash and occasional Oak, and a shrub layer that shows evidence of coppicing in the past, comprised of Hawthorn, Elder and Wild Privet (*Ligustrum vulgare*). Bluebell, Primrose and Snowdrop (*Galanthus nivalis*) are found in the herb layer.

Beyond Heath Wood the corridor then crosses some large areas of semiimproved grassland, with occasional standard Oak, Ash and Scots Pine to the centre, adjacent to a narrow wooded belt. The grassland is generally species-poor, suggesting lack of management, with encroaching Bracken and Bramble, and frequent Creeping Thistle (Cirsium arvense), Common Ragwort and Creeping Buttercup (Ranunculus repens). Rabbit-grazed areas have much greater herb diversity, with flora including Common Centaury, Birds Foot Trefoil, selfheal (Prunella vulgaris), and Musk Mallow (Malva moschata). Such habitat represents good locations for ground nesting birds. An unmanaged pond is situated within the grassland area, in a hollow. It is surrounded by Bramble and Nettles, with Willow (Salix spp), Ash and Elder adjacent. These, along with the tall Reed Mace (Typha latifolia), shade parts of the pond. Broadleaved Pondweed (Potamogeton natans) and Duckweed (Lemna minor) grow in the water. On leaving the grassland, the corridor crosses a small copse of Ash-dominated woodland, and then crosses three large arable fields.

Adjacent to Wroxham Road is Upper Blacksmiths' Wood, covered by a TPO, which lies within the corridor. It is an area of mature broadleaved woodland of Sycamore, Oak and Poplar, with Elder, Ivy and Hawthorn in the shrub layer, and has a herb layer that includes Bluebells and Snowdrops. Ortolans Grove, a belt of mature trees designated as an area of ancient woodland, also lies within the corridor, close to Wroxham Road. Wroxham Road is bordered by species-poor hedges with trees.

A1151 Wroxham Road to B1150 North Walsham Road

After crossing Wroxham Road the corridor runs along a long improved grassland field. Adjacent to this, also within the corridor, is Church Wood, Ladies Carr and Springs CWS. This diverse area is made up of several different types of woodland, grassland and standing water habitats. Church Wood is a mature mixed woodland, dominated by Oak, but with Sweet Chestnut, Birch, Ash and Scots Pine also present. The shrub layer is predominantly hazel, and the herb layer is species-poor, dominated by Bracken and Bramble. Ladies Carr is a mature broadleaved sycamore woodland, with frequent Alder, Ash and Holly, with a herb layer that includes bluebells locally. A number of ponds are present within the site, generally surrounded by willow scrub and carr, comprised of species including Reed Mace, Yellow Iris (Iris pseudacorus) and Great Willowherb (Epilobium hirsutum). A common Lime (Tilia x vulgaris) coppice occurs close to the main area of carr, with a rich herb layer including Dog's Mercury (Mercurialis perennis), Herb Robert (Geranium robertianum), Wood Avens and Bluebell. Areas of semi-improved and marshy grassland are also present within the site, both with species-rich communities present.

On the other side of the above grassland field, still inside the route corridor, lies Sprowston Wood, an area of mature broadleaved woodland designated as ancient woodland. It has a canopy made up of Sweet Chestnut, Oak, Beech, Poplar and exotic conifer species, with a shrub layer dominated by Hazel, and a herb layer locally dominated by Bracken and Bramble, with locally frequent Bluebell.

After passing between the two features described above, the route crosses arable land, three species-poor hedges, one with trees, and a tree belt of very old Oak and Scots Pine, with a shrub layer predominantly of Blackthorn. Beyond this it crosses more arable land and a belt of exotic conifers, and runs close to Tithe Plantation, an area of mixed woodland of Oak and Silver Birch, with Scots Pine and Spruce species (*Picea* spp).

B1150 North Walsham Road to Norwich Airport

Between North Walsham Road and Buxton Road, the corridor crosses arable fields, separated by species-poor hedges, and encroaches into the southern edge of Spixworth Plantation. This is a belt of semi-mature mixed woodland, with abundant Scots Pine and Oak, some of which are very old, offering ideal roost sites for bats. The shrub layer is predominantly Elder, over a poor herb layer of Ivy and Nettles. Buxton Road is bordered by species-rich hedges with mature trees, including Field maple, Oak, Ash, Hawthorn and Sycamore, with the ground cover comprised of Bramble, Nettle and Ivy.

Beyond Buxton Road the corridor crosses more arable land, including two species-rich hedges with trees, one of which contains ancient trees including Oak and occasional Beech. Around Quaker Lane are a number of species-rich hedges with trees, all with numerous standard trees, mostly oak, but occasionally beech and sycamore. Two hedges in the location are considered to be important under the Hedgerow Regulations. The majority of these have dead material in situ, holes and crevices, which are likely to provide roost sites for bats, bird nesting habitat and shelter for invertebrates. The corridor crosses an area of mixed broadleaved and deciduous saplings, and one more species-poor hedge with trees, dominated by hawthorn and pedunculate oak.

On the Northern edge of the route corridor close to the airport runway lies Bunker's Hill, a small area of mature broadleaved woodland of oak, sycamore, sweet chestnut and beech making up the canopy, with a shrub layer of holly and elder. Although the herb layer is dominated by bracken, bluebells (*Hyacinthoides non-scripta*) are locally abundant.

Norwich Airport to A140 Cromer Road

This section is similar to the eastern pink route, and therefore the same comments apply.

5.5.3 Assessment of Impacts

General

Generic impacts associated with all the routes are listed below. These impacts are not route specific.

Construction impacts

- Sediment and materials entering the river
- Physical disturbance to habitat
- Direct loss of habitat
- Disruption to local hydrological conditions and adverse change in the hydrological status of habitats
- Temporary severance and fragmentation of habitat
- Pollution and leachate from road construction materials and construction activities, including dewatering
- Disturbance to wildlife during construction by noise, vibration, lighting and movement
- Obstructions in the river channel
- Shading
- Decrease in water quality

Detailed impacts on ecology resulting from disruption due to construction (for example, haul routes, locations of borrow pits or surplus material for each route option) would be addressed at Stage 3, when more detailed engineering information would be available.

Operational impacts

- Loss of habitat
- Severance and fragmentation of habitats
- Change in river channel cross-section profile which alters flow conditions
- Obstructions in the river channel
- Reduction air quality particularly hydrocarbons and heavy metals.
- Changes to environment caused by shading and other microclimatic changes created by structures
- Changes in management of vegetation as a result of severance
- Reduction in water quality due to highway discharge
- Siltation due to highway run off
- Risk of collision between fauna and road traffic
- Disruption to local hydrological conditions and adverse change in the hydrological status of habitats
- Disturbance from lighting at junctions

The table below lists potential impacts on species for which the River Wensum SAC in particular is designated:

Feature	Potential impacts					
	Siltation	Removal of	Loss of	Chemical	Change in	Change in
		riparian	channel	water	flow	groundwater
		vegetation	habitat	pollution	regime	levels
Water-						
crowfoot	•		•			
White-clawed						
Crayfish	•		•			
Desmoulin's		•				
Whorl Snail		•		•		•
Bullhead	•		•	•		
Brook						
Lamprey			•	-		

All these potential impacts are the same for all of the crossings of the River Wensum.

Route specific impacts

In the assessments below, a feature that lies within the route corridor, and would be subject to direct land-take for construction of the road, is described as experiencing a direct effect. A feature that would not be subject to land-take is described as experiencing an indirect effect.

For each route option a table is given which lists the ecological features and their value, as described under the baseline conditions of this report, followed by a description of the potential impacts. The table also summarises the potential magnitude of impact and the impact assessment score based on the significance criteria in TAG. The tables show an assessment score which does not take any mitigation into account, therefore this is effectively the 'worst case scenario'. Details of potential impacts on ecology as a result of changes in hydrology, land take and severance will be assessed during Stage 3, when further engineering design details would be available.

(i) Western Green Route

Potential Impacts to Ecological Features resulting from the Western Green Route Option

Feature	Value	Magnitude of Impact	Assessment Score
SAC & SSSI (River Wensum)	Very High	Major negative	Very large adverse
Broads ESA (Wensum and Tud floodplains)	High	Major negative	Very large adverse
CWS (Low Row Meadow, Wensum Mount Farm, Drayton Wood)	High	Major negative (direct impact)	Very large adverse
Ancient Woodland (ancient trees in Drayton Wood)	High	Major negative (direct impact)	Very large adverse
TPO (Drayton Wood, around Hellesdon Hospital, south of Horsham St Faith)	Medium	Major negative (direct impact on Drayton Wood)	Moderate adverse
Other Woodland	Lower	Major negative (depending on exact route alignment)	Slight adverse
Species-rich hedgerows	Medium	Major negative	Moderate adverse
Semi-improved grassland	Lower	Minor negative	Slight adverse
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing marsh	Lower	Major negative	Slight adverse

Feature	Value	Magnitude of Impact	Assessment Score
Bats	Very High	Major negative	Very large adverse (depending on exact route alignment)
White-clawed crayfish	Very High	Major negative	Very large adverse (depending on exact route alignment)
Otters	Very High	Major negative	Very large adverse (depending on exact route alignment)
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The western green route directly impacts the River Wensum, which is a designated SAC and SSSI. The point at which the route crosses the River Wensum includes a mosaic of habitats, such as species-rich, semi-improved fen meadow grassland, a ditch network and broadleaf carr woodland, with the loss and disturbance of these habitats being a very large adverse impact.

The route cuts across the River Wensum and River Tud floodplains, which are within the Broads ESA, and follows the River Tud floodplain for a considerable distance crossing a mosaic of habitats. These areas will be directly affected resulting in the loss of habitats, with the Broads ESA consequentially suffering a very large adverse impact. The crossing point over the River Tud is however close to an existing road crossing, effectively reducing the impact if this is utilised.

Three CWS would be directly affected: Low Road Meadow, Wensum Mount Farm and Drayton Wood. The high ecological values of these sites would result in a very large adverse impact. The ancient trees in Drayton Wood would also be directly impacted on, leading to a very large adverse impact on ancient woodland.

Three areas covered under TPOs would be affected, including the direct impact on Drayton Wood. The TPOs around Hellesdon Hospital and south of Horsham St Faith would be indirectly affected, with these areas subject to a moderate adverse impact. Other areas of less valuable woodland would experience direct or indirect impacts dependent on the exact route alignment, suffering slight adverse impacts. Overall approximately 2 ha of woodland would be lost.

Sections of species-rich hedgerows would be directly affected with the loss of hedgerow resulting in moderate adverse impacts. The semi improved grassland

within the grounds of Hellesdon Hospital will be directly affected, suffering a slight adverse impact.

There are three active badger setts within the route corridor, which would suffer large to very large adverse impacts depending on the exact route alignment.

(ii) Western Orange

Potential Impacts to Ecological Features resulting from the Western Orange Route Option

Feature	Value	Magnitude of Impact	Assessment Score
SAC & SSSI (River Wensum)	Very High	Major negative	Very large adverse
Broads ESA (Wensum and Tud floodplains)	High	Major negative	Very large adverse
CWS Long Dale, Lord's Hill and Easton Reeds, Ringland Pit, Taverham Meadows, Blyth's Wood, Walsingham Plantation	High	Major negative (direct impact)	Very large adverse
Ancient Woodland (open woodland area with ancient Oaks & coppice Hazel stools to south side of River Wensum)	High	Major negative (direct impact)	Large adverse (depending on exact route alignment).
TPO (Snake Wood, Beech Avenue, Taverham, south of Horsham St Faith	Medium	Minor negative	Slight adverse
Other Woodland	Lower	Major negative (depending on exact route alignment)	Slight adverse
Species-rich hedgerows (including one important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Semi-improved grassland (golf course, banks of River Wensum.	Lower	Major negative	Slight adverse
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing marsh	Lower	Major negative	Slight adverse
Bats	Very High	Major negative	Very large adverse (depending on exact route alignment)

Feature	Value	Magnitude of Impact	Assessment Score
White-clawed crayfish	Very High	Major negative	Very large adverse (depending on exact route alignment)
Otters	Very High	Major negative	Very large adverse (depending on exact route alignment)
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)
Great crested newts	Very high	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The River Wensum is a designated SAC and SSSI and will be directly affected. The crossing point of the River Wensum includes a mosaic of habitats, including species-rich semi-improved grassland, mature trees, an open area of wet grassland with seasonal water bodies and more permanent "back-water" areas. The loss and disturbance of these habitats will be a very large adverse impact.

The River Wensum and River Tud floodplains are within the Broads ESA, and will be directly affected. The crossing point of the River Tud has flood grassland either side of the river with diverse flora, a ditch network and pools, coppice Alder and mature Alder. The silted-up ditches and surrounding marsh / pools are species-rich. The loss and disturbance of these habitats will be a very large adverse impact on the ESA.

Five CWS will be directly affected (Long Dale, Lord's Hill and Easton Reeds, Ringland Pit, Taverham Meadows and Blyth's Wood) and Walshingham Plantation CWS would be indirectly affected. CWS will overall be subject to a very large adverse impact.

The open woodland area with ancient Oaks & coppice Hazel stools to south side of River Wensum will be directly affected, resulting in a large adverse impact on ancient woodland, although this is dependent on the exact route alignment. Three areas covered by TPOs will be indirectly affected (Snake Wood, Beech Avenue in Taverham and Horsham St Faith), suffering a slight adverse impact. There will be slight adverse impacts on other areas of woodland within the route corridor. Overall approximately 8 ha of woodland would be lost.

Sections of species-rich hedges, including one that is considered important under the Hedgerow Regulations, would be directly affected, suffering a moderate adverse impact. The areas of semi improved grassland at Costessey golf course and along the banks of the River Wensum will be directly affected, with all being subject to slight adverse impacts.

Two active badger setts will be affected, suffering a large to very large adverse impact depending on the exact route alignment. Great crested newts are present in two ponds that would be indirectly affected at present, leading to a large to very large adverse impact depending on the exact route alignment.

(iii) Western Blue

Potential Impacts to Ecological Features resulting from the Western Blu	Je
Route Option	

Feature	Value	Magnitude of Impact	Assessment Score
SAC & SSSI (River Wensum)	Very High	Major negative	Very large adverse
Broads ESA (Wensum and Tud floodplains)	High	Major negative	Very large adverse
CWS (Walsingham Plantation (indirect, Harman's Grove (indirect), Adjacent to River Tud (direct))	High	Major negative (direct impact)	Very large adverse
Ancient Woodland (ancient trees near R. Wensum crossing point)	High	Major negative (direct impact)	Large adverse (depending on exact route alignment).
TPO (Snake Wood, Beech Avenue, Taverham, south of Horsham St Faith	Medium	Minor negative	Slight adverse
Other Woodland (number of woodland blocks, including Ringland Hills)	Lower	Major negative (depending on exact route alignment)	Slight adverse
Species-rich hedgerows (including three important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing marsh	Lower	Major negative	Slight adverse
Bats	Very High	Major negative	Very large adverse (depending on exact route alignment)
White-clawed crayfish	Very High	Major negative	Very large adverse (depending on exact route alignment)
Otters	Very High	Major negative	Very large adverse (depending on exact route alignment)

Feature	Value	Magnitude of Impact	Assessment Score
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)
Great crested newts	Very high	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The western blue route directly affects The River Wensum, which is a designated SAC and SSSI. The route runs alongside the River Wensum through an area of semi-improved grassland either side of the river, with low-lying wet areas and a ditch network with botanically diverse emergent vegetation. The crossing point of the river has wet flood meadows and a ditch network, and adjoins other potentially species-rich grassland along the floodplain. The loss and disturbance to these ecologically diverse areas will be a very large adverse impact.

The River Wensum and River Tud floodplains are within the Broads ESA, with the crossing point of the River Tud containing mature trees, species-rich grassland, a ditch network, and links to adjacent habitats. Loss and disturbance of these ecologically valuable features will result in the ESA suffering a very large adverse impact.

Walshingham Plantation CWS and Harman's Grove CWS will be indirectly impacted, and Adjacent to River Tud CWS will be affected directly. This will result in a very large adverse impact on CWS.

The area of ancient woodland near the River Wensum crossing point will be directly affected, and will suffer a large adverse impact depending on the exact route alignment. The TPOs at Snake Wood, Beech Avenue in Taverham, and south of Horsham St Faith will be indirectly affected, resulting in a slight adverse impact. There are a number of other woodland blocks along the route corridor, including Ringland Hills, which will be subject to slight adverse impacts. Overall approximately 1 ha of woodland would be lost.

Sections of species-rich hedgerows would be directly affected, including three that are considered important under the Hedgerow Regulations, resulting in a moderate adverse impact. The areas of semi-improved grassland at Costessey golf course and the banks of the River Wensum will be directly affected, suffering slight adverse impacts.

There is one active badger sett along the route that would be affected, enduring a large to very large adverse impact depending on the exact route alignment. Great crested newts are present in two ponds that would be indirectly affected at

present, leading to a large to very large adverse impact depending on the exact route alignment.

(iv) Western Red

Potential Impacts to Ecological Features resulting from the Western Red Route Option

Feature	Value	Magnitude of Impact	Assessment Score
SAC & SSSI (River Wensum)	Very High	Major negative	Very large adverse
Broads ESA (Wensum and Tud floodplains)	High	Major negative	Very large adverse
CWS – Walsingham Plantation, Attlebridge Hills, Church Hill Common, Harman's Grove, River Wensum Pastures Morton Hall, Jennis Wood, Adjacent to River Tud	High	Major negative (direct impact)	Very large adverse
Ancient Woodland (Harman's Grove, Jennis Wood, trees near C172 Ringland Road	High	Major negative (direct impact)	Large adverse (depending on exact route alignment).
TPO (south of Horsham St Faith	Medium	Minor negative	Slight adverse
Other Woodland (number of woodland blocks, including Primrose Grove)	Lower	Major negative (depending on exact route alignment)	Slight adverse
Species-rich hedgerows (including two important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Semi-improved grassland (banks of River Wensum).	Lower	Major negative	Slight adverse
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing marsh	Lower	Major negative	Slight adverse
Bats	Very High	Major negative	Very large adverse (depending on exact route alignment)
White-clawed crayfish	Very High	Major negative	Very large adverse (depending on exact route alignment)
Otters	Very High	Major negative	Very large adverse (depending on exact route alignment)

Feature	Value	Magnitude of Impact	Assessment Score
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds (including Barn Owl)	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The River Wensum is a designated SAC and SSSI, and will be directly affected. The crossing point of the river contains a mosaic of semi-improved grassland separated by ditches, which are botanically rich, and the loss and disturbance to these will be a very large adverse impact. The River Wensum and River Tud floodplains are within the Broads ESA, and will be directly affected leading to a very large adverse impact.

Adjacent to River Tud CWS will be direct impacted, and six other CWS will be indirectly affected (Walsingham Plantation, Attlebridge Hills, Church Hill Common, River Wensum Pastures Morton Hall, Harman's Grove and Jennis' Wood. Overall, CWS will be subject to a very large adverse impact.

The ancient woodland at Harman's Grove and that at Jennis Wood will be indirectly affected. The ancient trees near C172 Ringland Road will also be affected, resulting in a large adverse impact in ancient woodland depending on the exact route alignment. The TPO south of Horsham St Faith will be indirectly affected suffering a slight adverse impact. A number of other woodland blocks along the route corridor, including Primrose Grove, will be affected and subject to slight adverse impacts. Overall approximately 5 ha of woodland would be lost.

Some species-rich hedgerows will be directly affected, including two considered important under the Hedgerow Regulations, resulting in a moderate adverse impact. The semi-improved grassland along the banks of the River Wensum would be directly affected suffering a slight adverse impact.

Two active badger setts and two setts not currently used will be affected, leading to a large to very large adverse impact depending on the exact route alignment. Great crested newts are present in two ponds that would be indirectly affected at present, leading to a large to very large adverse impact depending on the exact route alignment.

(v) Western Brown

Potential Impacts to Ecological Features resulting from the Western Brown Route Option

Feature	Value	Magnitude of Impact	Assessment Score
SAC & SSSI (River Wensum)	Very High	Major negative (reduced if existing crossing utilised)	Very large adverse (reduced if existing crossing utilised)
Broads ESA (Wensum and Tud floodplains)	High	Major negative (reduced if existing crossing utilised)	Very large adverse (reduced if existing crossing utilised)
CWS – Triumph and Foxburrow Plantations, Attlebridge Hills, Hall Hills, River Wensum Pastures Morton Hall	High	Major negative (direct impact on Triumph and Foxburrow Plantations and Hall Hills)	Very large adverse
TPO (south of Horsham St Faith	Medium	Minor negative	Slight adverse
Other Woodland (number of woodland blocks)	Lower	Major negative (depending on exact route alignment)	Slight adverse
Species-rich hedgerows (including two important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing marsh	Lower	Major negative	Slight adverse
Bats	Very High	Major negative	Very large adverse (depending on exact route alignment)
White-clawed crayfish	Very High	Major negative	Very large adverse (depending on exact route alignment)
Otters	Very High	Major negative	Very large adverse (depending on exact route alignment)
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

Feature	Value	Magnitude of Impact	Assessment Score
Great crested newts	Very high	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The River Wensum is a designated SAC and SSSI, and is directly affected by the western brown route, resulting in a very large adverse impact. However, the crossing point would be close to the existing road crossing, effectively reducing the impact if this crossing is utilised.

The River Wensum and River Tud floodplains are within the Broads ESA, and will be directly affected leading to a very large adverse impact. The crossing point of the River Wensum would however be close to the existing road crossing, effectively reducing the impact.

Triumph and Foxburrow Plantations and Hall Hills CWS would be directly impacted, and three other CWS would be indirectly affected (River Wensum Pastures, Morton Hall and Attlebridge Hills), resulting in a very large adverse impact. Overall 11 ha of woodland would be lost.

The area covered by a TPO to the south of Horsham St Faith will be indirectly impacted, and will be subject to a slight adverse impact. A number of other woodland blocks along the route corridor will be affected, suffering slight adverse impacts. Sections of species-rich hedges will be affected, including two considered important under the Hedgerow Regulations, resulting in a moderate adverse impact on hedgerows.

Great crested newts are present in two ponds that would be indirectly affected at present, leading to a large to very large adverse impact depending on the exact route alignment.

(vi) Western Purple

Feature	Value	Magnitude of Impact	Assessment Score
SAC & SSSI (River Wensum)	Very High	Major negative (reduced if existing crossing utilised)	Very large adverse (reduced if existing crossing utilised)
Broads ESA (Wensum floodplain)	High	Major negative (reduced if existing crossing utilised)	Very large adverse (reduced if existing crossing utilised)
CWS – River Wensum Pastures, Morton Hall, Attlebridge Hills, Triumph and Foxburrow Plantations, Walsingham Plantation, The Waterfence, Old Covert Wood Lane	High	Major negative (direct impact on Triumph and Foxburrow Plantations and The Waterfence)	Very large adverse

Potential Impacts to Ecological Features resulting from the Western Purple Route Option

Feature	Value	Magnitude of Impact	Assessment Score
TPO (south of Horsham St Faith	Medium	Minor negative	Slight adverse
Other Woodland (number of woodland blocks)	Lower	Major negative (depending on exact route alignment)	Slight adverse
Species-rich hedgerows (including four important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing marsh	Lower	Major negative	Slight adverse
Bats	Very High	Major negative	Very large adverse (depending on exact route alignment)
White-clawed crayfish	Very High	Major negative	Very large adverse (depending on exact route alignment)
Otters	Very High	Major negative	Very large adverse (depending on exact route alignment)
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)
Great crested newts	Very high	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The River Wensum is a designated SAC and SSSI, and will be directly affected resulting in a very large adverse impact. However, the crossing point will be close to the existing road crossing, effectively reducing the impact if this crossing is used.

The River Wensum floodplain is within the Broads ESA, and will be directly affected leading to a very large adverse impact. The crossing point of the River Wensum will however be close to the existing road crossing, effectively reducing the impact.

Triumph and Foxburrow Plantations CWS and The Waterfence CWS will be directly impacted, and four CWS will be indirectly affected (River Wensum

Pastures, Morton Hall, Old Covert Wood Lane, Walsingham Plantation and Attlebridge Hills), resulting in a very large adverse impact. Overall approximately 8ha of woodland would be lost.

The area covered by a TPO to the south of Horsham St Faith will be indirectly impacted, and will be subject to a slight adverse impact. A number of other woodland blocks will be affected leading to a slight adverse impact. Sections of species-rich hedges will be directly affected, including four considered important under Hedgerow Regulations, with the loss of sections of these hedgerows resulting in a moderate adverse impact.

Great crested newts are present in two ponds that would be indirectly affected at present, leading to a large to very large adverse impact depending on the exact route alignment.

(vii) Western Brown Variation

Potential Impacts to Ecological Features resulting from the Western Brown
Alternative Route Option

Feature	Value	Magnitude of	Assessment Score
		Impact	
SAC & SSSI (River	Very High	Major negative	Very large adverse
Wensum)		(reduced if existing	(reduced if existing
		crossing utilised)	crossing utilised)
Broads ESA (Wensum	High	Major negative	Very large adverse
and Tud floodplains)		(reduced if existing	(reduced if existing
		crossing utilised)	crossing utilised)
CWS – Walsingham	High	Major negative	Very large adverse
Plantation, Attlebridge		(direct impact on	
Hills, Hall Hills, River		Attlebridge Hills	
Wensum Pastures		and Hall Hills)	
Morton Hall			
TPO (south of Horsham	Medium	Minor negative	Slight adverse
StFaith			
Other Woodland	Lower	Major negative	Slight adverse
(number of woodland		(depending on	
DIOCKS)		exact route	
	NA e elissies	alignment)	
Species-ricn	Medium	Major negative	Moderate adverse
neagerows (including			
two important under			
Hedgerow Regulations)			Oliabt advaraa
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing	Lower	Major negative	Slight adverse
marsn) (an el linda		
Bats	Very High	Major negative	Very large adverse
			(depending on exact
			route alignment)
white-clawed crayfish	very High	iviajor negative	very large adverse
			(uepenuing on exact
Ottore	Vondligh	Major pagativa	York large adverse
Utters	very High	iviajor negative	very large adverse
			(depending on exact
			route alignment)

Feature	Value	Magnitude of Impact	Assessment Score
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)
Great crested newts	Very high	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The River Wensum is a designated SAC and SSSI, and is directly affected by the western brown variation, resulting in a very large adverse impact. However, the crossing point would be close to the existing road crossing, effectively reducing the impact if this crossing is utilised.

The River Wensum and River Tud floodplains are within the Broads ESA, and will be directly affected leading to a very large adverse impact. The crossing point of the River Wensum would however be close to the existing road crossing, effectively reducing the impact.

Attlebridge Hills and Hall Hills CWS would be directly impacted, and two other CWS would be indirectly affected (Walsingham Plantation and River Wensum Pastures Morton Hall), resulting in a very large adverse impact. Overall approximately 5 ha of woodland would be lost.

The area covered by a TPO to the south of Horsham St Faith will be indirectly impacted, and will be subject to a slight adverse impact. A number of other woodland blocks along the route corridor will be affected, suffering slight adverse impacts. Sections of species-rich hedges will be affected, including two considered important under the Hedgerow Regulations, resulting in a moderate adverse impact on hedgerows. A Roadside Nature Reserve bordering the A1067 will be directly affected.

Great crested newts are present in two ponds that would be indirectly affected at present, leading to a large to very large adverse impact depending on the exact route alignment.

(vii) Western Purple Variation

Potential Impacts to Ecological Features resulting from the Western Purple Alternative Route Option

Feature	Value	Magnitude of Impact	Assessment Score
SAC & SSSI (River	Very High	Major negative	Very large adverse
Wensum)		(reduced if existing	(reduced if existing
		crossing utilised)	crossing utilised)

Feature	Value	Magnitude of	Assessment Score
Broads ESA (Wensum floodplain)	High	Major negative (reduced if existing crossing utilised)	Very large adverse (reduced if existing crossing utilised)
CWS – Walsingham Plantation, Attlebridge Hills, River Wensum Pastures Morton Hall, The Waterfence, Old Covert Wood Lane	High	Major negative (direct impact on Attlebridge Hills and The Waterfence)	Very large adverse
TPO (south of Horsham St Faith	Medium	Minor negative	Slight adverse
Other Woodland (number of woodland blocks)	Lower	Major negative (depending on exact route alignment)	Slight adverse
Species-rich hedgerows (including four important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Cereal field margins	Lower	Minor negative	Slight adverse
Floodplain grazing marsh	Lower	Major negative	Slight adverse
Bats	Very High	Major negative	Very large adverse (depending on exact route alignment)
White-clawed crayfish	Very High	Major negative	Very large adverse (depending on exact route alignment)
Otters	Very High	Major negative	Very large adverse (depending on exact route alignment)
Water voles	High	Major negative	Very large adverse (depending on exact route alignment)
Breeding birds	High	Major negative	Very large adverse (depending on exact route alignment)
Badgers	High	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)
Great crested newts	Very high	Major negative (depending on exact route alignment)	Very large adverse (depending on exact route alignment)

The River Wensum is a designated SAC and SSSI, and will be directly affected resulting in a very large adverse impact. However, the crossing point will be

close to the existing road crossing, effectively reducing the impact if this crossing is used.

The River Wensum floodplain is within the Broads ESA, and will be directly affected leading to a very large adverse impact. The crossing point of the River Wensum will however be close to the existing road crossing, effectively reducing the impact.

Attlebridge Hills CWS and The Waterfence CWS will be directly impacted, and three CWS will be indirectly affected (River Wensum Pastures, Morton Hall, Old Covert Wood Lane, Walsingham Plantation), resulting in a very large adverse impact. Overall approximately 3 ha of woodland would be lost.

The area covered by a TPO to the south of Horsham St Faith will be indirectly impacted, and will be subject to a slight adverse impact. A number of other woodland blocks will be affected leading to a slight adverse impact. Sections of species-rich hedges will be directly affected, including four considered important under Hedgerow Regulations, with the loss of sections of these hedgerows resulting in a moderate adverse impact. A Roadside Nature Reserve bordering the A1067 will be directly affected.

Great crested newts are present in two ponds that would be indirectly affected at present, leading to a large to very large adverse impact depending on the exact route alignment.

(ix) Eastern Pink

Potential Impacts to Ecological Features resulting from the Eastern Pink Route Option

Feature	Value	Magnitude of Impact	Assessment Score
CWS (Racecourse Plantation, Belmore & Brown's Plantations)	High	Major negative (direct impact on Racecourse Plantation)	Large adverse
TPO (South of Thorpe End, Triangle Wood, frontage of Sprowston Manor)	Medium	Major negative (direct impact, depending on exact route alignment)	Moderate adverse
Other Woodland (including tree belts, Round Hill Plantation & The Breck, Bunker's Hill)	Lower	Major negative (direct impact Round Hill Plantation & The Breck, tree belt along Buxton Road)	Slight adverse
Species-rich hedgerows (including at least four important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Great Crested Newts	Very High	Major negative (if directly affected)	M Moderate to Large adverse

Feature	Value	Magnitude of Impact	Assessment Score
Badgers	Very High	Neutral (as long as sett remains	Negligible (as long as sett remains
		unoccupied)	unoccupied)

Two CWS will be impacted; Belmore and Brown's Plantations indirectly, and Racecourse Plantation CWS directly. Racecourse Plantation will suffer a large adverse impact due to its mosaic of habitats and potential importance to terrestrial invertebrates. Overall approximately 3 ha of woodland would be lost, the majority of this from Racecourse Plantation.

Three areas covered under TPOs will be affected. The TPO south of Thorpe End will be indirectly affected, Triangle Wood will be directly affected, and the frontage of Sprowston Manor on Wroxham Road may be directly affected depending on the exact route alignment. These areas would be subject to a moderate adverse impact, dependent on the exact route alignment.

Various tree belts along the route, notably those along Buxton Road, would be directly affected, as would Round Hill Plantation and The Breck. Bunker's Hill would be indirectly affected. These woodland areas would suffer slight adverse impacts.

A number of species-rich hedges will be directly affected, including at least four that are considered important under the Hedgerow Regulations, the loss of which would be a moderate adverse impact.

Depending on the exact route alignment, ponds containing great crested newts may be indirectly or directly affected, resulting in a large to very large adverse impact. There is one currently unused Badger sett in the area, leading to a negligible impact if the sett remains unoccupied. There is the potential for badgers to move into the area, and the impact would alter if the sett became occupied in the future.

(x) Eastern Yellow

Potential Impacts to Ecological Features resulting from the Eastern Yellow Route Option

Feature	Value	Magnitude of Impact	Assessment Score
CWS (March Covert, Tolshill Wood)	High	Minor negative (indirect impact)	Slight adverse
Ancient Woodland (Tolshill Wood, Bulmer Coppice, area near North Walsham Road)	High	Minor negative (indirect impact)	Slight adverse
TPO (Tolshill Wood, frontage of Sprowston Manor)	Medium	Major negative (direct impact, depending on exact route alignment)	Moderate adverse

Feature	Value	Magnitude of Impact	Assessment Score
Other Woodland (including Paine's Yard Wood, Spanish Plantation, Foxburrow Plantation, Bunker's Hill)	Lower	Major negative (direct impact Spanish Plantation and Foxburrow Plantation)	Slight adverse
Species-rich hedgerows (including at least three important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Semi-improved grassland	Lower	Minor negative	Slight adverse
Great Crested Newts	Very High	Major negative (if directly affected)	Moderate to Large adverse
Badgers	Very High	Major negative (dependant on the exact alignment of the road)	Negligible (as long as sett remains unoccupied)

March Covert CWS and Tolshill Wood CWS will be indirectly affected by the eastern yellow route and will both suffer a slight adverse impact. Overall approximately 3 ha of woodland would be lost, the majority of which is from Payne's Yard Wood.

Three areas of ancient woodland (Tolshill Wood, Bulmer Coppice, and the area of free-standing ancient Oaks and Beech near North Walsham Road) will be indirectly affected, and all would be subject to a slight adverse impact. Two areas covered by a TPO would be affected: Tolshill Wood and the frontage of Sprowston Manor. The frontage of Sprowston Manor may be directly affected depending on the exact route alignment, and would be subject to a moderate adverse impact if this were the case.

Spanish Plantation and Foxburrow Plantation would be directly affected, although due to their lower value would suffer a slight adverse impact. Two other areas of woodland along the route corridor will be indirectly affected (Paine's Yard Wood and Bunker's Hill woodland), both being subject to a slight adverse impact.

Sections of species-rich hedges would be directly impacted, including at least three considered important under the Hedgerow Regulations. The difficulty of mitigating for the loss of hedgerows would result in a moderate adverse impact. An area of semi-improved grassland would be indirectly affected, suffering a slight adverse impact.

Depending on the exact route alignment, ponds containing great crested newts may be indirectly or directly affected, resulting in a large to very large adverse impact. There is one currently unused badger sett in the area, leading to a negligible impact if the sett remains unoccupied. There is the potential for badgers to move into the area, and the impact would alter if the sett became occupied in the future.

(xi) Eastern Blue

Potential Impacts to Ecological Features resulting from the Eastern Blu	ue
Route Option	

Feature	Value	Magnitude of Impact	Assessment Score
CWS (March Covert, Ortolans Grove, Ladies Wood, Church Carr and Springs)	High	Minor negative (indirect impact)	Slight adverse
Ancient Woodland (Ladies Wood, Church Carr and Springs, Church Wood, Ortolans Grove)	High	Minor negative (indirect impact)	Slight adverse
TPO (Upper Blacksmith's Wood)	Medium	Minor negative (indirect impact)	Slight adverse
Other Woodland (including Heath Wood, Tithe Plantation, Bunker's Hill)	Lower	Minor negative	Slight adverse
Species-rich hedgerows (including one important under Hedgerow Regulations)	Medium	Major negative	Moderate adverse
Semi-improved grassland	Lower	Minor negative	Slight adverse
Great Crested Newts	Very High	Major negative (if directly affected)	Moderate to Large adverse

March Covert CWS would be indirectly affected by the eastern blue route and will suffer a slight adverse impact. Each of the differing habitats within the Ladies Wood, Church Carr and Springs CWS will be indirectly affected. Their value and diversity means that the CWS will be subject to a slight adverse impact. Overall approximately 2 ha of woodland would be lost.

Three areas of ancient woodland (Ladies Wood, Church Carr and Springs, Church Wood and Ortolans Grove) will be indirectly affected and will suffer a slight adverse impact. Ancient woodland may support important terrestrial invertebrate assemblages. An area covered by a TPO bordering the A1151 Wroxham Road (including Upper Blacksmith's Wood) will also be indirectly affected and will be subject to a slight adverse impact. A number of other woodland blocks fall within the route corridor (including Heath Wood, Tithe Plantation and Bunker's Hill) and will suffer a slight adverse impact.

The loss of sections of species-poor hedges with trees will have a slight adverse impact. A number of species-rich hedges will be directly affected, including one which is considered to be important under the Hedgerow Regulations. Speciesrich hedgerows are difficult to substitute and therefore their loss is difficult to mitigate. Translocation of hedgerows may help to mitigate this impact, but it cannot fully compensate for the damage and it is not clear how successful translocation would be. For this reason, and the fact that there will be a direct impact, the loss of sections of these hedgerows will have a moderate adverse impact.

The loss of areas of semi-improved grassland will have a slight adverse impact.

Great crested newts are present in a pond at Quaker Farm and may suffer a moderate to large adverse impact, depending on the exact route alignment. If the pond is to be directly affected, translocation and possible new habitat creation elsewhere would be necessary.

5.5.4 <u>Mitigation Measures</u>

Detailed mitigation measures would be examined at Stage 3, however at this stage some general mitigation measures can be recommended.

Mitigation measures relating specifically to the River Wensum SAC (western route options)

Biological water quality in the River Wensum and River Tud is classed as Very Good (a) under the Environment Agency's General Quality Assessment for 2002 (see Water Quality and Drainage chapter of this report). It will be essential that there is no deterioration in water quality as a result of the scheme. All of the western route options cross the River Wensum and all (with the exception of the purple route and purple variation) also cross the River Tud.

Any bridge or viaduct design would have to;

- maintain flow conditions
- maintain water quality
- maintain appropriate levels of suspended soils with the river
- maintain appropriate silt content within the river

Secondary requirements of any design would have to;

- maintain the extent and composition of floating formations of water crowfoot
- maintain the extent of gravel/pebble dominated substrate, slackwater refuges, high tree canopy tree cover, submerged higher plants, emergent riparian vegetation, bankside refuges and wood debris (habitat structure)
- do not introduce artificial obstructions within the river
- maintain depth of water table
- maintain temperature regime

The following design parameters are advisable in the design of a crossing over the Wensum to minimise potential impacts;

- Bridge at 90⁰ to the river
- No obstructions in the river
- No hard engineering solutions along the river bank
- Limit amount of shade created
- No highway drainage or run off discharging directly into the river or groundwater
- Minimise the structures/foundations within the floodplain
- Limit lighting to necessary safety requirements only
- No new groundwater pathways to be formed (foundations)

There should be good working practices in place to ensure that no pollution, road run-off or increased suspended solids enter any watercourses, during both construction and operational phases of the scheme. Any disruption to flow as a

result of the construction of bridges and embankments should be avoided. A viaduct spanning across the floodplain will reduce fragmentation of otter habitat, for example, while a bridge would require otter ledges to allow free passage.

There are possible measures to consider in particular for mitigation and enhancement of any adverse effects on the River Wensum SAC;

- <u>Water-crowfoot</u> Establish riffle/run communities to provide suitable habitat for establishment of water-crowfoot beds.
- <u>Crayfish</u> Establish in-channel habitat by improving existing habitat or creating new habitat outside of the SAC boundary.
- <u>Bullhead</u> Establish areas of shade.
- <u>Lamprey</u> Establish in-channel habitat by improving existing habitat or creating new habitat outside of the SAC boundary
- <u>Desmoulin's Whorl Snail</u> Establish riparian habitat.

Although mitigation measures may reduce some impacts, the overall impact on the River Wensum SAC remains very large adverse. During consultation for this scheme, the Environment Agency provided the following advisory comments:

- Any road crossing the floodplain of the rivers Wensum and Tud should be constructed as a viaduct in order to minimise impacts on flood storage/conveyance and ecology. A split carriageway is a likely requirement in order to prevent excessive shading of riverine habitat.
- Any crossing of other watercourses should be a clear span bridge, retaining a strip of natural bank along each side of the watercourse
- The issue of flood risk must be considered thoroughly through the production of a flood risk assessment and appropriate mitigation put in place where required.
- Any discharge of surface water run-off from a new road will need to be attenuated to the greenfield run-off rate. The use of SuDS and other measures will be required to adequately control pollution risks.

General mitigation measures for all route options

Localised realignment of the route should be the first form of mitigation, whereby the route is altered to avoid sensitive areas, or to reduce the impact as much as possible. However, this will not always be practical, so a suite of other mitigation measures will be necessary. It is recognised, however, that it will be difficult to adequately mitigate for the adverse impacts which may be experienced and the scope for realignment is limited for the western route options as every route includes one or more river crossings. Route realignment may, however, prove effective in reducing impacts for the eastern yellow and eastern blue routes, where the assessment of Large Adverse is mainly due to the presence of Great Crested Newts which the routes may be able to avoid.

Comprehensive mitigation proposals can only be formulated when all affected protected species have been effectively surveyed, and their population sizes and extents established. However typical mitigation measures for protected species identified in earlier sections of the report are briefly outlined below:

- <u>Great crested newts</u> exclusion fencing would be required as a minimum but any mitigation measures are likely to include trapping and translocation of species, the provision of tunnels, new ponds and terrestrial habitat.
- <u>Badgers</u> exclusion fencing (both permanent and temporary), tunnels/underpasses and the construction of artificial setts.

- <u>Bats</u> construction of artificial roost sites and/or bat boxes and provision of foraging habitat.
- <u>Birds</u> ensuring vegetation is cut and cleared outside of the bird nesting season and the provision of replacement habitat.
- <u>Otter</u> provision of passage way sand ledges under bridges or other structures over the river, replacement habitat including the provision of holts, if necessary.
- <u>Water vole</u> exclusion, trapping and translocation of species and the provision of replacement habitat.
- <u>Reptiles</u> exclusion, trapping and translocation of species and the provision of replacement habitat.

Protected species that may be present within each of the route corridors are described in the relevant sections above. (Protected species are those afforded protection under the Wildlife and Countryside Act 1981, and the Conservation (Natural Habitats &c.) Regulations 1994).

The presence of any priority species and habitats included in the Norfolk Biodiversity Action Plan should also be ascertained, (also described in the relevant sections above) and mitigation measures developed accordingly. The mitigation measures included below are not based on specific details regarding species location and population size, as this information is not available at this stage. They are therefore broad and generalised in their approach, and represent a base from which full measures can be developed.

Where protected species will be directly affected, it will be necessary to translocate them to alternative suitable habitat, which, if none is available, will have to be artificially created. Any new habitat would need to be created well in advance. If their habitats, route corridors or likely breeding areas are affected or severed, then measures will be required to ensure that the new road does not act as a barrier for the species. These may include further habitat creation, fencing, maintenance of existing wildlife corridors with faunal tunnels underneath the road etc. Design of drainage systems should include provision for pollution control features, as well as the possibility of creating dual-use lagoons where habitat creation for aquatic/semi aquatic species is combined with measures for addressing drainage issues. Detailed mitigation measures will be considered during Stage 3, but will include as standard appropriate mitigation measures for protected species (such as badger crossings). Any site clearance work will be required to take place outside of the bird breeding season (March to July inclusive). Once species / habitat mitigation or compensation measures have been agreed, there should be a commitment to monitor all these measures over an agreed period of time, such as 5 years. An Environmental Management Plan would be required to provide environmental protection during the construction phase.

Mitigating against the loss of a large number of standard trees and areas of mature woodland is not a practical proposition. The timescales involved in growing new trees to the stage where they offer the same benefits of those they replace are prohibitively large. New areas of planting would be a prerequisite, but would not be an effective replacement for areas lost, except in the very long term. The same is true of many other affected habitats, whereby the ecological communities that exist within them have developed over very long periods, and equivalent communities will not become established and settled in the medium or possibly even long term. Ancient woodland cannot be replaced. Exact areas of mature and ancient woodland to be affected by the scheme will be assessed

when more details are available during Stage 3. During consultation for this scheme, English Nature have recommended that any compensatory replacement woodland should cover an area several times larger than the original area of mature or ancient woodland affected.

Extensive habitat creation and recreation would be necessary, and there is the opportunity for significant variation to be included in the landscaping regime, in order to provide habitats for a diversity of species. Sufficient area for landscaping must be included in any Compulsory Purchase Orders that are carried out.

Although putting the road in a cutting may have benefits in terms of visual intrusion, where groundwater feeds nearby wetlands or marshes, dewatering is likely to result in significant degradation of habitat, and a consequent loss of value. This is potentially the case for the eastern blue route close to the Ladies Wood, Church Carr and Springs CWS, where the entire ecosystem is based around the damp waterlogged soil and numerous ponds. Any other habitats based around similarly damp conditions would also need protection from this potential problem.

Recommendations for further surveys required

Detailed studies at Stage 3 should be carried out for protected species and river crossing locations. A number of the species surveys would have to be undertaken by licensed specialists.

5.5.5 <u>Conclusions and Recommendations</u>

The ecological assessment shows that each of the route options has the potential to significantly affect habitats, including those occupied by protected species. Although extensive mitigation will be required, it will usually only be partially effective, due to the lengthy timescales involved in forming suitable replacement habitats.

Based on the information gathered for this ecological assessment, the green, orange, blue and red western routes all have very large adverse impacts, mainly due to the need to cross the rivers Wensum and Tud. Although the brown and purple routes (and the brown and purple variations) also have river crossings and overall have very large adverse impacts, these can be reduced substantially if the existing river crossing location of the River Wensum is utilised. In addition these routes use the largest amount of existing road corridor and, on balance, may be preferable ecologically to the other western routes.

Of the routes on the eastern side of Norwich, all are likely to generate adverse impacts mainly due to the presence of Great Crested Newts. On balance, the blue or yellow route may have less adverse impacts than the pink route, which has a direct impact on Racecourse Plantation CWS and 2 sites with Great Crested Newt populations.

5.6 Landscape Effects

5.6.1 Introduction and Methodology

Landscape effects result from impacts of the proposed works on the surrounding landscape and visual intrusion on the local community. The landscape evaluation includes the classification of the landscape into broadly homogeneous units of character, and an assessment of their relative quality. This section assesses the existing landscape for the proposed NDR corridor and provides an indication of the predicted impacts of the possible schemes.

Identification of Impacts and Effects

Effects during construction are likely to be temporary, whilst those resulting from the permanent scheme will be long term and permanent. Visual effects resulting from the scheme may be:

- Substantial: Adverse or beneficial effects where the scheme would cause a significant deterioration or improvement in landscape character or the existing view.
- Moderate: Adverse or beneficial effects where the scheme would cause a noticeable deterioration or improvement in landscape character or the existing view.
- Slight: Adverse or beneficial effects where the scheme would cause a barely perceptible deterioration or improvement in the existing view.
- No change: No discernible deterioration or improvement in landscape character or the existing view.

5.6.2 Baseline Conditions

(i) Introduction

The study area for the NDR falls into two broadly distinct landscape character areas, which approximately fall either side of the airport, although it should be noted that the arable land which characterises the eastern part of the study area continues westwards as far as the A1067, before the different character area of the Wensum valley is encountered. However, since the airport also provides a localised pinch point for route options in this vicinity it is convenient to refer to route corridors to the east and west of this location.

The routes to the east of the airport tend to occupy relatively flat arable land with no major rivers, although a cluster of historic parklands lies between Rackheath and Spixworth. In the west, the combination of major river valleys with pasture in the valley floor and steep glacial topography provide considerable constraints in terms of finding route options that are likely to be acceptable in landscape terms.

The centre of Norwich consists of a thriving commercial environment centred on a unique and irreplaceable historic medieval core. On the edges of the city are extensive urban fringes typically consisting of relatively modern residential suburbs of rather uniform visual character. Away from the urban area the surrounding villages are old in character with varied features such as ancient churches and historic buildings and with a strong sense of history associated with their setting within the landscape. None of the route options pass directly though any areas of townscape. However, all pass within relatively close proximity to villages and built up areas, potentially resulting in visual intrusion and effects on the setting of these settlements, which is covered as part of the following landscape assessment. Areas to the west potentially affected include Weston Longville, Attlebridge, Ringland, Taverham, Costessey and New Costessey. Areas to the east include the northern and eastern fringes of Norwich and the villages of Horsham St Faith, Spixworth, Rackheath and Thorpe End.

(ii) Previous Landscape Studies

The study area for the majority of the NDR is defined regionally within the Countryside Agency's Character Map of England as Central North Norfolk, and much of it is designated as an Area of Landscape Value within the Broadland District Local Plan (see figure in Part 3 of this report).

In 1999 Broadland District Council (BDC) commissioned Chris Blandford Associates to carry out a landscape assessment of the district to help define areas of important landscape quality. This study covered the majority of the NDR study area and subdivided the Central North Norfolk character zone into eight discreet zones, six of which lie within the NDR study area and broadly correspond to the character zones defined within this report.

The study area for the NDR also falls within the remit of the Wensum Valley Project and the Norwich Fringe Countryside Management Project. A strategy for the Wensum Valley was prepared in June 1994 and for the Norwich Fringe in October 1996, both of which aim to manage this area of countryside in a way that balances the often conflicting needs of the various users, without compromising the environment and protecting and enhancing the area for future generations. Landscape studies were included in both of these strategies, the results of which were broadly confirmed by the 1999 BDC study.

(iii) Eastern Route Corridors

There are essentially three main route corridors to the east; the pink, yellow and blue routes, each moving further out from the edge of Norwich but all following the same alignment around the airport to the west and past Thorpe St Andrew in the east.

In terms of the baseline conditions, the eastern end of the corridor commences at the A47 in the vicinity of a new business park. The surrounding arable farmland is generally open and is of ordinary quality, with few landscape constraints. However, around Great Plumstead and Witton further to the east the landscape is more wooded and intimate on account of the presence of a small tributary of the River Yare and is generally of a high quality in this location. On moving north, visual intrusion becomes an issue due to the close proximity of the many villages and hamlets.

This open arable land continues as far as the B1140, where the character begins to change, with a higher degree of woodland cover and more undulating landform. This area is also characterised by the presence of large parklands, noticeably Beeston Park, Rackheath Hall and Sprowston Manor (now converted to a golf course), and has an attractive landscape quality.

The western end of the eastern route corridor is dominated by the airport, which occupies a flat plateau area surrounded by open arable land which is essentially devoid of landscape features and is of rather ordinary landscape quality. Just to

the north of the airport, but largely screened from it by a low ridge, lies the attractive village of Horsham St Faith.

A small tributary lies to the north of Horsham St Faith and flows eastwards past the northern edge of Spixworth and into the River Bure near Wroxham. This is a particularly attractive intimate little valley comprised of a mosaic of damp pasture and woodland, in contrast to the predominately open arable land lying to the south between this valley and the urban edge of Norwich.

(vi) Western Route Corridors

Four western route corridors were taken to public consultation in December 2003; the green, orange, blue and red routes, each moving further out from the edge of Norwich. Following consultation, two further routes were added to the west; the brown route (which roughly follows the pylon line between Easton and Attlebridge), and the purple route (which is similar but commences further west hear Honingham).

In terms of the baseline conditions, the area west of the airport is generally open arable gently undulating land of rather ordinary landscape quality. West of Horsford towards the A1067, the land becomes dominated by large woodlands giving the area a more attractive and distinctive landscape character.

Moving further south, the western end of the study area near Lenwade consists of a very attractive area of woodland and parkland around Weston Hall and Weston House, forming part of a ridge of well wooded rolling topography on glacial sand and gravel deposits which extend westwards as far as Easton on the edge of Norwich, where the deposits are currently being worked. This landscape is bounded by the river valleys of the Wensum and Tud. The Wensum in particular is a very dominant landscape feature and the juxtaposition of this with the rolling wooded landscape gives rise to a very attractive, unique and valuable landscape, particularly in the vicinity of Ringland. This attractive river valley landscape continues into the urban edge of Norwich and adds significantly to the visual character of the villages of Taverham, Drayton and Costessey

In contrast the study area between Attlebridge and Honingham is largely dominated by undulating open arable land with some significant woodland belts. Generally this land is of fairly ordinary landscape quality, but with some local variation, particularly around the poultry farm near Weston Green where the landscape is generally of poorer quality.

(v) Landscape Character Zones

Approximate character zones were mapped out as part of the Stage 1 study. These have now been refined for the Stage 2 Assessment and are shown in part 3 of this report.

Eastern side

The principal characteristics of each zone on the eastern side of Norwich are described as follows;

Urban Areas

This broadly encompasses any built up area, from the edge of Norwich to historic villages such as Horsham St Faith, Spixworth, Rackheath and Thorpe End. A number of these villages have had significant levels of new

housing built, consequently, the quality and character of these townscape areas varies considerably.

Urban Fringe

This area occurs on the edge of Norwich and is the zone where the built up area begins to influence the character of the surrounding farmland. As with the 'urban areas' the character of this zone varies considerably; it includes the bleak expansive open area of Norwich airport and the more enclosed area of the golf course around Sprowston Manor with the adjacent 'Park and Ride' site. Also included is the expanding business park and associated influence of the A47 dual carriageway at the eastern end of the study area near Postwick. With the exception of the area in the vicinity of the golf course (ranked as having 'medium' landscape quality), the BDC study ranked these areas as having 'low' to 'medium/low' landscape quality. The area north of the airport and around the Postwick business park were in fact ranked as having the lowest landscape quality of any area within Broadland District.

• Expansive and Largely Featureless Open Arable Farmland

This area occupies a plateau area on relatively higher ground above the river valleys, and merges into the open area covered by the airport. Lack of topographic or vegetation features gives this area a rather bleak feel and the landscape has a rather ordinary quality. This is confirmed by the findings of the BDC study which ranked this area at the bottom of their quality scale, having a 'low' to 'medium/low' landscape quality rating.

Partly Enclosed Arable Farmland

This is the largest character zone within the eastern corridor study area and is characterised by undulating topography combined with a relatively high density of hedges and small woodland blocks. The quality varies from 'ordinary' to 'attractive' depending on the density and juxtaposition of these various vegetation and topographic elements, and largely falls within the 'medium/low' to 'medium' categories within in the BDC study .

Enclosed Well Wooded Arable Farmland

This area is characterised by extensive woodland cover resulting from the presence of three former estates; Beeston Park (still extant though much of the former parkland is ploughed), Rackheath Hall (now converted to apartments but mature largely deciduous shelterbelts still remain within a farmed landscape), and Sprowston Manor (former parkland converted to golf course and included within 'urban fringe' character area, though woodland to the north is included in this character zone). During the war airmen from nearby Rackheath airfield were billeted at Rackheath Hall and the presence of wartime buildings and concrete access tracks also influences the character of this area, particularly near the village of Rackheath where dense woodland has grown up around such remains. This zone also includes a relatively large area of recreational woodland (mostly coniferous) on the very edge of Norwich, between Thorpe End and Sprowston. Overall this area is considered to be of 'good' landscape quality on account of the high woodland cover, and this is confirmed within the BDC study where the majority of this zone (i.e. the parklands of Beeston and Rackheath Hall) is ranked as 'medium/high' landscape guality and designated as an 'Area of Landscape Value' within the local plan.

Enclosed Mixed Arable and Pastoral Farmland

This localised area occurs around a small tributary of the River Yare, the villages of Witton and Great Plumstead, and the well wooded grounds of the old hospital. The combination of grazing land, smaller fields sizes on undulating topography, and tall hedges and woodland cover make this an area of 'good' landscape quality, in contrast to the rather more open 'ordinary' landscape further to the west in the vicinity of the new business park, and this is confirmed within the BDC study where it is ranked as having 'medium/high' landscape quality. The area is also designated as an 'Area of Landscape Value' within the local plan.

Enclosed and Largely Pastoral River Valley Farmland

This small area occurs along a tributary of the River Bure, lying to the north of Horsham St Faith and Spixworth, on the northern boundary of the study area. It is a small intimate valley, well wooded and largely laid down to pasture, and is of 'attractive' landscape quality, largely ranked as 'medium/high' (rising to 'high' as it approaches the Broads to the west) landscape quality, and included in the 'Area of Landscape Value' designation within the local plan.

Western side

The principal characteristics of each zone on the western side of Norwich are described as follows;

Urban Areas

This broadly encompasses any built up area, from the edge of Norwich to historic villages such as Ringland and Attlebridge and new housing developments such as around Taverham and Costessey. Consequently, the quality and character of these townscape areas varies considerably.

Urban Fringe

This area occurs on the edge of Norwich and is the zone where the built up area begins to influence the character of the surrounding farmland. As with the 'urban areas' the character of this zone varies considerably; it includes the golf course on the western edge of Taverham (rated as 'medium/high' landscape quality in the BDC study on account of the dramatic topography, and included in the 'Area of Landscape Value' by the local council) and the small holdings on the other side of the A1067 towards Horsford (rated as 'medium/ low ' in the BDC study).

• Expansive and Largely Featureless Open Arable Farmland.

This area occupies a plateau area on relatively higher ground above the river valleys, and merges into the open area covered by the airport to the east of the A140. Lack of topographic or vegetation features gives this area a rather bleak feel and the landscape has a rather ordinary quality, ranked as 'medium/low' in the BDC study.

• Open Arable Farmland

This character zone occurs in the far west of the study area beyond Honingham and Weston Longville, and is characterised by large scale open arable land but with some vegetation features such as small copses and hedges. The overall impression however is of a rather ordinary nondescript area of landscape which is locally degraded by the presence of poultry sheds and other modern farm buildings. This assessment is reflected by the findings of the 1999 BDC report which rated this area as having 'medium/low' landscape quality.

• Partly Enclosed Arable Farmland.

This is similar to the largest character zone within the eastern corridor study area but in the western study area it only really occurs as a small area to the south of the A47. It is characterised by undulating topography combined with a relatively high density of hedges and small woodland blocks. The quality varies from 'ordinary' to 'attractive' depending on the density and juxtaposition of these various vegetation and topographic elements, and is classed overall as having 'medium' landscape quality in the BDC study.

• Enclosed Well Wooded Arable Farmland.

This area is similar to that found in the eastern study area and is characterised by extensive woodland cover resulting from the presence of former estates (in this case Weston Hall and Weston House), and large plantation woodlands. The character around Weston is more intimate than that found in the eastern corridor on account of the nearby presence of the river Wensum and a greater degree of woodland cover. Around Horsford large Forestry Commission woodlands with recreational access create an attractive landscape character which is similar to the recreational woodlands near Sprowston in the eastern corridor. The majority of this area is ranked within the BDC study as having 'high' landscape quality and is designated as an 'Area of Landscape Value' within the local plan.

• Well Wooded Arable Farmland on Glacial Topography.

This very attractive character zone encompasses the popular local recreational area of Ringland Hills, and is distinguished by steep sided rolling topography on gravely glacial deposits, with mature predominantly deciduous woodland blocks on the higher slopes. The 1999 BDC study ranked the majority of this character zone in their top category of 'high' landscape quality, and this is reflected in the Broadland District Local Plan by its designation as an 'Area of Landscape Value'.

• Enclosed and Largely Pastoral River Valley Farmland.

This character zone encompasses the various river valleys within the study area, which for the western routes are the Wensum and the Tud. This zone is broadly comparable with the area defined for the small tributary of the River Bure north of Horsham St Faith and Spixworth in the eastern study area, although the individual character of each valley varies considerably. The 1999 BDC study rated the Wensum valley as having 'high' landscape quality, and this is reflected in the Broadland District Local Plan by its designation as an 'Area of Landscape Value'.

5.6.3 Assessment of Impacts

The impact of each of the routes in terms of landscape character and visual intrusion is described moving from west to east. The approximate likely extent of visual intrusion associated with each of the routes and their variations is shown on figures contained in Part 3 of this report.

(i) Western Green

The route begins at the A140 in a grade separated junction. This junction would be an extensive structure, causing substantial to moderate levels of visual intrusion for the 10 or so properties in the immediate vicinity, even allowing for the mitigating effects of any planting scheme. The route then crosses open arable land (crossing the Reepham Road via a roundabout) before passing close to the western edge of Hellesdon in a shallow cutting, resulting in varying levels of visual intrusion for 30 or so properties. Beyond here it cuts through the eastern side of Drayton Wood, a mixed wood of birch scrub and mature Scots pine interspersed with sheltered accommodation units, which also contains the remains of a Gertrude Jeckyll garden. The route would cause substantial adverse visual effects on both the wood and the accommodation units within it, before joining the A1067 at a roundabout.

The route would then traverse open arable land before crossing the river valley and flood plain of the Wensum, which in this location is of high visual quality; well wooded with extensive reed beds, and the area has a remote and tranquil feel to it. Given the nature of the area the presence of the new road would be likely to have a significant adverse effect on landscape character. The route then crosses Marriotts Way recreational route before rising out of the valley in a deep cutting (8 m) through arable land, before passing through several paddocks to join Ringland Lane at a roundabout.

The route then turns west to pass between the settlements of Costessey and New Costessey along the flood plain of the river Tud, crossing Longwater Lane immediately to the south of the recreation ground. Approximately 100 properties would experience varying levels of visual intrusion which, due to the close proximity of the route and its location in an open valley landscape, would be difficult to mitigate. In addition, the high visual quality of the valley landscape would be lost.

Beyond the river, the route would turn south to cross largely arable undulating farmland with woodland blocks to join the A1074 in the vicinity of the A47 Longwater junction.

(ii) Western Orange

The route begins at the A140 in a grade separated junction. This junction would be an extensive structure, causing substantial to moderate levels of visual intrusion for the 10 or so properties in the immediate vicinity, even allowing for the mitigating effects of any planting scheme. The route then runs west from the airport across open arable land of generally ordinary quality, largely in a shallow cutting, before passing to the north of Thorpe Marriott to join the Reepham road at a roundabout, and then swinging southwards towards the A1067. Over this stretch there is generally sufficient space available to provide adequate mitigation to minimise effects on landscape character and visual intrusion on properties on the edge of Thorpe Marriott (many of which would be screened by an existing shelter belt) and Horsford, although towards the A1067 the route would pass within 300m of some 50 properties which would be likely to experience high levels of visual intrusion, even allowing for mitigation.

The route crosses Marriott's Way a long distance footpath, bridleway and cycle route, which at this point comprises part of national cycle route 1, measures, would have to be put in place to screen the road from users of the footpath.

The route crosses the A1067 via a roundabout, and then cuts southwards to the west of Taverham, passing close to a hotel, a care centre and Taverham Secondary school, as well as bisecting a Golf course and passing close to the attractive 18th century buildings of Taverham Hall School. This is an attractive landscape because of the steep topography which affords fine views out across the valley to the south, and the route would have substantial adverse effects in this location, even allowing for mitigation, both in terms of landscape quality and visual intrusion.

The route runs parallel to the Wensum before passing under Ringland Road in a deep cutting 9up to 8m), then continues over arable land past Taverham Hall Farm to cross the River Wensum and its associated flood plain on a viaduct. The River Wensum in this location is of very high landscape quality; intimate, tranquil and enclosed, with an interesting mix of reeds/fen and tall trees. Crossing the valley at this location would have substantial adverse effects in terms of landscape character as this is the widest and most densely wooded section of the Wensum Valley within the study area. The route would also pass very close to an old thatched property by the river bank at a height of approximately 7m above ground level, effectively precluding any form of effective mitigation, before cutting through the densely wooded ridge of the Ringland Hills in a 20m deep cutting. This would cut a huge swath through the Ringland Ridge and create a large notch in the skyline (although this would be avoided if the option of a bored tunnel through the ridge was to be pursued).

The juxtaposition of these elements in this location is particularly attractive and the route would be particularly damaging. The landscape character would completely change and as such it would not be possible to adequately mitigate for the adverse effects of this route option.

The final section of the route passes through the Longwater business park and around the edge of active sand and gravel workings, with reclaimed areas covered by rough grassland, gorse and birch scrub. It terminates at the Longwater junction on the A47. This area is generally rather poor in terms of landscape quality and undergoing change as the business park expands and the gravel is worked out.

(iii) Western Blue

This route broadly follows the alignment of the orange route as far as Ringland Road, and comments made for that option apply. The route then swings further to the west, continuing in a deep cutting through a small hummock of arable land caught in the fold of the river valley and cutting across the grain of the land, before emerging to cross the River Wensum and its associated flood plain on a viaduct. In this location the river valley is much more open, but still very attractive with a lot of marginal vegetation and traditional grazing pasture. The road would be very dominant and visually intrusive in this open landscape.

After crossing the river the route would cut through the wooded skyline of the Ringland Hills in a deep cutting, causing substantial adverse effects on the landscape character of the Ringland Hills and creating a notch in the skyline.

The route would then descend across arable land in a shallow (4m) cutting, before crossing the River Tud and terminating near the end of the dual carriageway section of the A47. The valley landscape here is relatively open, and locally degraded by the presence of the busy A47 and a dominant line of pylons.

(iv) Western Red

This route follows the orange route past the north of Thorpe Marriott to the Reepham Road, and comments made above apply. The route then takes a more westerly alignment to join the A1067 just to the east of the mature woodland at Deighton Hills, joining the A1067 at a roundabout, before crossing the Wensum flood plain. This area is much more open than the wooded river valley sections to the east, comprising a shallow valley bounded to the north by the busy A1067. Although a high proportion of trees and hedges adds to the landscape character the more open landscape and presence of the A1067 diminishes its quality.

The road then passes through a belt of mature deciduous woodland in a 15 m deep cutting, which would create a noticeable notch in the sky line, before passing to the west of Ringland, resulting in adverse visual intrusion for some 10 properties on the edge of the village. In this area the combination of glacial topography and mature deciduous woods on steep slopes gives rise to an intimate and tranquil dry wooded valley landscape of high quality, which would be adversely affected by this route option.

The red route then crosses the western end of the Ringland Hills, going against the grain of the land on alternate cutting and embankment. Although this landscape is still attractive it lacks the special quality of the eastern section on account of less steep topography and a higher coniferous component within the woodland blocks. In addition these woods are private with no recreational use.

As with the blue route, this option terminates near the end of the dual carriageway section of the A47, having crossed the Tud valley, and comments above apply.

(v) Western Brown

This route follows the orange route past the north of Thorpe Marriott, but then continues westwards through Mileplain Plantation (along the alignment of the Marriott's Way recreational route and the Reepham Road), before turning south to join the A1067 at a roundabout just to the east of Attlebridge. The route would then follow the line of the A1067 across the River Wensum, before turning south towards Weston Longville. As with the red route, the Wensum valley here is largely open and affected to some degree by the presence of the A1067, reducing its landscape quality. However, there would be increased visual intrusion on properties in Attlebridge resulting from the increased scale of the new road when compared against the existing A1067.

The route follows Marriott's Way for over 1km, a recreational long distance footpath, bridleway and cycle route, which at this point comprises part of national cycle route 1.

The route would then cross an attractive landscape of well wooded undulating glacial topography lying between Weston and Morton Halls, before passing to the east of Weston Longville in a 6-7 m cutting, effectively screening it from much of the village.

The route would then pass further to the west of the high quality landscape around Ringland, passing instead through fairly nondescript open farmland. In the vicinity of Weston Green the landscape is further degraded by the presence of pig and poultry farming, and the lack of landscape features in this section would provide the opportunity for these to be provided as part of the route in terms of landscape planting. The final section of the route passes through largely coniferous woodland to the north of Honingham before crossing the Tud valley. As with the blue route, this option terminates near the end of the dual carriageway section of the A47 and comments above apply.

(vi) Western Purple

This option follows the brown route as far as Weston Green, and comments made for that route apply. The route then moves further west to cross predominantly open arable farmland to finish at the A47 in the vicinity of Honingham. The advantage of this option is that the route avoids a crossing of the river Tud, and the majority of the route traverses open arable farmland of fairly ordinary landscape quality, thus avoiding the issues concerning effects on landscape quality associated with most of the other western routes. However, land to the immediate south of the junction with the A47 at Berry Hill has been designated as being of outstanding interest under the Inheritance Act, and the visual quality of this land would be adversely affected by the junction and associated lighting.

(vii) Western Brown/Purple Variation

The variation follows the red route to join the A1067, and then follows the alignment of the A1067 to rejoin the routes of the brown and purple routes to the east of Attlebridge. It would therefore avoid the impacts on Mileplain Plantation and the Marriott's Way recreational route.

(viii) Eastern Pink

This route would commence at a grade separated junction with the A47 north of Postwick and continue through the Broadland Business Park, before crossing open farmland and then swinging westwards to cross over the railway line to the north of Thorpe St Andrew. This initial section would have slight to moderate adverse visual intrusion effects on approximately 15 localised properties, but these effects could potentially be reduced by optimising the route alignment combined with screen mounding and planting, possibly in conjunction with expansion proposals for the business park. At the junction with the A47 the route would be in cutting; then it would be largely at grade before rising to cross the railway.

Once the railway line is crossed the route passes through a narrow gap between Thorpe End and Thorpe St Andrew, causing adverse visual intrusion for approximately 50 properties, although existing woodland and shelterbelts would help to minimise some of these impacts and would be augmented by additional screen planting as part of the mitigation for the scheme. None the less, visual intrusion would be 'substantially adverse' for some properties on the edge of Thorpe End and Thorpe St Andrew which, owing to the very close proximity of the route (approximately 150m away in some places), is unlikely to be fully mitigated, reducing to only 'moderately adverse' over time as the planting matures.

On crossing the minor road to Little Plumstead (via an at grade roundabout junction), the route would then cut through an area of woodland forming part of an enclosed landscape with approximately 10 properties in the immediate vicinity (including a Hotel and public house), particularly those along the C283 Salhouse Road (also crossed via an at grade roundabout), which would suffer substantially adverse visual intrusion. This woodland is very important within the
local urban fringe and imparts considerable landscape character to this part of the city, which would be substantially adversely affected by the route.

The route would then pass between a supermarket on the edge of Sprowston and the former parkland of Sprowston Hall, now a golf course, and would have an adverse visual effect on the parkland and golf course, which currently retains an attractive visual quality. The route crosses the A1151 via a roundabout just to the south of the park and ride site, causing substantial adverse visual intrusion for some 5 properties and moderate visual intrusion for about 20 more, plus a cemetery, all of which lie along the urban edge of Norwich in this vicinity. However, the route would be in a slight cutting over this length which, if deepened or augmented by a false cutting, would help to reduce these impacts to 'moderate ' and 'slight', particularly as the mitigation planting matures over time.

The route then crosses the B1150 via a roundabout, passing through Norwich Rugby Football Club's ground and close to a playing field, before passing over the top of the Spixworth Road on an embankment which would cause substantial visual intrusion for about 20 properties in the vicinity of the crossing point. Again, to some extent planting would mitigate these effects over time, although due to the very close proximity of some properties (as close as 25 m) the intrusive effects would remain substantially adverse.

The route then crosses open arable land (largely at grade) to pass through a narrow gap between the airport perimeter and Quaker Farm and associated cottages. The farm is partially screened by an existing tree belt but the two cottages would have open views of the road as it passed their frontage some 120 m away. A roundabout junction at the northern most end of the airport would enable the route to turn southwards to follow the airport perimeter more closely, thus minimising intrusive effects on the village of Horsham St Faith lying to the north. Around the northern part of the airport the majority of the route would also be in a cutting approximately 5 m deep, which would also help to screen the route from the village. The route would pass south of West Farm to cut through the western end of the airport perimeter, passing immediately to the south of Norwich Aviation Museum, before terminating at the A140 in a grade separated junction. This junction would be an extensive structure, causing substantial to moderate levels of visual intrusion for the 10 or so properties in the immediate vicinity, even allowing for the mitigating effects of the planting scheme.

(ix) Eastern Yellow

This route follows the pink route to just beyond Thorpe St. Andrew (for which comments made above apply), but continues northwards across open arable land in a slight cutting before turning westwards to cross the railway between the northern edge of Thorpe End and the southern edge of New Rackheath. The elevated crossing would be visible from both settlements, affecting upwards of 100 properties, but there would be sufficient distance between the route and these settlements to be able to provide sufficient screening to minimise adverse effects, reducing visual intrusion to only 'slightly adverse' for the majority of properties over time as the mitigation planting matures.

The route crosses the Salhouse road via a roundabout to run adjacent to a reclaimed landfill site and pass through mature woodland forming part of the southern boundary of the former Rackheath estate. The Hall itself lies to the north in a hollow between two ridges, and provided the route is optimised to

retain a sufficient amount of the outer woodland belt, the integrity of the hall and parkland would be maintained.

Beyond the Rackheath Estate, the route passes through the northern edge of Sprowston Manor Golf Course before crossing the A1151 via a roundabout. The route would be on embankment up to 6 m across part of the golf course and would pass very close to 6 dwellings along the A1151, causing substantial adverse effects on both the parkland and these dwellings.

Once the route crosses the A1151 it passes immediately to the south of the outer edge of the woodland belt that forms the boundary to the parkland of Beeston Hal and the adjoining Sprowston Lodge to the north east. It is therefore unlikely that the route would be visible from the frontage of the Hall. Extensive mitigation planting would ensure that any potentially adverse effects on the visual integrity of this very attractive historic landscape would be minimised.

The route then joins the alignment of the pink route and comments made above apply.

(x) Eastern Blue

This route follows the alignment of the yellow route as far as the railway crossing, for which comments made above apply, before crossing open arable land close to the southern edge of New Rackheath to join the Salhouse Road at a roundabout. An existing shelterbelt would partially screen the route, but it is likely that around 50 properties on the edge of the village would experience various levels of adverse visual intrusion, although this would reduce over time as the mitigation planting matured.

The route then passes to the north of Rackheath Hall though an area that is well wooded and undulating, on alternate cutting and embankment. This area contains many isolated properties and small industrial units making it difficult to optimise the route to avoid impacts on all properties, a few of which may suffer substantial adverse effects in terms of visual intrusion, even after the mitigation planting has matured.

The route then crosses the A1151 via an at grade roundabout, passing in a cutting through a narrow gap between two woodland blocks before crossing the northern part of Beeston Park. This section of the park is in arable cultivation and the route would not be visible from the main frontage of the hall, although an estate cottage would lie close to the route and experience substantial visual intrusion, even allowing for mitigation. It should be possible to optimise the route alignment to minimise effects on the woodland belts and add to the existing mature woodland framework with new planting to help integrate the route into the landscape.

From here, the route would cross the B1150 via an at grade roundabout to run along the southern edge of a narrow woodland belt that would provide a natural screen from housing on the southern edge of Spixworth, although there would be some impact on Red Hall Farm lying some 270 m to the south of the route. The alignment crosses the Spixworth Road on embankment, causing substantial visual intrusion on some 10 properties situated along this road, before passing within 100 m of Quaker Cottages to join the alignment of the pink and yellow routes, for which the comments made above apply.

(xi) Other Impacts

Tranquility

All of the routes considered would pass through areas of tranquil countryside, despite the relatively close proximity to Norwich. On the eastern side of the study area these primarily relate to the wooded parkland areas of Rackheath and Beeston, and the coniferous plantations near Sprowston. Despite being relatively localised these areas provide an important contrast to their surroundings and would be adversely affected by the blue, yellow and pink routes respectively. On the western side of the study area the entire length of the Wensum valley is very tranquil and possesses a remote quality, even as close in to the urban area as Costessey. The area around Ringland and Ringland Hills also possesses a remote and tranquil quality, as does the countryside to the west of these locations. All of these areas would be affected to some degree by one or another of the western routes.

Lighting

Although it is unlikely that the entire route of the new NDR would be lit, lighting would be provided at junctions for safety reasons, which would give rise to additional light pollution on nearby properties and the surrounding countryside. However, since the majority of these occur at crossing points with existing roads where there are often lit settlements nearby, such effects into more remote areas of countryside are likely to be minimised. To further avoid unwanted light spill, the lighting scheme would utilise fully cut off lanterns (which direct the light downwards onto the road surface).

Construction Impacts

Although construction effects are of a temporary nature and relatively short term, visual intrusion and localised impacts on landscape character could be moderately adverse during the construction process. Such impacts would include the presence of active construction plant and operations such as earthmoving and bridge construction.

The location of construction compounds, storage areas and borrow pits outside the road corridor are not yet defined and would be subject to planning procedures with the local authority. However, the presence of such compounds could have a moderate adverse effect on landscape character in localised areas for the duration of the construction period.

5.6.4 <u>Mitigation Measures</u>

Mitigation on this scheme would involve optimising the route alignment (of which ever option was chosen) in order to retain existing features or vegetation of interest and reduce visual intrusion where possible. This may involve altering the vertical or horizontal alignment, subject to engineering considerations.

An extensive landscaping scheme would be designed in order to integrate the road into the surrounding landscape as far as possible, and to reduce visual intrusion near housing. This would involve extensive mounding and grading out of side slopes to blend the road as far as possible into the surrounding topography, together with linking the road planting with adjoining existing vegetation.

Effective mitigation measures for short-term construction impacts would be difficult due to the relatively short time scale for the proposed implementation of the works. This would preclude effective screening through planting. However, good and effective site management would ensure that waste materials and

debris were controlled to avoid items from blowing off site. Careful site planning would minimise the loss of existing trees and shrubs.

5.6.5 <u>Conclusions and Recommendations</u>

A summary of the impacts is presented in table 5.6.1.

In landscape terms, based on current information, there is no clearly preferable option between the blue, yellow or pink routes; each has some adverse effect in terms of both landscape character and visual intrusion. Whichever route is chosen, optimisation is required to minimise these effects. However, in terms of countryside severance the pink route would be preferable as it is the closest route to the existing urban edge and could be more readily assimilated into the urban fringe. Because they are further out, both the blue and yellow routes would cause fragmentation of relatively unified areas of rural countryside and introduce urban elements into the wider countryside.

In landscape terms there are significant constraints to either the green, orange, blue and red routes. These are principally concerned with effects on settlements (principally Costessey and New Costessey for the green route, and Ringland and Taverham for the others) and effects on the Wensum valley and Ringland Hills. All of these options would have substantial adverse effects in terms of visual intrusion and the local landscape. Both the brown and purple routes avoid some of these issues, and perhaps offer the best solution in terms of minimising landscape effects.

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Table 5.6.1: NDR Landscape Impact Summary Table

Route	Landscape	Impact at	Impact at	Visual	Visual	Historic	Historic	Trees and	Tranquillity
	character	Year 1	Year 15	Intrusion at Year 1	Intrusion at Year 15	Landscape at year 1	Landscape at year 15	Woodlands	
Western	Majority of	Sub-	Sub-	Substantial VI	Substantial VI	Slight	Slight	Some loss of	Substantial
Green	route runs	stantial	stantial	for properties	for properties	impact on	impact on	valley	impact on
	through	impact.	impact.	along the route,	along the route,	historic	historic	vegetation and	Wensum valley.
	attractive			particularly in	particularly in	garden near	garden near	part of Drayton	Moderate impact
_	river valley			Costessey.	Costessey.	Drayton	Drayton	Wood.	on Tud valley.
	landscape.					Wood.	Wood.		
Western	Predominant-	Sub-	Sub-	Substantial VI	Substantial VI	Minimal	Minimal	Substantial loss	Substantial
Orange	ly very	stantial	stantial	on the edge of	on the edge of	impact.	impact.	of river valley	impact on
	attractive	impact.	impact.	Taverham	Taverham			vegetation and	attractive rural
	river valley							mature	area.
	landscape.							deciduous	
								woodland.	
Western	Predominant-	Sub-	Sub-	Substantial VI	Substantial VI	Minimal	Minimal	Loss of river	Substantial
Blue	ly very	stantial	stantial	on the edge of	on the edge of	impact.	impact.	valley	impact on
	attractive	impact.	impact.	Taverham	Taverham			vegetation and	attractive rural
	river valley							mature	area.
	landscape.							deciduous	
_								woodland.	
Western	Predominant-	Sub-	Sub-	Moderate VI on	Slight VI on the	Minimal	Minimal	Substantial loss	Substantial
Red	ly very	stantial	stantial	the edge of	edge of	impact.	impact.	of mature	impact on
	attractive	impact.	impact.	Ringland.	Ringland.			deciduous	attractive rural
	woodland							woodland.	area.
	and river								
	landscape.								
Western	Largely open	Moderate	Slight	Moderate VI on	Moderate VI on	Minimal	Minimal	Some loss of	Moderate impact
Brown	farmland.	impact.	impact.	Attlebridge and	Attlebridge:	impact.	impact.	plantation	on rural area.
				the edge of	slight VI on the			woodland.	
				Weston	edge of Weston				

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or Route	ent Report	
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Route	Landscape	Impact at	Impact at	Visual	Visual	Historic	Historic	Trees and	Tranquillity
	character	Year 1	Year 15	Intrusion at Year 1	Intrusion at Year 15	Landscape at year 1	Landscape at year 15	Woodlands	
Western	Largely open	Moderate	Slight	Moderate VI on	Moderate VI on	Moderate	Moderate	Minimal impact.	Moderate impact
Purple	tarmiand.	Impact.	Impact.	Attlebridge and	Attlebridge;				on rural area.
				the edge of	slight VI on the	Berry Hall,	Berry Hall,		
_				Weston	edge of Weston	south of	south of		
_				Longville.	Longville.	A47.	A47.		
Western	Largely open	Moderate	Slight	Moderate VI on	Moderate VI on	Moderate	Moderate	Minimal impact.	Moderate impact
Brown/	farmland.	impact.	impact.	Attlebridge and	Attlebridge:	impact on	impact on		on rural area.
Purple				the edge of	slight VI on the	Berry Hall,	Berry Hall,		
variatio				Weston	edge of Weston	south of	south of		
c				Longville.	Longville.	A47 (purple	A47 (purple		
Eastern	Largely open	Moderate	Slight	Slight VI on	Slight VI on	No effects	No effects	Moderate	Minimal impact as
Pink	farmland.	impact.	impact.	properties on	properties on			impact on	close to urban
		-	-	Norwich	Norwich			plantations near	edge of Norwich
				northern fringe;	northern fringe;			Thorpe St.)
_				substantial near	substantial near			Andrew	
				Thorpe St.	Thorpe St.				
_				Andrew.	Andrew.				
Eastern	Largely open	Moderate	Slight	Moderate VI on	Slight VI on	Slight	Negligible	Moderate	Slight impact
Yellow	farmland.	impact.	impact.	properties in	properties in	impact on	impact on	impact on	around Beeston
_				Thorpe End;	Thorpe End;	parkland at	parkland at	woodland	Park and Red
				substantial	substantial	Beeston	Beeston	around	Hall.
				along Spixworth	along Spixworth	Hall	Hall	Rackheath Hall.	
				Road.	Road.				
Eastern	Largely open	Moderate	Slight	Moderate VI on	Slight VI on	Moderate	Slight	Moderate	Moderate impact.
Blue	farmland.	impact.	impact.	properties in	properties in	impact on	impact on	impact on	
_				Thorpe End;	Thorpe End;	Beeston	Beeston	woodland near	
				substantial for	substantial for	Park.	Park.	Rackheath Hall	
				some properties	some properties			and Beeston	
				near Rackheath	near Rackheath			Hall.	
_				and substantial	and substantial				
				along Spixworth	along Spixworth				
				Road.	Road.				

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5.7 Land Use

5.7.1 Introduction and Methodology

The assessment was carried out in accordance with the DMRB Volume 11: Environmental Assessment. The overall approach is to examine the existing land use pattern, assess the areas of land lost and the resultant impact on land use. The study area for the assessment of land use is a corridor 400m wide for each route.

(i) Main impacts

The main impacts covered in the assessment of land use effects are as follows:

Loss of land used by the community

Community land is land used by the community; this includes common land, town and village greens and general public open spaces.

Loss of development land

Development land is land identified in the local and structure plans that have been allocation for potential future development. The development may be housing or industry or business based.

Demolition of private property and associated land take

This section looks at the demolition of private properties but also the impacts on business/commercial properties.

Loss of agricultural land and severance

Agricultural land is classified in terms of quality by the Agricultural classification developed by MAFF. Included in this are also impacts on the loss of farming buildings and wider viability of the farm holdings.

(ii) Significance Criteria

There are no established methods for assessing impacts on agricultural receptors or attributing a level of significance to any impacts. A significance criteria has therefore been developed for the current assessment.

- Major Adverse Where the scheme would lead to the direct loss of over 50 Hectares of the best and most versatile agricultural land (grade 1 and grade 2), and or the impact of the proposal would be likely to render the whole farm unviable.
- Moderate Adverse Where the scheme would lead to the loss of between 20 and 50 ha of the best and most versatile agricultural land, and or require significant day to day changes in manage-ment of the business but not threat the viability of the business.
- Minor Adverse Where the scheme would lead to the loss of less than 20 ha of the best and most versatile agricultural land, and or slight changes in business practices would be required but the viability of the business is affected.

The land use around the NDR options is shown on figures in Part 3 of this report.

5.7.2 <u>Baseline Conditions</u>

(i) *Private Property*

The area is predominately agricultural, interspersed with individual properties or groups of properties. Few buildings are very close to the routes; this has been one of the criteria when developing the alternatives routes.

The purple and brown routes and their variations would required the demolition one properties, a grade II listed building. In addition for all routes land associated with properties would be required.

Business/commercial premises may also be affected through the need of land for the construction of a road. Below is a list of business that could be affected through landtake:

- Norwich International Airport
- Taverham Garden Centre
- Sprowston Manor Golf Club
- Wensum Valley Golf Club
- Costessey Golf Club

(ii) Community Land

With in the study area there are very few examples of common land - one is Church Hill Common, Ringland on the west of Norwich. In addition three golf courses that although are business are regularly used by the community, they are Costessey Golf Course, Wensum Valley Golf Course and Sprowston Manor golf club.

Ringland Hills on the west of Norwich is regularly used by the public for recreational purposes, although this is only in an informal manner.

(iii) Development Land

Two areas of land are proposed employment areas, both directly link to the A47, Broadland Business Park and the Long Water industrial estate. The majority of both areas have planning permission; much of the development has already taken place.

Four areas are earmarked for housing.

- An area of about 10ha is allocated for housing to the north of White Woman Lane to the west of North Walsham Road.
- A further area of approximately 17ha to the east of Blue Boar Lane, Sprowston is allocated for housing development.
- Adjacent the land at Blue Boar Lane which is to the north and north east of the existing Tesco store has been allocated for mixed use. Outline planning permission for development of part of the 12ha site has been granted, the remainder of the site is for residential purposes.
- A significant housing development at the old quarry site at Costessey already has outline planning permission.

(iv) Agricultural land

According to the Agricultural Land Classification (ALC) map of England and Wales (1988) the land is mainly grade 3. Two areas of grade 2 land also exist within the study area. The largest of these exists to the east of the railway line at Thorpe End and the second, between the B1150 North Walsham Road and the eastern boundary of the airport. In addition the Waveney Valley is grade 4.

Both the Countryside Stewardship and Environmentally Sensitive Area schemes are in operation, although at this stage the extent of them is not fully known.

The Broads ESA, which covers the River Wensum valley, aims to maintain and enhance the distinctive pastoral landscape and historic resources of the area by encouraging extensive grassland management. There are no special planning obligations is an area is in ESA.

The Countryside Stewardship (CS) scheme operates outside of ESA's. The CS aims to improve the natural beauty and diversity of the countryside, enhance, restore and recreate targeted landscapes, their wildlife habitats and historical features, and to improve opportunities for public access.

The basic landtake for all the routes (does not take into consideration any addition land necessary for screening and mitigation purposes) is shown in table 5.7.1 below.

Route	Agricul- tural (m)	Highway (m)	Industrial /Com- mercial (m)	Private (m)	Wood- land (m)	Com- munity (m)	Other (m)	Total (ha)
Western Green	208645	16335	23730	26390	23180	0	690	29.90
Western Orange	273874	13335	26490	64165	82185	0	700	46.07
Western Blue	386075	5495	0	64025	12625	0	700	46.89
Western Red	437250	6330	0	0	52160	0	710	49.65
Western Brown	471823	43882	0	6851	105561	0	10787	63.89
Western Purple	462262	46517	0	6851	76957	0	10787	60.34
Western Brown Variation	524761	49200	0	612	53834	0	710	62.91
Western Purple Variation	518782	51835	0	5561	26257	0	710	60.31
Eastern Pink	392940	18850	29995	6045	32356	0	12555	49.27
Eastern Yellow	411930	9480	29995	32915	27185	0	24740	53.62
Eastern Blue	476515	8895	29995	4565	20525	0	460	54.10

Table 5.7.1 Basic landtake for all routes

5.7.3 Assessment of Impacts

(i) Western Green

Private property

The green route would require land-take from at least two private properties; Drayton Wood Residential Home and Horsford Manor. None of these properties would need to be demolished, and the route has been aligned to prevent the need to demolish domestic and commercial properties. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

<u>Community Land</u>

No formal recreation sites will experience land loss.

Development Land

There will be no effects on development land from this route.

Agricultural Land

The green option would result in the loss of 21 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 30 ha of land would be necessary for the engineering layout of the green route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(ii) Western Orange

Private Property

Land is likely to be required from the following private properties; Taverham Hall Farm, Breck Farm and New Home Farm. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive. None of these properties would need to be demolished.

Wensum Valley Golf Course would however be subject to landtake which could have a major effect.

<u>Community Land</u>

No formal recreation sites will experience land loss.

Development Land

The route will pass through the western edge of the area allocated for housing to the south of Taverham.

<u>Agricultural Land</u>

The orange route would result in the loss of 27 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor

adjustments to the route alignment with the provision of new accesses could overcome this. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 46 ha of land would be necessary for the engineering layout of the orange route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(iii) Western Blue

<u>Private Property</u>

Land is likely to be required from the following private properties; Taverham Hall Farm, Breck Farm and New Home Farm. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive. None of these properties would need to be demolished.

Wensum Valley Golf Course would however be subject to landtake which could have a major effect.

<u>Community Land</u>

No formal recreation sites will experience land loss.

Development Land

There will be no effects on development land from this route.

Agricultural Land

The blue route would result in the loss of 39 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. In addition Easton Estate would be divided in half by the blue route. At this stage the full impacts of this are not fully known, and if this route is chosen for the NDR a more detailed assessment of the impacts would be required. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 47 ha of land would be necessary for the engineering layout of the blue route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(iv) Western Red

Private Property

Land is likely to be required from the following private properties; Taverham Hall Farm, Breck Farm and New Home Farm. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive. None of these properties would need to be demolished. Wensum Valley golf course would also suffer from land loss with this route. Until detailed investigation has taken place on how the golf course would be affected, the significance of the impact is uncertain.

<u>Community Land</u>

Church Hill Common, a formal recreation area is within the route corridor however with the current route alignment, the Common is not likely to experience any land take.

Development Land

There will be no effects on development land from this route.

Agricultural Land

The red route would result in the loss of 44 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. In addition Easton Estate and the Black Estate would be divided in half by the red route. At this stage the full impacts of this are not fully known, and if this route is chosen for the NDR a more detailed assessment of the impacts would be required. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 50 ha of land would be necessary for the engineering layout of the red route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(v) Western Brown

Private Property

Land is likely to be required from the following private properties; Green Farm, Pump Farm, and New Home Farm. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

Morton lodge is currently adjacent to the A1067, it would require demolition is the brown is selected as the preferred.

<u>Community Land</u>

Church Hill Common, a formal recreation area is within the route corridor however with the current route alignment, the Common is not likely to experience any land take.

Development Land

There will be no effects on development land from this route.

<u>Agricultural Land</u>

The brown route would result in the loss of 47 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. In addition Easton Estate would be divided in half by the brown route. At this stage the full impacts of this are not fully known,

and if this route is chosen for the NDR a more detailed assessment of the impacts would be required. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 64ha of land would be necessary for the engineering layout of the green route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(vi) Western Purple

Private property

Land is likely to be required from the following private properties; Church Farm and Morton Lodge. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

Morton lodge is currently adjacent to the A1067, it would require demolition is the brown is selected as the preferred.

<u>Community Land</u>

Church Hill Common, a formal recreation area is with the route corridor however with the current route alignment, the common is not likely to experience any land take.

• <u>Development Land</u>

There will be no effects on development land from this route.

Agricultural Land

The purple route would result in the loss of 46 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 60ha of land would be necessary for the engineering layout of the purple route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(vii) Western Brown Variation

Private Property

Land is likely to be required from the following private properties; Church Farm and Morton Lodge. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

Morton lodge is currently adjacent to the A1067, it would require demolition is the brown variation is selected as the preferred.

Wensum Valley golf course would also suffer from land loss with this route. Until detailed investigation has taken place on how the golf course would be affected, the significance of the impact is uncertain.

<u>Community Land</u>

Church Hill Common, a formal recreation area is within the route corridor however with the current route alignment, the Common is not likely to experience any land take.

Development Land

There will be no effects on development land from this route.

Agricultural Land

The brown variation would result in the loss of 53 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. In addition Easton Estate would be divided in half by the brown variation. At this stage the full impacts of this are not fully known, and if this route is chosen for the NDR a more detailed assessment of the impacts would be required. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 63ha of land would be necessary for the engineering layout of the brown variation, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(vii) Western Purple Variation

Private Property

Land is likely to be required from the following private properties; Church farm and Morton Lodge. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

Morton lodge is currently adjacent to the A1067, it would require demolition is the brown is selected as the preferred.

Wensum Valley golf course would also suffer from land loss with this route. Until detailed investigation has taken place on how the golf course would be affected, the significance of the impact is uncertain.

<u>Community Land</u>

Church Hill Common, a formal recreation area is with the route corridor however with the current route alignment, the common is not likely to experience any land take.

Development Land

There will be no effects on development land from this route.

<u>Agricultural Land</u>

The purple variation would result in the loss of 47 ha of grade 3 and 4 agricultural land. Land severance would occur along the route corridor

resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. The overall impact is considered to be moderate at this stage. However until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 64 ha of land would be necessary for the engineering layout of the purple variation, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(viii) Eastern Pink

Private Property

Sprowston Manor Golf Course would be subject to loss of less than 0.3ha as the pink route alignment is along the south eastern corner of the course. The impact on the Golf course is considered to be minor. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

In addition approximately 3 ha of land will be required from the Norwich Airport as well as the road accommodating the existing landing lights. The pink route would therefore have a minor impact on the airport.

<u>Community Land</u>

There would be no loss of land used by the community as formal recreation areas. However, the route runs along the boundary between the Norwich School playing fields at Redmayne Field and the Norwich Rugby Club playing fields (0.1 ha), both are likely to be subject to land take.

There are no formal areas of open space along the pink route.

<u>Development Land</u>

On the outskirts of Sprowston an area of housing has been allocated, and the route is aligned inside the development boundary. There would be direct effects on development land.

Agricultural Land

The pink option would result in the loss of 40 ha of grade 2 and 3 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. The overall impact is considered to be moderate at this stage. However, until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 50 ha of land would be necessary for the engineering layout of the pink route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(ix) Eastern Yellow

Private Property

Land is likely to be required from the following private properties; The Grange, Smee House, Oaks Farm and Newman's Farm, and approximately 0.15ha from Quaker Farm. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

Sprowston Manor Golf Club may also be subject to land loss, approximately 0.33 ha would be required for the footprint of the road. Following a conversation with the management of the golf course it is believed although the amount of land is relatively minor, it would still create a major impact of the ranking of the golf course, which would then have knock on implications.

In addition approximately 3 ha of land will be required from the Norwich Airport as well as the road accommodating the existing landing lights. The pink route would therefore have a minor impact on the airport.

<u>Community Land</u>

There would be no loss of land used by the community as formal recreation areas.

Development Land

There would be no effects on development land; the route alignment is outside of the development boundary.

Agricultural Land

The yellow option would result in the loss of 41 ha of grade 2 and 3 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. The overall impact is considered to be moderate at this stage. However, until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 54 ha of land would be necessary for the engineering layout of the yellow route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

(ix) Eastern Blue

Private Property

The route will result in the loss of approximately 0.15 ha of land at Quaker Farm, which is a domestic property. Land is also likely to be required from the following private properties; The Grange, Smee House, Oaks Farm and Hall Farm. The route has been aligned to prevent the need demolish domestic and commercial properties. At this stage, however, the full extent of land ownership is not currently known; therefore the list of properties may not be exhaustive.

In addition approximately 3 ha of land will be required from the Norwich Airport.

<u>Community Land</u>

There would be no loss of land used by the community as formal recreation areas.

Development Land

There will be no effects on development land from this route.

Agricultural Land

The blue route would result in the loss of 48 ha of grade 2 and 3 agricultural land. Land severance would occur along the route corridor resulting in uneconomic field sizes and difficulties with field access. Minor adjustments to the route alignment with the provision of new accesses could overcome this. The overall impact is considered to be moderate at this stage. However, until further information in gathered on the farming operations the level of impact may change, and with mitigation measures in place the impact could reduce to minor.

Overall approximately 54 ha of land would be necessary for the engineering layout of the blue route, this does not take into consideration any addition land necessary for screening and mitigation purposes.

5.7.4 Mitigation Measures

Construction works would be carried out in such a way as to avoid irreversible damage to agricultural land. The adverse impact to agriculture could be reduced by maintaining access to fields during construction; this may include the provision of temporary crossing points. This would help mitigate the impacts of land severance and allow current management practises to continue until new field accesses are built and field boundaries are reviewed.

Minor changes in the vertical and horizontal alignment would optimise the design reducing the level of impact.

Where fields cannot be incorporated into adjoining fields and they remain uneconomical to farm, they could be incorporated in to the landscape plan to help screen the effects of the road. If hedgerows are to be removed, the ecological impact of this would need to be considered.

The individual landowner/commercial business that would lose the greatest area of land is Sprowston Manor Golf Club, as the yellow route alignment would divide the 18 hole golf course. The yellow route is likely to make the layout of the present golf course uneconomical as a business venture. Moving the route towards the boundary of the Golf Course would alleviate the impact. However the exact alignment would have to take into consideration the two areas of ancient woodland adjacent to the Golf Course.

5.7.5 Conclusions and Recommendations

All route options would result in the loss of grade 3 or 4 agricultural land, so having a minor adverse impact. However, the further away from the boundaries of Norwich the route options pass, the less affected potential development land would be. This is because all of the land allocated for potential strategic housing sites is situated on the outskirts of Norwich. However if the yellow option would was to become the preferred route, careful consideration of the route alignment would be required at the Sprowston Manor Golf Course to overcome the significant impact.

The purple and brown routes and their variations will require the demolition of one property, a Grade II listed building.

5.8 Traffic Noise and Vibration

5.8.1 Introduction and Methodology

When considering noise and vibration impacts it is important to take into consideration traffic noise and the nuisance associated with the traffic noise.

For assessment purposes, there are two aspects to noise in relation to a northern distributor road. Given the main reasons for the road in relation to NATS, the first aspect is traffic noise within the city and its northern suburbs, for which there can be expected to be a reduction in levels. The second aspect is noise created by traffic that would use a northern distributor road that will affect areas currently not subject to traffic noise.

Noise levels will vary primarily according to engine speed rather than vehicle speed, but also due to the road surface and whether the surface is wet or dry. Noise levels at a particular point will also be affected by other factors. Among these are distance from the noise source (road), the nature of the intervening ground surface and presence of obstructions.

The objective at this stage is to undertake sufficient assessment to identify the noise and vibration effects to be taken into account in developing and refining route options. The assessment takes into account the high number of routes still being considered at this stage.

Plans in Section 3 show 300m wide bands on either side of the centre-line of each option divided into three 100m wide strips. Noise-sensitive locations within 300m of the centre-line, are identified along with the number of properties within 300m of each route option, using the bands 0-100m, 100-200m and 200-300m

Noise-sensitive locations likely to be significantly affected by a route option, are also identified

An accurate assessment of vibration nuisance is difficult to carry out at this stage. Unscreened buildings within 40m of route options may experience a degree of airborne and traffic-induced vibration. With the number of route options being assessed at this stage, and with the degree of flexibility of alignments within routes, there are few properties in this situation. Full assessment will be made at stage 3.

5.8.2 Baseline Conditions

The main sources of noise in the study area are;

- Road traffic, dominating the rural and urban environment in the vicinity of main roads.
- Norwich Airport which has commercial, aircraft repair, passenger and light aircraft operations. The main communities affected by the flight path are Taverham, Drayton, Horsham St Faith, Spixworth and Rackheath.

Less significant and more localised sources are;

- RAF Coltishall lying about 10km to the north-east.
- Trains on the Cromer and Great Yarmouth/Lowestoft railway lines.

For the western routes, with the exception of the green, most of the properties within 300 metres of the routes are around Taverham and Thorpe Marriott.

To the east of the city, the overall number of properties within 300 metres is relatively similar for each route.

5.8.3 Assessment of Impacts

Traffic noise along the route of a new road can be a matter of concern over a wide distance. It not only depends on the distance from the road, but also whether there are existing noise generators contributing to the ambient noise levels.

An example might be where a road is built say half a mile away from a previously quiet part of the countryside. Before the road, with no other noise sources other than natural sounds, the noise level could be in the region of 40 dB(A). After the road it could be in the region of high 40s dB(A). This is a level that would not prevent normal conversation, and is well below levels where compensation or insulation become considerations. Many people would not be bothered by this. However, some people would find this change annoying because of the nature of the noise. Traffic noise will tend to be constant low frequency noise rather than the intermittent sounds of the countryside.

By contrast, there could be locations where a road is built within hundreds of metres, that experience existing noise - from say another road, or other noise generator. A similar change in noise level may occur, albeit that the original and new levels could be higher, say in the 60s dB(A). However, the nature of the noise could be similar and the change less noticeable that in the other situation.

(i) Western Green

The green route is within 300 metres of 537 properties, located mostly in Costessey and the north western fringe of Hellesdon. The route also passes close to county wildlife sites at Wensum Mount Farm and Drayton Wood.

(ii) Western Orange

The orange route is within 300 metres of 165 properties, consisting mostly of isolated properties along the whole length and those situated on the fringes of Taverham and Thorpe Marriott. The route also passes close to county wildlife sites at Lord's Hills, Easton Reeds, Blyth's Wood and Walsingham Plantation.

(iii) Western Blue

The blue route is within 300 metres of 185 properties, consisting mostly of isolated properties along the whole length and those situated on the fringes of Taverham and Thorpe Marriott. The route also passes close to county wildlife sites at Walsingham Plantation and "Adjacent to the Tud".

(iv) Western Red

The red route is within 300 metres of 82 properties, consisting mostly of isolated properties along the whole length and those situated on the fringe of Thorpe Marriott. The route also passes close to county wildlife site at "Adjacent to the Tud"

(v) Western Brown

The brown route is within 300 metres of 143 properties, consisting mostly of isolated properties along the whole length and those situated at Morton and Attlebridge. The route also passes close to county wildlife sites at "Adjacent to the Tud" and Mileplain Plantation.

(vi) Western Purple

The purple route is within 300 metres of 139 properties, consisting mostly of isolated properties along the whole length and those situated at Morton and Attlebridge. The route also passes close to county wildlife sites at Foxburrow Plantation and Mileplain Plantation.

(vii) Western Brown Variation

The brown variation is within 300m of 111 properties, consisting mostly of isolated properties along the whole length and those situated at Morton, Attlebridge and on the fringe of Thorpe Marriott. The route also passes close to county wildlife sites at "Adjacent to the Tud".

(viii) Western Purple Variation

The purple variation is within 300m of 111 properties, consisting mostly of isolated properties along the whole length and those situated at Morton, Attlebridge and on the fringe of Thorpe Marriott. The route also passes close to county wildlife sites at Foxburrow Plantation.

(ix) Eastern Pink

The pink route is within 300m of 221 properties, consisting mostly of isolated properties along the whole length and those situated around the north and east of Norwich and on the fringe of Thorpe End. The route also passes close to county wildlife sites at Racecourse Plantation.

(x) Eastern Yellow

The yellow route is within 300m of 148 properties along its length, consisting mostly of isolated properties along the whole length and those situated on the fringe of Thorpe End. The route also passes close to county wildlife sites at Paine's Yard Wood.

(xi) Eastern Blue

The eastern blue route is within 300m of 174 properties, consisting mostly of isolated properties along the whole length and those situated on the fringe of Rackheath. The route also passes close to Heath Wood.

A summary of the routes is given in table 5.8.1 below.

Route	Approximate Number of properties Distance from route					
	0 – 100m	100 – 200m	200 – 300m			
Western Green	73	168	296			
Western Orange	18	25	122			
Western Blue	13	20	152			
Western Red	6	5	71			
Western Brown	17	25	101			
Western Purple	17	23	99			

Table 5.8.1 Summary of Properties

Route	Approximate Number of properties Distance from route				
	0 – 100m	100 – 200m	200 – 300m		
Western Brown Variation	20	35	56		
Western Purple Variation	20	33	58		
Eastern Pink	20	38	163		
Eastern Yellow	16	23	109		
Eastern Blue	20	42	112		

5.8.4 <u>Mitigation Measures</u>

The level of traffic noise can be reduced significantly by the choice of surfacing. Using low noise surfacing materials can bring base levels down by 3dB(A). The choice of materials open to contractors should be restricted to those meeting at least this requirement. The use of low noise surfacing is becoming best practice.

The design of the road should take account of opportunities to shield properties, keeping the road low in the natural topography by exploiting natural screening and enhance this by the use of cuttings and bunding. There are also likely to be considerations for other environmental reasons such as visual intrusion and landscaping. Giving opportunities for designing features that mitigate a range of effects.

Where other measures cannot be considered, noise barriers should be considered. Fences or natural barriers within the highway or on the highway boundary.

(i) Western Green

Mitigating the effects of noise will be difficult in Costessey and Hellesdon. At Hellesdon, bunds may be an option, but could be limited by available space. Noise fencing could be considered for mitigation in this area.

(ii) Western Orange

Mitigation measures could be considered on this route, for example putting the road in cutting to the north of Taverham and around Thorpe Marriott. Bunds may also be a consideration for landscaping and mitigation for visual intrusion. Noise fencing may also be considered.

(iii) Western Blue

A number of mitigation measures could be considered on this route, for example it may be possible to put the road in cutting to the north of Taverham and around Thorpe Marriott. Bunds, may also be a consideration for landscaping and mitigation for visual intrusion. Noise fencing is another option. Mitigation for isolated properties could be difficult especially in the Tud and Wensum valleys, where the road would be on embankment or a viaduct.

(iv) Western Red

A number of mitigation measures could be considered on this route, for example it may be possible to put the road in cutting along several sections, including to the north of Thorpe Marriott. Bunds may also be a consideration for both landscaping and mitigation for visual intrusion. Noise fencing may also be considered. Mitigation for isolated properties could be difficult especially in the Tud and Wensum valleys, where the road would be on embankment or a viaduct.

(v) Western Brown

A number of mitigation measures could be considered on this route. It may be possible to put the road in cutting along several sections, including to the north of Thorpe Marriott. Bunds may be considered for landscaping and mitigation for visual intrusion. Noise fencing may also be considered. Mitigation for isolated properties could be more difficult especially in the Tud valley, where the road would be on embankment.

(vi) Western Purple

A number of mitigation measures could be considered on this route. It may be possible to put the road in cutting along several sections, including to the north of Thorpe Marriott. Bunds may be considered for landscaping and mitigation for visual intrusion. Noise fencing may also be considered.

(vii) Western Brown Variation

A number of mitigation measures could be considered on this route. It may be possible to put the road in cutting along several sections, including to the north of Thorpe Marriott. Bunds may be considered for landscaping and mitigation for visual intrusion. Noise fencing may also be considered. Mitigation for isolated properties could be a problem where such measures would not be an option, especially in the Tud valley, where the road would be on embankment.

(viii) Western Purple Variation

A number of mitigation measures could be considered on this route. It may be possible to put the road in cutting along several sections, including to the north of Thorpe Marriott. Bunds may also be considered for landscaping and mitigation for visual intrusion. Noise fencing may also be considered.

(ix) Eastern Pink

A number of mitigation measures could be considered on this route. It may be possible to put the road in cutting along several sections, including to the north of the airport. Bunds may also be considered for landscaping and mitigation for visual intrusion. Noise fencing may also be considered.

(x) Eastern Yellow

It may be possible to put the road in cutting along several sections, including to the north of Norwich airport. Bunds, for landscaping and mitigation for visual intrusion, and noise fencing may also be considered.

(xi) Eastern Blue

It may be possible to put the road in cutting along several sections, including to the north of the airport and to the south of Spixworth and Rackheath. Bunds, for landscaping and mitigation for visual intrusion, and noise fencing may also be considered.

5.8.5 Conclusions and Recommendations

Any route option would give rise to a change in the noise and vibration envelope within the proximity of its location. The use of low noise surfacing, along with careful route alignment utilising existing natural screening, would help minimise the impacts a new road would give. Any placement of sections of route in cutting would further minimise noise impacts. Full consideration should be given to mitigation during Stage 3 detailed design.

5.9 **Pedestrians, Cyclists, Equestrians and Community Effects**

5.9.1 Introduction and Methodology

This assessment considers journeys made by people as pedestrians (including ramblers), cyclists and equestrians. Considerations of road safety contribute to the overall assessment of amenity. In some cases, a scheme may cause community severance – significant changes in journey lengths or travel patterns within a community. This may occur, for example, if a new road acts as a barrier which deters people from using certain facilities. If a new road diverts traffic and makes an existing road easier for people to cross, community severance may be reduced.

The following facilities which are likely to attract pedestrians need to be identified:

- Doctor's surgeries
- Hospitals
- Retirement Homes
- Schools
- Libraries
- Bus-stops
- Shops
- Post Offices
- Churches & places of worship
- Parks, play areas and sports centres.

Public rights of way including footways, cycleways and bridleways need to also be identified.

Ideally, the levels of use of each of the above facilities should be identified. However, with the number of route options considered it has not been possible to carry out a detailed assessment of each facility.

5.9.2 Baseline Conditions

Pedestrians: There are many places to visit on a recreational basis, particularly around the Wensum Valley. A network of Public Rights of Way has been developed around the countryside surrounding the city. In particular, Marriotts Way, which follows the former M&CN railway line from the city centre to Reepham and Aylsham, has been developed for both cycle and pedestrian use and attracts many pedestrians, particularly at weekends. For pedestrians within the city, most of the IRR, ORR and radial routes have adjacent footways and limited crossing points, mostly at junctions or controlled crossings. A significant proportion of area inside the IRR is pedestrianised.

Cyclists: The cycle network in the area comprises a mix of on and off road facilities. There are two major off road cycleways within the study area. The first of these is Marriotts Way, described above. The other is the Old Catton to Spixworth cycleway which runs alongside the C246 Buxton Road. Both are used for leisure and commuting. Present Government Policy is to increase cycling levels.

Community Effects: Within the study area, there are a wide range of community and educational facilities, serving the needs of the local residents. These include schools (primary and secondary), health centres, libraries, post offices and a range of sports and recreational facilities.

5.9.3 Assessment of Impacts

(i) Western Green

Community severance is a particular issue for the green route. It will sever Old Costessey from New Costessey and also Drayton from Hellesdon.

It passes close to:

- St. Augustine's Primary School, Costessey
- Arden Grove First school, Hellesdon
- Benell Residential Care Home, Drayton
- The Limes, Drayton
- Woodland Nursing Home, Hellesdon
- Black Swan International Residential Home
- Recreation Ground, Costessey
- Drayton Wood
- Sports Field Aylsham Road

The green route severs a Public Right of Way between the River Tud and the River Wensum and also crosses the Marriotts Way Cycle Path.

(ii) Western Orange

The orange route skirts Costessey, Ringland, Taverham and Thorpe Marriott, generally avoiding community severance. There would be some severance of individual properties, remote from village centres. Minor roads such as Ringland Lane and Taverham Road are unlikely to be linked to the distributor road, and could pass under the new road.

It passes close to:

- Taverham High School
- Taverham Hall Preparatory School
- Taverham Golf Course
- Hinks Meadow (Thorpe Marriott)
- Bell Farm Riding School
- Sports Field (Aylsham Road)

The orange route severs a Public Right of Way north of Thorpe Marriott and also crosses the Marriotts Way Cycle Path.

(iii) Western Blue

The blue route skirts Ringland, Taverham and Thorpe Marriott, generally avoiding major community severance. There would be some severance of individual properties, remote from village centres. Minor roads such as Ringland Lane and Taverham Road are unlikely to be linked to the distributor road, and could pass under the new road.

It passes close to:

- Taverham High School
- Taverham Hall Preparatory School
- Taverham Golf Course
- Hinks Meadow (Thorpe Marriott)
- Bell Farm Riding School
- Sports Field (Aylsham road)

The blue route severs a Public Right of Way north of Thorpe Marriott and also crosses the Marriotts Way Cycle Path.

(iv) Western Red

The red route passes to the west of Ringland and Taverham, and skirts Thorpe Marriott, but would not create major community severance. There would be some severance of individual properties, remote from village centres. Minor roads between the A47 and A1067 connect Easton and Ringland to areas to the west these are unlikely to be linked to the distributor road. Each road would need consideration to decide whether they could be stopped up or pass under or over the new road.

It passes close to:

- Sports Field (Aylsham Road)
- Bell Farm Riding School

The red route severs a Public Right of Way at Ringland, although this is in the flood plain where the route will be on a viaduct. It also crosses a PROW at Deighton Hills, the Marriotts Way Cycle Path and a PROW to the east of Thorpe Marriott.

(v) Western Brown

The brown route passes to the east of Weston Longville and Attlebridge but does not create major community severance, but there would be some severance of individual properties, remote from village centres. Minor roads at Easton, Ringland and Weston Longville are unlikely to be linked to the distributor road. Each road would need consideration to decide whether they could be stopped up or remain under or over the new road.

It passes close to:

- Bell Farm Riding School
- Felthorpe Flying Club
- Sports Field (Aylsham Road)

The brown route severs a Public Right of Way north of the A1067, plus another two to the north of Thorpe Marriott. It also severs the Marriotts Way Cycle Path.

(vi) Western Purple

The purple route passes to the east of Weston Longville and Attlebridge but does not create major community severance, but there would be some severance of individual properties, remote from village centres. Minor roads at Honingham and Weston Longville are unlikely to be linked to the distributor road. Each road would need consideration to decide whether they could be stopped up or remain under or over the new road.

It passes close to:

- Bell Farm Riding School
- Felthorpe Flying Club
- Sports Field (Aylsham Road)

The purple route severs a Public Right of Way north of the A47, another to the north of the A1067 and another two to the north of Thorpe Marriott. It also crosses Marriotts Way Cycle Path.

(vii) Western Brown Variation

The brown variation follows the line of the existing A1067 between Attlebridge and Taverham. This could cause access restrictions to individual properties along this road. It passes close to:

- Bell Farm Riding School
- Sports Field (Aylsham Road)

The variation crosses Marriotts Way cycle path.

(viii) Western Purple Variation

The purple variation would use the line of the existing A1067 between Attlebridge and Taverham. This could cause access restrictions to individual properties along this road. It passes close to:

- Bell Farm Riding School
- Sports Field (Aylsham Road)

The variations cross Marriotts Way cycle way.

(ix) Eastern Pink

The pink route skirts Old Catton, Sprowston and Thorpe St Andrew. Community severance is caused where it severs Thorpe End from Thorpe St Andrew. Most roads crossing the route are likely to be connected to the distributor road although the traffic flows are likely to make it difficult for non-motorised road users to cross.

Some minor roads may not be connected and each road would need consideration to decide whether they could be stopped up or remain over or under the new road.

It passes close to:

- Aviation Museum
- North Walsham Road Playing Field
- Norwich Rugby Football Club
- Sprowston Manor Hotel and Golf Course
- Cemetery, Sprowston

The pink route severs the cycleway along Buxton Road and at Postwick the route severs a Public Right of Way between Low Road and Smee Lane.

(x) Eastern Yellow

The yellow route skirts Old Catton, passing further out to the east of Sprowston and Thorpe End & Thorpe St Andrew. Most roads crossing the route are likely to be connected to the distributor road although the traffic flows are likely to make it difficult for non-motorised road users to cross.

Some rural minor roads may not be connected and each situation would have to be examined to decide whether they could be stopped up or remain over or under the new road.

It passes close to:

- Aviation Museum
- North Walsham Road Playing Field
- Norwich Rugby Football Club
- Sprowston Manor Hotel and Golf Course

The yellow route severs the cycleway along Buxton Road and at Postwick the route severs a Public Right of Way between Low Road and Smee Lane.

(xi) Eastern Blue

The blue route passes closer to Spixworth and Rackheath that the other eastern routes and is the furthest away from Old Catton, Sprowston, Thorpe St Andrew and Thorpe End. Most roads crossing the route are likely to be connected to the distributor road although the traffic flows are likely to make it difficult for non-motorised road users to cross.

Some minor roads such as Quaker Lane, Buxton Road Middle Road Low Road and Smee Lane, may not be connected and each situation would have to be examined decide whether they could be stopped up or remain over or under the new road.

It passes close to:

- Aviation Museum
- Beeston Park

The blue route severs the cycleway along Buxton Road. At Postwick the route severs a Public Right of Way between Low Road and Smee Lane.

5.9.4 <u>Mitigation Measures</u>

Linking minor roads and public rights of way would need careful consideration. The new road is likely to be a dual carriageway with significant traffic flows. There will be significant flows on the radials feeding the city making junctions busy and dangerous for non-motorised road users.

Careful consideration should be given to measures to ensure the distributor road does not become a barrier to pedestrians, cyclists and other non-motorised users. Rights of way should be maintained where possible, preferably passing over or under the road.

Junctions should be designed to allow space and facilities to enable these users to cross in safety.

Consideration should be given to screening the road from facilities such as such as community centres, playing fields and open spaces.

5.9.5 Conclusions and Recommendations

Careful consideration should be given during Stage 3 detailed design to the provision of segregated pedestrian/cyclist crossing facilities, where practicable. The severance of Public Rights of Way should be avoided, and diversions of existing Rights of Way limited to acceptable distances.

The construction of any of the routes will enable the implementation of pedestrian and cycling elements within NATS. This will encourage cycling and walking within the city centre and northern suburbs.

5.10 Vehicle Travellers

5.10.1 Introduction and Methodology

This section of the Stage 2 Environmental Assessment covers the impacts on vehicle travellers which are not included in the cost-benefit economic analysis as quantifiable effects. The two impacts considered in the assessment are 'view from the road' and 'driver stress'.

DMRB considers that driver stress has three components; frustration, fear of potential accidents, and uncertainty relating to the route being followed. This stress can be graded as Low, Moderate or high. On main roads within the city driver stress can be classified as "high" due to the high traffic flows, low speeds and poor alignments/junction layouts in places. By comparison, driver stress on the A47 Southern Bypass would be classified 'moderate'.

DMRB also considers "View from the road". This tends to be restricted within the urban area and dominated by the adjacent streetscape. On the outskirts of Norwich views are of open, rolling countryside and generally unrestricted.

5.10.2 Baseline Conditions

(i) Views from the Road

As the proposed routes are all new roads in rural settings, baseline assessment cannot be taken for these locations. However, the routes which are set to be relieved of congestion by the proposed routes are, in the main, residential or light industrial areas, affording few attractive views for vehicle travellers. The existing road network in the vicinity of the Wensum Valley does afford attractive views of the area, but the standards of the road, and number of vehicles, gives rise to driver stress.

(ii) Driver Stress

The Norwich Area Transportation Strategy Options Report (produced for Norfolk County Council by Mott MacDonald) concluded that there is currently a high adverse impact on driver stress arising from congestion on the existing road network in the northern suburbs of Norwich.

5.10.3 Assessment of Impacts

View from the Road

(i) Western Green

From the A1074 Dereham Road the route heads north east crossing arable undulating farmland and also woodland over the River Tud and along its floodplain, enabling intermittent views. Continuing north east to the A140 the route passes through Wensum Valley and on to Drayton Wood. This river valley and floodplain are of high visual quality with woodland and extensive reed beds, the area has a remote and tranquil feel to it. There is potential for good views of this area providing envisaged landscape mitigation is carried out sympathetically.

(ii) Western Orange

The beginning section at the Longwater junction would restrict views due to the current and envisaged development in this area.

The route crosses the River Tud and River Wensum and continues to the west of Taverham. This is an attractive landscape due to the steep topography which enables fine views out across the valley to the south, and open views across the Wensum Valley.

Between the A1067 and the A140 the route crosses arable land of generally ordinary quality. However, landscape mitigation works may restrict views.

(iii) Western Blue

From the A47 the route heads north as it crosses the Tud valley, enabling open views in this area. The route runs through the wooded skyline of the Ringland Hills before crossing the river Wensum and running along the valley to the east of Ringland. The route affords good views of the Ringland Hills, the Wensum valley and the village of Ringland. Between the A1067 and the A140 the route crosses arable land of generally ordinary quality. However, landscape mitigation works may restrict views.

(iv) Western Red

From the A47 the route heads north crossing the Tud valley, where the landscape affords open views. The route then crosses the western end of the Ringland Hills, passing through attractive coniferous woodland. The road then passes to the west of Ringland, where the topography and mature deciduous woods provide a landscape of high quality that affords intermittent views. After crossing the River Wensum and the A1067 Fakenham Road the area is much more open enabling good views from the road over this section. Between the A1067 and the A140 Cromer Road the route crosses arable land of generally ordinary quality. However, landscape mitigation works may restrict views.

(v) Western Brown

This route starts to the west of Easton and crosses the River Tud gradually rising in a cutting through Ringland Covert thus restricting any views. Again at Weston Green envisaged landscape planting would inhibit views from the road.

The road continues to the east of Weston Longville where it crosses an attractive landscape consisting of well wooded undulating topography and by utilising the route of the existing minor road between Weston and Morton Halls. It then follows the A1067 westwards to Attlebridge bridging the river Wensum at Attlebridge where there are open views. From here the route passes through woodland at Mileplain Plantation and Big Plantation where views will be restricted and then continues in a slight cutting across arable land of generally ordinary quality. However, landscape mitigation works may restrict views

(vi) Western Purple

The route starts to the west of Honingham at the A47 and heads north west, crossing open arable farmland and strips of woodland, enabling some open views of the surrounding areas. From Weston Green the route follows the brown option and the same comments apply.

(vii) Western Brown Variation

The brown variation follows the brown route to Attlebridge and then continues along the existing A1067 to Deighton Hills. This section provides open views over the Wensum valley. From here the route follows the western red option and comments are the same.

The variation follows the brown route to Attlebridge and then continues along the existing A1067 to Deighton Hills. This section provides open views over the Wensum valley. From here the route follows the western red option and comments are the same.

(viii) Western Purple Variation

This route has little difference in terms of views afforded from the road as the western brown variation option.

(ix) Eastern Pink

This route would be classed as an Intermittent view, as the road is generally at ground level, but with landscape mitigation hindering views from the road.

(x) Eastern Yellow

The yellow route is classed as providing intermittent views, as the road is generally at ground level, but envisaged landscape mitigation may hinder views from the road.

(xi) Eastern Blue

The blue route heads to north of the airport and continues to the southern edge of Spixworth, where it is screened by a narrow woodland belt to Beeston Park. route alignment and new planting would limit views of Beeston Park and its parkland.

From Beeston Park the route then passes through a narrow gap between two woodland blocks before crossing to the north of Rackheath Hall. Mitigation planting envisaged would again minimise views across open arable land.

Between the settlements of New Rackheath and Thorpe End the route crosses the Cromer to Norwich railway line and then continues across open farmland to the A47. Possible mitigation and planting may limit views from the road.

Driver Stress

DMRB Volume 11 Section 3 Part 9 Clause 4.7 allows that for new routes designed in accordance with current standards the appropriate category will normally be "moderate" or "low" for the whole route. The table in Clause 4.9 confirms that a dual carriageway with an average speed of 60-80Km/hr, with average peak hourly flow per lane of 1200-1600 units¹ will give rise to Moderate driver stress. At offpeak times, if flow per lane reduces to under 1200 units, and the average speed increases to over 80Km/hr (50mph), driver stress may fall to Low.

5.10.4 Mitigation Measures

Not applicable

¹ A car or light van equals one flow unit

5.10.5 Conclusions and Recommendations

Due to the envisaged landscape planting and use of earthwork cutting required to reduce the visual impact of the possible routes, views from the road would not be as extensive as without the mitigation. However, all the route options afford improved views for vehicle travellers over the existing condition. Even sections of road passing through wooded or newly landscaped areas would be more attractive than the urban environment of the existing condition.

Driver stress would be improved from the existing condition from high adverse to moderate beneficial.

5.11 Water Quality and Drainage

5.11.1 Introduction and Methodology

(i) Purpose of the Assessment

The objective at this stage is to undertake sufficient assessment to identify the likely impacts of the proposed scheme on water quality and flows, fisheries and floodplain capacity. These potential impacts should be taken into account during the development and refinement of route options.

On account of the number of potential route options and the early stage in design, it has not yet been practical to undertake route specific monitoring to establish the baseline conditions of surface water flow, quality and aesthetics. Such monitoring should be undertaken before or as part of the Stage 3 assessment and specific recommendations for this have be made in the Conclusions and Recommendations Section.

(ii) Study area

The water quality, drainage and hydrology evaluation includes an assessment of the existing conditions of surface water, groundwater and floodplains in the area of the Northern Distributor Road (NDR) and provides an indication of the predicted impacts of each of the possible proposed schemes. Where more detailed assessment will be required, more substantial baseline data or mitigation measures are required, recommendations are given.

(iii) Potential Impacts, Effects and Receptors

The scheme could potentially impact on the following aspects:

- Hydrology of Streams and Rivers
- Water Quality in Streams and Rivers (including potential aquatic biodiversity)
- Indicative Floodplain
- Groundwater
- Pollution Incidents and Landfill Sites

(iv) Water Quality in Streams and Rivers

The baseline conditions for surface water quality in this assessment are taken from existing monitoring data from the Environment Agency based on the General Quality Assessment (GQA) methodology.

(v) *Methodology*

The assessment has been made in accordance with the guidance provided by the Highways Agency, in the Design Manual for Roads and Bridges (DMRB) Volume 11 Section 3 Part 10 Water Quality and Drainage. This guidance includes the procedure in CIRIA Report 142 (as outlined in Annex III), to calculate the potential for localised pollution effects and to assess accidental spillage risks in the Study area. Mitigation measures would be an integral part of the scheme and assessment of effects does not take into account such measures, in order to identify areas of greater need at this stage. The impacts of the proposed scheme will be considered during construction and fifteen years after opening. The total study area for this chapter is based on a 1 km buffer zone around all proposed route options. The study area has been divided into two sub-areas for the western route options and the eastern route options, as delineated in a Figure provided in Part 3 of this report.

The geographical extent of the study areas stretches around the northern boundary of Norwich from the New Costessey area in the west, to Great Plumsted to the East of Norwich. The exact study area for each possible route lies within a locus of points 1 km from that route.

The areas considered most sensitive to the risk and consequences of accidental spillages and water quality, hydrological or physical changes, caused by traffic or the proposed route itself, are identified.

(vi) Sources of Information

The information for this section has been obtained from the sources listed in Table 5.11.1

Source	Information
Maps	Ordnance Survey 1:50 000 scale Landranger map series No. 134 (Norwich and the Broads), 1997 Ordnance Survey 1:50 000 scale Landranger map series No. 133 (North East Norfolk), 2002 Ordnance Survey 1:25 000 scale Explorer series No. 238 (East Dereham and Aylsham), 1999 Ordnance Survey 1:25 000 scale Explorer series No. OL40 (The Broads), 2002 Groundwater Vulnerability 1:100,000 Map Series, Sheet 26, Environment Agency Solid Geology Map Series 1:250 000 scale, Sheet 52N 00 (East Anglia), British Geological Survey, 1985 Soils of England and Wales 1:250 000 scale, Sheet 4 (Eastern England)
Environment	Pollution incident data Details of licensed abstractions and consented
Contro for Ecology	discharges Surface water quality data Groundwater quality and levels from monitoring network (awaiting) Indicative floodplain extents Public water supplies and groundwater protection zones Landfill Sites
and Hydrology	Hydrological data UK Hydrometric Register and Statistics 1991 – 1996
(formerly Institute of	Flood Estimation Handbook (1999) CD-ROM
Hydrology), British	Report No 108, Low Flow Estimation in the United
Geological Survey Wallingford	Kingdom
Norfolk County Council	Vertical road alignments for proposed routes

Table 5.11.1: Data Sources

(vii) Significance Criteria

The evaluation of the impact significance is based on the following criteria:

- Substantial Such impacts are large-scale direct impacts, for example dramatic changes in water quality or quantity of surface flow resulting in flooding. The effects may be difficult to mitigate and would be of regional or national importance.
- Moderate Such impacts involve small-scale direct impacts, for example increased risk of pollution or concentration of surface flow to cause a hazard to traffic. The effects may be difficult to mitigate and would be of local or regional importance.
- Slight Such impacts would be localised, of low magnitude and would be easy to mitigate. For example there may be potential for a small change to water quality during construction and/or use.
- Insignificant No discernible effect.

5.11.2 Baseline Conditions

(i) Introduction

Hydrology of Streams and Rivers

Four rivers flow through the designated Study areas. These are the River Wensum, River Tud, a tributary of the River Bure and a tributary of the River Yare. Also in the vicinity are the Rivers Yare, Tiffey and Tas, however these are all considered to be sufficiently separated from the proposed routes that they have not been considered in detail in this assessment.

Flows

In the absence of flow monitoring, data has been taken from the Centre for Ecology and Hydrology (BGS) Hydrometric Register for 1991 to 1995. Table 5.11.2 details the useful data taken from river flow gauging stations on the Rivers Wensum and Tud, within the Study area.

Station no.	034004	034005
River name	Wensum	Tud
Station name	Costessey Mill	Costessey Park
NGR (east)	617700	617000
NGR (north)	312800	311300
Period of record	1960-1995	1961-1995
Mean annual rainfall (mm)	676	664
Mean annual flood (m ³ s ⁻¹)	18.6	3.2
Base flow index	0.73	0.65
95 Percentile flow (m ³ s ⁻¹)	1.28	0.09

Flows are not known for streams and tributaries in the area. However more minor rivers and streams are likely to run dry during periods of low groundwater levels, in particular during summer months. This is typical of Chalk areas, where surface waters have high base flow indices, i.e. are largely fed by groundwater.
Groundwater

Limited data is available at this time relating to groundwater quality, levels and flow within the Study area. In order to provide a basis for the assessment of impacts on groundwater two factors relating to groundwater have been examined. These are designated protected resources and groundwater vulnerability.

The Environment Agency has designated areas around Public Water Supplies (PWS), as Source Protection Zones (SPZs).

In order to provide protection to drinking water supplies, the Environment Agency has designated areas around Public Water Supplies (PWS), as Source Protection Zones (SPZs). There are four categories of protection assigned. Descriptions of the designations are provided in Box 5.11.3.

Box 5.11.3: Source Protection Zone Criteria

- Zone I (Inner Protection Zone) This zone is defined by a travel time of 50 days or less from any point within the zone at, or below, the water table. Additionally, the zone has as a minimum 50 metre radius. It is based principally on biological decay criteria and is designed to protect against the transmission of toxic chemicals and water-borne disease.
- **Zone II (Outer Protection Zone)** This zone is defined by the 400 day travel time, or 25% of the source catchment area, whichever is larger. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants.
- **Zone III (Total catchment)** This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source.
- Zone of Special Interest For some groundwater sources an additional Zone of Special Interest may be defined. These zones highlight areas (mainly on non-aquifers) where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

Source: www.environment-agency.gov.uk

In addition to identifying groundwater SPZs, overall groundwater vulnerability has been identified. Groundwater vulnerability is derived from a combination of two factors:

Aquifer classification. Aquifers are classified into three types, based on the permeability of the aquifer. These include: Major Aquifers (highly permeable), Minor Aquifer (variably permeable) and Non-Aquifers (with negligible permeability).

Soil classification. Soils are again classified into three types, based on the potential for contaminants to leach through the soils into an underlying aquifer. These include: Soils of high leaching potential, soils of intermediate leaching

potential and soils of low leaching potential. It is important to note that, according to the Policy and Practice for the Protection of Groundwater (National Rivers Authority, 1994), because soil information for urban areas is less reliable and based on fewer observations than in rural areas, the worst case is assumed and such land is classified as high leaching potential until proved otherwise.

The vulnerability of the aquifer is determined by the aquifer classification and soil class, Table 5.11.4 sets out the criteria.

Aquifer Classification	Soil Class
Major Aquifer (High Permeability)	High Leaching Potential
	Intermediate Leaching Potential
	Low Leaching Potential
Minor Aquifer (Low Permeability)	High Leaching Potential
	Intermediate Leaching Potential
	Low Leaching Potential
Non Aquifer (Negligible Permeability)	

Table 5.11.4: Groundwater Vulnerability Criteria

Surface Waters

The GQA methodology is employed to provide a standardised method of classifying water quality of rivers and canals. The method examines four "windows" on water quality comprising:

- Chemical Quality (dissolved oxygen, biochemical oxygen demand, and ammonia)
- Biological Quality (using macro invertebrates)
- Nutrient Status (Phosphates and Nitrates)
- Aesthetic Quality (litter, foam, odour and colour)

Each of these windows are considered separately and rated on a scale appropriate to the parameters measured. A detailed outline of this methodology is provided in Part 2 of this report. Table 5.11.5 presents a summary of classifications used in the GQA methodology.

Table 0.11.0. Outlinnary of OQA Olassifications		
Window		
Chemical	Biological	Nutrients (Nitrates/Phosphates
A – Very Good	a – Very Good	1 – Very Low/Very Low
B – Good	b – Good	2 – Low/Low
C – Fairly Good	c – Fairly Good	3 – Moderate/Moderately Low
D – Fair	d – Fair	4 – High/Moderate
E – Poor	e – Poor	5 – Very High/High
F – Bad	f – Bad	6 – Excessively High/Very High

Table 5.11.5: Summary of GQA Classifications

² A grade (from 1-6) is allocated to both phosphate and nitrate as these represent different aspects of water quality. There are also no "good" or "bad" grades for nutrient levels as different systems require different nutrient loads.

Currently no information relating to aesthetic quality of watercourses in the area is available and therefore this factor has not been included in the establishment of the baseline environment of this scoping report.

Information, from individual monitoring points along watercourses within the area, has been provided by the Environment Agency for the purpose of establishing the baseline environmental conditions at this site. The information comprises classifications of water quality as described in Table 5.11.5, as well as raw sampling data for a period of three years.

In addition to a review of GQAs, the raw data has been assessed at sites within the Study area and comparison has been made with relevant Environmental Quality Standards (EQS) and Drinking Water Standards (DWS).

In order to determine the current usage of surface water resources, Environment Agency water abstraction licence records for the Study area have been obtained. Abstractions along watercourses have been noted.

Schedules of discharge consents and existing Integrated Pollution Control (IPC) and Pollution Prevention and Control (PPC) licences, issued by the Environment Agency, have been examined. The presence of these discharges has been noted in order to indicate current stresses on surface waters within the Study area.

(ii) Eastern Route Corridors

River Yare

A stretch of the River Yare, approximately 200 m in length, intersects the southern boundary of the eastern Study area. Considering the distance from this stretch of the river to the nearest proposed route option, the risk of impacts posed to this watercourse by the proposed route options is considered to be negligible and therefore further investigation has not been undertaken.

Tributary of the River Yare, "Witton Run"

Witton Run originates within the eastern study area and flows south east, intersecting the study area boundary approximately 5 km from its source. Witton Run ultimately confluences with the River Yare a further 3.5 km beyond the study area.

Three licensed surface water abstractions from Witton Run have been identified within the study area. Details of these abstractions are provided in Part 2 of this report.

No licensed discharge consents, PPC or IPPC licences allowing discharges into Witton Run have been identified.

As outlined in the flows section above, it is likely that this stream has low flows or does not flow at all during certain times of the year, as is typical of streams in an area underlain by Chalk. This renders such streams particularly sensitive to changes in water quality because they have very little or no diluting potential.

The nearest available Environment Agency monitoring point is approximately 2.5 km downstream of the study area boundary and is downstream of an urban area. Thus results from this monitoring station should only be considered indicative and further monitoring should be established within the study area to provide an accurate baseline, as conditions further upstream within the study area are likely to be of better water quality.

Site	Indicator			
	Chemical	Biological	Nitrate	Phosphate
226	Poor (E)	Good (b)	Moderate (4)	Moderate (3)

Fable 5.11.6: General Quality Assessment	t (GQA) of Witton Run (2002)
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Data from this monitoring point indicates chemical water quality is poor (GQA grade E) however biological water quality is good (GQA grade b).

Indicative Floodplain

The area through which the proposed road would pass currently drains predominantly to groundwater. One of the proposed route variations at the A47 Postwick Junction (Cucumber Lane Route 1) runs along Witton Run (a tributary of the River Yare) and would thus impact its floodplain. The significance of such an impact would need to be assessed on site, if this route is to be considered further. The blue route passes within about 200 m of a tributary of the River Bure, and in the event of substantial rainfall there may be surface runoff to this stream. No watercourses are crossed by any of the three main proposed routes, and no part of the area through which they pass is in a floodplain.

Groundwater

No PWSs have been identified from Environment Agency records as lying within the eastern Study area. However, approximately the southern third of this study area is within a SPZ III, designated for PWSs to the south, and a central portion of the study area intersects an adjoining 2.5 km wide band of SPZ III, extending from PWSs in the south of Norwich, up to PWSs in the north at Belaugh. The study area also encroaches slightly into the designated Zone II protection area to the south and that to the north. SPZs are displayed, along with study areas, in Figures presented in Part 3 of this report.

Thirty four licensed abstractions from groundwater have been identified within the eastern study area, these are shown in Figures presented in Part 3 of this report. Full details of abstractions from groundwater within the eastern study area are presented in Part 2 of this report.

Five licensed discharges to groundwater were identified within the eastern study area and shown in Figures presented in Part 3 of this report. Full details of discharge consents are presented in Part 2 of this report.

As explained above, groundwater level data is still awaited, but will form an important part of the assessment in considering the impact of cuttings and tunnels on groundwater flows and supplies and to identify contaminant pathways in groundwater.

Pollution Incidents and Landfill Sites

Existing sites of pollution incidents have been considered in order to demonstrate the current level of incident in the Study area. Pollution incidents over the last three years were identified from public records made available by the Environment Agency. Within the eastern route corridor nine incidents were identified which had resulted in contamination of the water environment or land. These pollution incidents are detailed in Part 2 of this report.

The presence of known landfill sites within the study area has been investigated. Construction near or over landfill sites has the potential to create "pathways" for contaminants, which are currently harmlessly contained within the ground. Landfill sites were identified from the Environment Agency's "What's in My Backyard" internet service. Within the eastern route corridor one site was identified. The locations of these landfills are displayed on Figures presented in Part 3 of this report.

(iii) Western Route Corridors

River Wensum

The River Wensum flows through the western Study area from the north-west to the south-east and ultimately into the River Yare in the Thorpe Hamlet area south-east of Norwich.

Surface water quality at this site appears to be of very good quality both chemically and biologically, however nutrient levels are high. It is likely that these high nutrient levels are attributable to diffuse pollution from local agricultural practices rather than existing road runoff. The presence of high nutrient levels in the river leaves the ecosystem vulnerable to the process of eutrophication.

Twenty licensed surface water abstractions from the River Wensum and tributaries have been identified within the Study area. The locations of these abstractions are shown on a Figure presented in Part 3 of this report, and further details are given in Part 2 of this report.

Examination of discharge consents within the area has identified five licensed discharge consents to surface waters on, or in the immediate vicinity of the River Wensum. The locations of these discharge points are presented in Part 3 of this report, and details of the consented activities can be found in Part 2.

No existing IPC or PPC licences were identified allowing such discharges to the River Wensum, within the western study area.

The Environment Agency has provided results of GQAs along the River Wensum. From this data only one site has been identified as lying within the designated study area. A summary of information from this site is presented in Part 2 of this report.

Table 5.11.7: General Quality Assessment (GQA) of the River W	ensum
(2002)	

Site	Indicator			
	Chemical	Biological	Nitrate	Phosphate
225	Very Good (A)	Very Good (a)	Moderate (4)	Very High (5)

Examination of the raw chemical testing data, again provided by the Environment Agency, has shown no exceedances of EQS or DWS.

River Tud

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The River Tud flows through the western Study area from the west to the east. The Tud ultimately flows into the River Wensum, east of the New Costessey area of Norwich.

Water quality at both of these sites can be said to be of very good quality both chemically and biologically, however nutrient levels are high. It is likely that these high nutrient levels are attributable to diffuse pollution from agriculture

rather than existing road runoff. The presence of high nutrient levels in the river leaves the ecosystem vulnerable to the process of eutrophication.

Nine licensed water abstractions from the River Tud and tributaries have been identified within the study area. The locations of these abstractions are shown on a Figure provided in Part 3 of this report and further details are given in Part 2.

Examination of discharge consents within the area have identified that there are three discharge consents to surface waters on, or in the immediate vicinity of the River Tud.

The locations of these discharge points are shown on a Figure presented in Part 3 of this report and details of the consented activities can be found in Part 2.

No IPC or PPC licences were identified as discharging to the River Tud, within the study area.

The Environment Agency has provided results of GQAs along the River Tud. From this data only two sites have been identified as lying within the designated study area. A summary of information from these sites is presented in Part 2 of this report.

Site	Indicator			
	Chemical	Biological	Nitrate	Phosphate
060	Very Good (A)	Very Good (a)	High (5)	Very High (5)
070	Very Good (A)	Very Good (a)	Moderate (4)	High (4)

Table 5.11.8: General Quality Assessment (GQA) of the River Tud (2002)

Examination of the raw chemical testing data, again provided by the Environment Agency, has identified no exceedances of EQS or DWS.

Tributary of the River Bure

A tributary to the River Bure flows from west to east across the eastern half of the northern boundary of the western Study area. It flows along the south side of Horsford then to the north of Horsham St. Faith, before confluencing with Stone Beck (just before Spixworth Bridge), which flows eastwards into the River Bure.

No direct surface water abstractions from the Bure tributary under examination, have been identified from the schedule of surface water abstractions in the area, provided by the Environment Agency.

Examination of discharge consents within the area have revealed two discharge consents to surface waters on, or in the immediate vicinity of the tributary of the River Bure. The locations of these discharge points are presented in a Figure provided in Part 3 of this report and details of the consented activities are listed in Part 2.

No IPC or PPC licences were identified as discharging to the tributary of the River Bure, within the study area.

Indicative Floodplain

The proposed western routes all cross the floodplain of the River Wensum and all but the purple route also cross the River Tud floodplain, as shown in a Figure

presented in Part 3 of this report. Of these the Wensum floodplain is the most extensive and hence will be the more critical.

Groundwater

Within the western Study area, one SPZ source (PWS) has been identified from Environment Agency records, this is shown in a Figure presented in Part 3 of this report. Details of this site are presented in Table 5.11.9. The source is located centrally within the Study area and associated protection zones spread out from this point broadly to the north and west.

Table 5.11.9: SPZ Sources	s in Western	Routes Corridor
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Source Code	Source Name	Easting	Northing
AN046	Costessey	616340	313240

Ninety-nine licensed abstractions from groundwater have been identified within the Study area and are shown in Figures presented in Part 3 of this report. Full details of abstractions from groundwater within the study area are given in Part 2 of this report.

Thirteen consented discharges to groundwater were identified within the western Study area and shown in Figures presented in Part 3 of this report. Full details of discharge consents are presented in Part 2 of this report.

Groundwater level data has not been used in the current assessment.

These data are important for understanding the groundwater flow regime and identifying contaminant pathways, between potential sources and receptors of contamination, and will be addressed in impact assessments during Stage 3.

Additionally, the data are important to identify whether the base of any proposed road cuttings or tunnels are likely to lie below the depth of groundwater levels. Although such circumstances will primarily be engineering considerations, as cuttings may be destabilised or flooded by groundwater seepage, secondary impacts may be important environmental considerations.

For example, if dewatering of such structures is required, groundwater levels will be lowered, potentially disrupting abstractions and altering the local groundwater flow regime by drawing in groundwater. Groundwater flows into rivers may, in turn, be critically affected and nearby road runoff outfalls may need to be located a certain distance away from the structure as discharged drainage may be drawn into the pumped cutting from soakaways or balancing ponds. Not only would this add to the problem of the presence of groundwater in the structure, but may also disrupt the residence time requirements of runoff water for the mitigation of contaminants, thus rendering such measures less effective.

Pollution Incidents and Landfill Sites

Existing sites of pollution incidents have been considered in order to demonstrate the current level of incident in the Study area. Pollution incidents over the last three years were identified from public records made available by the Environment Agency. Within the western Study area twenty one incidents were identified which had resulted in contamination of the water environment or land. Within the western route corridor twenty one such incidents were identified. These pollution incidents are detailed in Part 2 of this report.

The presence of known landfill sites within the Study area has been investigated. Construction near or over landfill sites has the potential to create

"pathways" for contaminants, which are currently harmlessly contained within the ground. Landfill sites were identified from the Environment Agency's "What's in My Backyard" internet service. Within the western Study area four sites were identified. The locations of these landfills are displayed on Figures presented in Part 3 of this report.

5.11.3 Assessment of Impacts

(i) Introduction

None of the Environment Agency's GQA sites within the Study area lie on the River Bure tributary in question. It has therefore not been possible to make an assessment of the water quality of this watercourse, nor has it been possible to make a comparison of its water quality against EQS and DWS.

Within the western Study area, one SPZ source (PWS) has been identified from Environment Agency records, this is shown in a Figure provided in Part 3 of this report. Details of this site are presented in Table 5.11.10. The source is located centrally within the study area and associated protection zones spread out from this point broadly to the north and west.

Source Code	Source Name	Easting	Northing
AN046	Costessey	616340	313240

In addition to the zones associated with the Costessey source, the south-east of the Study area intersects a protection area designated as Zone III. Coverages of the protection zones are presented in a Figure presented in Part 3 of this report.

In addition to the SPZs, groundwater vulnerability has been examined. The entire area of interest overlies a major Chalk aquifer. The predominant soil classification for the western Study area is Newport 4, which is comprised of typical brown sands. On account of its high permeability this soil type has a high leaching potential, giving most of the Study area high groundwater vulnerability. Exceptions to this classification are the less permeable alluvial floodplains in the area, which lower the groundwater vulnerability to an intermediate (or an occasional low) level. These lower vulnerability areas are delineated in a Figure presented in Part 3 of this report.

(ii) Eastern Routes

No PWSs have been identified from Environment Agency records as lying within the eastern Study area. However, approximately the southern third of this Study area is within a SPZ III, designated for PWSs to the south, and a central portion of the study area intersects an adjoining 2.5 km wide band of SPZ III, extending from PWSs in the south of Norwich, up to PWSs in the north at Belaugh. The study area also encroaches slightly into the designated Zone II protection area to the south and that to the north. SPZs are displayed, along with study areas on a Figure presented in Part 3 of this report.

In addition to the SPZs, groundwater vulnerability has been examined. The entire area of interest overlies a major Chalk aquifer. The predominant soil classification for the eastern Study area is Wick 2, comprised of typical brown earths. On account of its high permeability this soil type has high leaching

potential, giving most of the study area high groundwater vulnerability. Exceptions to this classification, which lower the vulnerability to an intermediate level, are the less permeable alluvial floodplains, one relatively small area of which lies close to a short stretch of the blue route option on its north-east side of the study area and another just intersects the study area in the south. The intermediate areas are represented in a Figure presented in Part 3 of this report.

Construction Effects

These principally relate to suspended solids and chemicals used in the construction process. Suspended solids can either be a result of airborne dust or runoff from the site. Chemicals used in construction can be contained in fuels, oils and cement. The suspended solids offer little threat to the water environment for the major route options due to the absence of defined surface flow. There is some potential risk where the routes cross the surface watercourses. The liquid chemicals offer a potential threat following any accidental spillages. Standard Environment Agency Special Requirements included in the Contract would set out measures required to minimise the possibility of such events occurring. Provided these are adhered to, construction impacts and effects are expected to be insignificant.

It should be noted that a potentially more damaging effect, which could arise during construction, would be if river flows are disrupted during the construction of bridges, embankments and the road near to or across surface watercourses. Any disruptions to flow should be avoided as they could cause long term impacts on biodiversity and ecology and also short term impacts on water quality and surface water abstractions.

Operational Effects - Water Quality Issues

The construction and operation of a road creates an impermeable surface over which water flows. The pollutants that have built up on the road surface during its use are washed off by this water into the drainage system and into the local watercourses selected to receive the drainage water. This could create undesirable levels of contaminants in the water body that cause detrimental effects to the water quality and ecological components of the water body.

The main sources of pollutants in road runoff are vehicular although the gradual wear and tear of the road also contributes. The DMRB describes typical constituents of road runoff to include:

- Suspended solids
- Hydrocarbons
- Metals, dissolved and insoluble including copper, zinc and iron
- Cyanide
- Chlorides
- Sulphides
- PCB's and pesticides
- Bacteria

Road surface runoff can not only enter the surrounding environment by surface flow, but also by airborne spray caused by vehicle turbulence. Most spray from the carriageway is deposited nearby. Research by the Department of Transport has found that the highest concentration of salt (from winter de-icing operations) in the soil is found in the central reserves closest to the carriageway. On verges 5 m from the hard shoulder the concentration of salt in the soil has been found to be a negligible hazard to plants.

Impact Assessment Matrices

The potential impacts to surface water, groundwater and flooding have been considered for each proposed route and summarised, with applied significance criteria, in the matrices included as Tables 5.11.11 to 5.11.19 (inclusive).

The potential impact matrices are an assessment of each individual route in association with the current surface water, groundwater and flooding conditions. The matrices, as this stage, do not include the reduction of potential impact which will occur once all the mitigation measures have been implemented. Individual mitigation action plans will be developed during Stage 3 assessments for each route once more detailed surface water, groundwater and flooding information is available.

The following abbreviations/meanings have been used in the matrices:

Study area:	within 1 km buffer of route or routes in question
gw:	groundwater;
SW:	surface water
PWS:	Public water supply
GSPZ:	Source Protection Zone (I innermost; II intermediate; III outermost)
GV:	Groundwater vulnerability
AL:	Abstraction Licence; DC: Discharge Consent
BFI:	Baseflow Index

Signifi cance	Moderate to Substantial	Moderate	Slight	Substantial	Substantial
Magnit ude	Local to regional (if landfill containment impacted)	Local to Regional (if rivers impacted)	Local	Regional	Regional
Description of impact	Construction - no gw protection from spillages and suspended solids (short term); excavation near landfill can create new pathways for gw flow and pollutant leaching (long term). <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions or PVVSs if within GSPZs. Also discharges may require sufficient gw flow for dilution	Construction (bridges/embankments/ general operations close to sw) - no sw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to rivers	<u>Construction</u> of bridges/road embank- ments may require temporary diversion of flow or operations within river – major obstruction to flow having long term effects on biodiversity and ecology and short term effects on quality and abstractions. <u>Operational</u> – minor effects on above if bridge/ embankment obstruction to flow is mitigated with sufficient openings	Obstruction of flood flows by bridges and road embankments; increase to flood levels upstream of river crossing; loss of storage on flood plain; impact of additional runoff from new road; effects on local drainage system – could destroy habitats, farmland, buildings and structures
Impact	Construction - adverse major short term and potential long term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	<u>Construction</u> – adverse, minor, short term effects <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> – adverse, major, short term effects <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> – adverse, major, long term effects <u>Operational</u> – adverse, major, long term effects (unless bridge/ embankment obstruction to flow is mitigated).	Construction – adverse minor, short term effects. Operational – adverse, major, long term effects (unless bridge/embank- ment obstruction to flood flow is mitigated)
Importance	High – PWS; High quality (chemical and biological) Rivers Wensum, Bure, Tud and Yare	Moderate – PWS only GSPZ III potentially affected, but major crossing; few DCs. Maintenance of river flow important, but unlikely to be heavily impacted	High – SSSI; Fisheries; Ecology/biodiversity	High – SSSI; Fisheries; Ecology/biodiversity	High – flood risk impacts on nearby upstream woodland, agricultural land, urban areas and other road crossings
Sensitivity	High – major aquifer; environ- mentally sensitive local rivers	High – major aquifer; ecologically important rivers	High – GQA (chemical & bio- logical) Grade A (very good); Designated salmon fisheries (details to be confirmed)	High– GQA (chemical and biological) Grade A (very good); Designated salmon fisheries (details to be confirmed)	High – River Tud floodplain has multiple crossings at wide points and River Wensum is also a major river
Baseline	Route has a single major crossing of GSPZ III. Almost entire route lies in area of high GV. 23 gw ALs in study area. Landfill site lies along section of proposed route. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Approximately half the route overlies a GSPZ III. gw DCs in study area. 23 gw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Route crosses environmentally sensitive Rivers Tud and Wensum (SSSI). 8 sw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Route crosses environmentally sensitive Rivers Tud (Q_{95} : 0.09 m ³ s ⁻¹) and Wensum (Q_{95} : 1.28 m ³ s ⁻¹) – constant flow maintains high quality, dilutes discharges and supports biodiversity and abstractions. No sw DCs in study area	Route crosses floodplains of the Rivers Tud twice (width at crossings: 150m & 260m) and Wensum (width at crossing: 260m). Passes close to Tud floodplain at a third point
Attri bute	Quality	Quantity	Quality	Conveyance of Flow	Conveyance of Flood Flows
Feat ure	Groun	dwater	Surfa	ace Water	Floodplain

Table 5.11.11: Western green route impacts matrix

Feat ure	Attri bute	Baseline	Sensitivity	Importance	Impact	Description of impact	Magnitude	Signifi cance
Groundw	Quality	Route crosses GSPZ III three times & GSPZ II once. Almost entire route lies in area of high GV 70 gw ALs in study area. Landfill site lies along section of proposed route. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	High – major aquifer; environmentally sensitive local rivers	High – PWS; High quality (chemical and biological) Rivers Wensum, Bure, Tud and Yare	Construction - adverse major short term and potential long term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	<u>Construction</u> - no gw protection from spillages and suspended solids (short term); excavation near landfills can create new pathways for gw flow and pollutant leaching (long term). <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	Local to regional (if landfill containment impacted)	Moderate to Substantial
vater	Quantity	Route crosses GSPZ III three times and GSPZ II once. 3 gw DCs in study area. 70 gw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	High – major aquifer; Ecologically important rivers	Moderate – PWS GSPZ II & III potentially affected; few DCs). Maintenance of river flow important, but unlikely to be heavily impacted	<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – adverse, minor, long term effects	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions or PWSs if within GSPZs. Also discharges may require sufficient gw flow for dilution	Local to regional (if rivers impacted)	Moderate
Surfa	Quality	Route crosses environmentally sensitive Rivers Tud and Wensum (SSSI). 20 sw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	High – GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	High – SSSI; Fisheries; Ecology/biodiversity	<u>Construction</u> – adverse, major, short term effects. <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> (bridges/embankments/ general operations close to sw) - no sw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to rivers	Local	Slight
ace Water	Conveyance of Flow	Route crosses environmentally sensitive Rivers Tud (Q_{95} : 0.09 m ³ s ⁻¹) and Wensum (Q_{95} : 1.28 m ³ s ⁻¹) – constant flow maintains high quality, dilutes discharges and supports biodiversity and abstractions. 3 sw DCs in study area 20 sw ALs in study area	High– GQA (chemical and biological) Grade A (very good); Designated salmon fisheries (details to be confirmed)	High – SSSI; Fisheries; Ecology/biodiversity	<u>Construction</u> – adverse, major, long term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank- ment obstruction to flow is mitigated)	<u>Construction</u> of bridges/road embankments may require temporary diversion of flow or operations within river – major obstruction to flow having long term effects on biodiversity and ecology and short term effects on quality and abstractions. <u>Operational</u> – minor effects on above if bridge/embankment obstruction to flow is mitigated with sufficient openings	Regional	Substantial
Floodplain	Conveyance of Flood Flows	Route crosses floodplains of the Rivers Tud (width at crossing: 195m) & Wensum (width at crossing: 340m) Passes close to River Wensum floodplain at a second point	High – River Wensum is wider and thus more critical (and a major river)	High – flood risk impacts on nearby upstream woodland, agricultural land, urban areas and other road crossings	Construction – adverse, minor, short term effects. Operational – adverse, major, long term effects (unless bridge/embank- ment obstruction to flood flow is mitigated)	Obstruction of flood flows by bridges and road embankments; increase to flood levels upstream of river crossing; loss of storage on flood plain; impact of additional runoff from new road; effects on local drainage system – could destroy habitats, farmland, buildings and structures	Regional	Substantial

Table 5.11.12: Western orange route impacts matrix

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ge 2 Scheme Assessment Report	
Stag	
Distributor Route -	
Northern	
Norwich	

Signifi cance	Slight	Moderate	Slight	Substantial	Substantial
Magnit ude	Local	Local to Regional (if rivers impacted)	Local	Regional	Regional
Description of impact	Construction - no gw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions, PWSs if within GSPZs and baseflow into rivers. Also discharges may require sufficient gw flow for dilution	<u>Construction</u> (bridges/embankments/ general operations close to sw) - no sw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to rivers	<u>Construction</u> of bridges/road embankments may require temporary diversion of flow or operations within river – major obstruction to flow having long term effects on biodiversity and ecology and short term effects on quality and abstractions. <u>Operational</u> – minor effects on above if bridge/embankment obstruction to flow is mitigated with sufficient openings	Obstruction of flood flows by bridges and road embankments; increase to flood levels upstream of river crossing; loss of storage on flood plain; impact of additional runoff from new road; effects on local drainage system – could destroy habitats, farmland, buildings and structures
Impact	Construction - adverse major short term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – adverse, minor, long term effects	Construction – adverse, major, short term effects. Operational – adverse, minor, long term effects	<u>Construction</u> – adverse, major, long term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank- ment obstruction to flow is mitigated)	Construction – adverse, minor, short term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank- ment obstruction to flood flow is mitigated)
Importance	High – PWS; High quality (chemical and biological) Rivers Wensum, Bure, Tud and Yare	Moderate – PWS, but only outer GSPZ potentially affected; few DCs ; maintenance of river flow important, but unlikely to be heavily impacted	High – SSSI; Fisheries; Ecology/biodiversity	High – SSSI; Fisheries; Ecology/biodiversity	High – flood risk impacts on nearby upstream woodland, agricultural land, urban areas and other road crossings
Sensitivity	High – major aquifer; environmentally sensitive local rivers	High – major aquifer; ecologically important rivers	High – GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	High– GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	High – River Wensum is wider and thus more critical (and a major river)
Baseline	Route crosses GSPZ III twice Almost entire route lies in area of high GV. 41 gw ALs in study area Environmentally sensitive Rivers Wensum, Bure, Tud and Yare have high BFIs (0.73, 0.83, 0.65 and 0.65, respectively)	Route crosses GSPZ III twice. 5 gw DCs in study area. 41 gw ALs in study area. Environmentally sensitive Rivers Wensum, Bure, Tud and Yare have high BFIs (0.73, 0.83, 0.65 and 0.65, respectively)	Route crosses environmentally sensitive Rivers Tud and Wensum (SSSI). 12 sw ALs in study area	Route crosses environmentally sensitive Rivers Tud (Q_{95} : 0.09 m ³ s ⁻¹) and Wensum (Q_{95} : 1.28 m ³ s ⁻¹) – constant flow maintains high quality, dilutes discharges and supports biodiversity and abstractions. 3 sw DCs in study area area. 12 sw ALs in study area	Route crosses floodplains of the Rivers Tud (width at crossing: 110 m) and Wensum (width at crossing: 320 m)
Attri bute	Quality	Quantity	Quality	Conveyance of Flow	Conveyance of Flood Flows
Feat ure	Ground	d-water	Surfa	ace Water	Flood-plain

Table 5.11.13: Western blue route impacts matrix

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Stage 2 Scheme
Distributor Route -
lorwich Northern

_	Signifi cance	Moderate to substantial	Moderate	Slight to Insignificant	Substantial	Substantial
	Magnit ude	Local to regional (if landfill containment	Local to Regional (if rivers	Local	Regional	Regional
	Description of impact	<u>Construction</u> - no gw protection from spillages and suspended solids (short term); excavation near landfills can create new pathways for gw flow and pollutant leaching (long term). <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions or PWSs if within GSPZs. Also discharges may require sufficient gw flow for dilution	<u>Construction</u> (bridges/embankments/ general operations close to sw) - no sw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to rivers	<u>Construction</u> of bridges/road embank- ments may require temporary diversion of flow or operations within river – major obstruction to flow having long term effects on biodiversity and ecology and short term effects on quality and abstractions. <u>Operational</u> – minor effects on above if bridge/embankment obstruction to flow is mitigated with sufficient openings	Obstruction of flood flows by bridges and road embankments: increase to flood levels upstream of river crossing; loss of storage on flood plain; impact of additional runoff from new road; effects on local drainage system – could destroy habitats, farmland, buildings and structures
	Impact	<u>Construction</u> - adverse major short term and potential long term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	Construction – adverse, minor, short term effects. <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> – adverse, major, short term effects. <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> – adverse, major, long term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank-ment obstruction to flow is mitigated)	Construction – adverse, minor, short term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank-ment obstruction to flood flow
	Importance	High – PWS; High quality (chemical and biological) Rivers Wensum, Bure, Tud and Yare	Moderate to low – PWS, but only GSPZ III potentially affected. Few DCs. Main- tenance of river flow important, but unlikely to be heavily impacted	High – SSSI; Fisheries; Ecology/biodiversity	High – SSSI; Fisheries; Ecology/biodiversity	High – flood risk impacts on nearby upstream woodland, agricultural land, urban areas and other road crossings
	Sensitivity	High – major aquifer; environmentally sensitive local rivers	High – major aquifer; ecologically important rivers	High – GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	High– GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	High – River Wensum is wider and thus more critical (and a major river)
	Baseline	Route crosses GSPZ III twice. Almost entire route lies in area of high GV. 55 gw ALs in study area. Landfill site within 200m of proposed route. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Route crosses GSPZ III twice. 5 gw DCs in study area. 55 gw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Route crosses environmentally sensitive Rivers Tud and Wensum (SSSI). 8 sw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Route crosses environmentally sensitive Rivers Tud (Q_{96} : 0.09 m ³ s ⁻¹) and Wensum (Q_{96} : 1.28 m ³ s ⁻¹) – constant flow maintains high quality, dilutes discharges and supports biodiversity and abstractions. 3 sw DCs in study area rea. 8 sw ALs in study area	Route crosses floodplains of the Rivers Tud (width at crossing: 115m) and Wensum (width at crossing: 340m)
	Attri bute	Quality	Quantity	Quality	Conveyance of Flow	Conveyance of Flood Flows
	Feat ure	Ground	water	Surfac	ce Water	Flood-plain

Table 5.11.14: Western red route impacts matrix

Signifi cance	Slight	Moderate	Slight to Moderate	Substantial	Moderate
Magnit ude	Local	Local to Regional (if rivers impacted)	Local	Regional	Regional
Description of impact	<u>Construction</u> - no gw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions or PWSs if within GSPZs. Also discharges may require sufficient gw flow for dilution	<u>Construction</u> (bridges/embankments/ general operations close to sw) - no sw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to rivers	Construction of bridges/road embank- ments may require temporary diversion of flow or operations within river – major obstruction to flow having long term effects on biodiversity and ecology and short term effects on quality and abstractions. <u>Operational</u> – minor effects on above if bridge/embankment obstruction to flow is mitigated with sufficient openings	Obstruction of flood flows by bridges and road embankments; increase to flood levels upstream of river crossing; loss of storage on flood plain; impact of additional runoff from new road; effects on local drainage system – could destroy habitats, farmland, buildings and
Impact	Construction - adverse major short term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> – adverse, major, short term effects. <u>Operational</u> – adverse, minor, long term effects	Construction – adverse, major, long term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank- ment obstruction to flow is mitigated)	Construction – adverse, minor, short term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embankment obstruction to flood flow
Importance	High – PWS; High quality (chemical and biological) Rivers Wensum, Bure, Tud and Yare	Moderate – PWS, but only GSPZ III potentially affected. High number of DCs. Maintenance of river flow important, but unlikely to be heavily impacted	High – SSSI; Fisheries; Ecology/biodiversity	High – SSSI; Fisheries; Ecology/biodiversity	Moderate – flood risk impacts on nearby upstream woodland, agricultural land, urban areas and other road crossings of River Tud
Sensitivity	High – major aquifer; environmentally sensitive local rivers	High – major aquifer; ecologically important rivers	High – GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	High– GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	Moderate – River Tud flood- plain crossed, but at relatively narrow point. Negligible effect on River
Baseline	Route crosses GSPZ III twice. Almost entire route lies in area of high GV. 64 gw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively). The variation has an extra 4 gw ALs	Route crosses GSPZ III twice. 8 gw DCs in study area. 64 gw ALs in study area. Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Route crosses environmentally sensitive Rivers Tud and Wensum (SSSI). 14 sw ALs in study area Environmentally sensitive Rivers Wensum and Tud have high BFIs (0.73 and 0.65 respectively)	Route crosses environmentally sensitive Rivers Tud (Q_{95} : 0.09 $m^3 s^{-1}$) and Wensum (Q_{95} : 1.28 $m^3 s^{-1}$) – constant flow maintains high quality, dilutes discharges and supports biodiversity and abstractions 9 sw DCs in study area 14 sw ALs in study area	Route crosses the floodplain of the River Tud (width at crossing: 185m) Floodplain modified to nil at crossing point of River Wensum because of existing features
Attri bute	Quality	Quantity	Quality	Conveyance of Flow	Conveyance of Flood Flows
Feat ure	Groui	nd-water	Surf	ace Water	Flood-plain

Table 5.11.15: Western brown route and brown variation impacts matrix

aseline Sensitivity Importance Impact	Sensitivity Importance Impact	Importance Impact	Impact	-	Description of impact	Magnit ude	Signifi cance
oute crosses GSPZ III once. High – major High – PWS; High <u>C</u> most entire route lies in area of aquifer; quality (chemical and m gh GV. 70 gw ALs in study environmentally biological) Rivers pr ea. Landfill site within 200 m of sensitive local Wensum, Bure, Tud el oposed route. Environmentally rivers and Yare – - sitive River Wensum has high trivers and Yare – - - 1 (0.73). The variation adds an trivers	High – major High – PWS; High – <u>C</u> aquifer; quality (chemical and m environmentally biological) Rivers pr sensitive local Wensum, Bure, Tud fe rivers and Yare – te	High – PWS; High <u>C</u> quality (chemical and m biological) Rivers pr Wensum, Bure, Tud et and Yare te	OIE T T T T T T T T T T T T T T T T T T T	onstruction - adverse lajor short term and otential long term ffects on gw and rivers ed by gw. <u>Operational</u> adverse minor long rm effects on gw and <i>jers</i> fed by gw	Construction - no gw protection from spillages and suspended solids (short term);excavation near landfill material can create new pathways for gw flow and pollutant leaching (long term). <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	Local to regional (if landfill containment	Moderate to substantial
oute crosses GSPZ III once High – major Moderate to low – 9 gw DCs in study area aquifer; PWS, but only GSPZ III 1 0 gw ALs in study area ecologically potentially affected; 6 1 gw ALs in study area ecologically potentially affected; 6 1 gw ALs in study area ecologically potentially affected; 6 1 out on the study area ecologically high no of DCs 8 nvironmentally sensitive River important rivers high no of DCs 8 ensum has high BFI (0.73) flow important, but 10 10 impacted unlikely to be heavily 10 10	High – major Moderate to low – aquifer; PWS, but only GSPZ III r ecologically potentially affected; e important rivers high no of DCs a Maintenance of river t flow important, but unlikely to be heavily impacted	Moderate to low – PWS, but only GSPZ III potentially affected; high no of DCs Maintenance of river flow important, but unlikely to be heavily impacted		Construction – adverse, minor, short term effects. <u>Operational</u> – adverse, minor, long erm effects	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions or PWSs if within GSPZs. Also discharges may require sufficient gw flow for dilution	Local to Regional (if rivers impacted)	Slight to Moderate
oute crosses environmentally High – GQA High – SSSI; Fisheries; Institive River Wensum (SSSI). (chemical and Ecology/biodiversity biological) as ALs in study area. biological) avironmentally sensitive River Grade A (very ensum has high BFI (0.73) good); Designation fisheries (details to be confirmed) to be confirmed)	High – GQA High – SSSI; Fisheries; I (chemical and Ecology/biodiversity biological) Grade A (very good); Desig- nated salmon fisheries (details to be confirmed)	High – SSSI; Fisheries; Ecology/biodiversity		<u>Construction</u> – adverse, major, short term effects. <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> (bridges/embankments/ general operations close to sw) - no sw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to rivers	Local	Slight
oute crosses environmentally ansitive River Wensum (Q ₉₆ : 28 m ³ s ⁻¹) - constant flow aintains high quality, dilutes scharges and supportsHigh – GQA (chemical and biological)High – SSSI; Fisheries; chemical and biological)28 m ³ s ⁻¹) - constant flow aintains high quality, dilutes scharges and supportsHigh – GQA (chemical and biological)High – SSSI; Fisheries; cology/biodiversity and biological)28 m ³ s ⁻¹) - constant flow aintains high quality, dilutes scharges and supportsBiological) Grade A (very good); Desig- nated salmon v DCs in study areaHigh – GQA to be confirmed)	High–GQA (chemical and biological) Grade A (very good); Desig- nated salmon fisheries; Ig Ecology/biodiversity Ecology/biodiversity Ecology/biodiversity fisheries; Ig Ecology/biodiversity fisheries; Ig Ecology/biodiversity fis	High – SSSI; Fisheries; 1 Ecology/biodiversity	0	<u>Construction</u> – adverse, major, long term effects. <u>Operational</u> – adverse, major, long erm effects (unless oridge/embank-ment obstruction to flow is mitigated)	<u>Construction</u> of bridges/road embank- ments may require temporary diversion of flow or operations within river – major obstruction to flow having long term effects on biodiversity and ecology and short term effects on quality and abstractions. <u>Operational</u> – minor effects on above if bridge/embankment obstruction to flow is mitigated with sufficient openings	Regional	Substantial
oodplain previously modified to Low – River Not applicable I at crossing point because of Wensum is a disting build up features major river, but modified floodplain results in low sensitivity	Low – River Not applicable Wensum is a major river, but modified floodplain results in low sensitivity	Not applicable		<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – negligible	Obstruction of flood flows by bridge/road embankment construction; increase to flood levels upstream of river crossing; loss of storage on flood plain; impact of additional runoff from new road; effects on local drainage system – could destroy habitats, farmland, buildings and structures	Local	Slight to Insignificant

Table 5.11.16: Western purple route and purple variation impacts matrix

Feat ure	Attri bute	Baseline	Sensitivity	Importance	Impact	Description of impact	Magnit ude	Signifi cance
Ground-v	Quality	Greater than half the route overlies GSPZ III and study area intersects 1 areas of GSPZ II. Entire route lies in area of high GV. 26 gw ALs in study area. Landfil lies within study area. Environmentally sensitive Rivers Bure and Yare have high BFIs (0.83 and 0.65, respectively)	High – major aquifer; environmentally sensitive local rivers	High – PWS; High quality (chemical and biological) Rivers Bure and Yare	<u>Construction</u> - adverse major short and potential long term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	Construction - no gw protection from spillages and suspended solids (short term); excavation near landfill material can create new pathways for gw flow and pollutant leaching (long term, although too far away to be a significant risk) <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	Local	Slight to Moderate (if GSPZ II affected)
vater	Quantity	Greater than half the route overlies GSPZ III and study area intersects 2 areas of GSPZ II 2 gw DCs in study area 26 gw ALs in study area Environmentally sensitive Rivers Bure and Yare have high BFIs (0.83 and 0.65, respectively)	High – major aquifer; ecologically important rivers	Moderate – PWS; few DCs; maintenance of river flow important, but unlikely to be heavily impacted	<u>Construction</u> – adverse, minor, short term effects <u>Operational</u> – adverse, minor, long term effects	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions, PWSs if within GSPZs and baseflow into rivers. Also discharges may require sufficient gw flow for dilution	Local to Regional (if rivers impacted)	Moderate
Surfac	Quality	No surface water features intersected by route or study area. 0 sw ALs in study area	Not applicable	Not applicable	None	Not applicable	None	In- significant
e Water	Conveyance of Flow	No surface water features intersected by route or study area. 0 sw DCs in study area. 0 sw ALs in study area	Not applicable	Not applicable	None	Not applicable	None	In- significant
Flood-plain	Conveyance of Flood Flow	Route does not cross any floodplains	Not applicable	Not applicable	None	Not applicable	None	In- significant

Table 5.11.17: Eastern pink route impacts matrix

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thern Distributor Route	
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Signifi cance	Substantial	Moderate	In- significant	In- significant	In- significant
Magnit ude	Regional	Local to Regional (if rivers impacted)	None	None	None
Description of impact	Construction - no gw protection from spillages and suspended solids (short term); excavation into and near or removal of landfill material can create new pathways for gw flow and pollutant leaching (long term). <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions, PWSs if within GSPZs and baseflow into rivers. Also discharges may require sufficient gw flow for dilution	Not applicable	Not applicable	Not applicable
Impact	<u>Construction</u> - adverse major short and long term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – adverse, minor, long term effects	None	None	None
Importance	High – PWS; High quality (chemical and biological) Rivers Bure and Yare	Moderate – PWS; few DCs; maintenance of river flow important, but unlikely to be heavily impacted	Not applicable	Not applicable	Not applicable
Sensitivity	High – major aquifer; environmentally sensitive local rivers	High – major aquifer; ecologically important rivers	Not applicable	Not applicable	Not applicable
Baseline	Greater than half the route overlies GSPZ III and study area intersects 2 areas of GSPZ II. Entire route lies in area of high GV. 32 gw ALs in study area. Route traverses a landfill site. Environmentally sensitive Rivers Bure and Yare have high BFIs (0.83 and 0.65, respectively)	Greater than half the route overlies GSPZ III and study area intersects 2 areas of GSPZ II. 2 gw DCs in study area. 32 gw ALs in study area. Environmentally sensitive Rivers Bure and Yare have high BFIs (0.83 and 0.65, respectively)	No surface water features intersected by route or study area 0 sw ALs in study area	No surface water features intersected by route or study area 0 sw DCs in study area, 0 sw ALs in study area	Route does not cross any floodplains
Attri bute	Quality	Quantity	Quality	Conveyance of Flow	Conveyance of Flood Flows
Feat ure	Ground	-water	Surfac	e Water	Flood-plain

Table 5.11.18: Eastern yellow route impacts matrix

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Signifi cance	Slight to Moderate (if GSPZ II affected)	Moderate	Insignificant for original blue route
Magnit ude	Local	Local to Regional (if rivers impacted)	Local
Description of impact	Construction - no gw protection from spillages and suspended solids (short term); excavation near landfill material can create new pathways for gw flow and pollutant leaching (long term, although too far away to be a significant risk). Operational – suspended solids and contaminants from accidental spillage and routine road runoff discharging to gw via soakaway	If base of road cuttings are below gw levels then gw flow will be intercepted, affecting nearby licensed/private abstractions, PWSs if within GSPZs and baseflow into rivers. Also discharges may require sufficient gw flow for dilution	<u>Construction</u> (bridges/embankments/ general operations close to sw) - no sw protection from spillages and suspended solids. <u>Operational</u> – suspended solids and contaminants from accidental spillage and routine road runoff discharging to rivers
Impact	<u>Construction</u> - adverse major short and potential long term effects on gw and rivers fed by gw. <u>Operational</u> – adverse minor long term effects on gw and rivers fed by gw	<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – adverse, minor, long term effects	<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – adverse, major, long term effects
Importance	High – PWS; High quality (chemical and biological) Rivers Bure and Yare	Moderate – PWS, but mostly only outer GSPZ potentially affected; few DCs; maintenance of river flow important, but unlikely to be heavily impacted	Low – minor tributaries
Sensitivity	High – major aquifer; environmentally sensitive local rivers	High – major aquifer; ecologically important rivers	High – minor tributaries ex- pected to have very low to no flow at certain times of year, rendering them very sensitive to quality changes
Baseline	Greater than half the route over- lies GSPZ III and study area inter- sects 2 areas of GSPZ II. Almost entire route lies in area of high GV. 26 gw ALs in study area. Landfill lies within study area. Environmentally sensitive Rivers Bure and Yare have high BFIs (0.83 and 0.65, respectively). Surface water features, small lakes close to the proposed route sourced from ground-water, water quality is sensitive	Greater than half the route over- lies GSPZ III and study area inter- sects 2 areas of GSPZ II. 2 gw DCs in study area. 26 gw ALs in study area. Environmentally sensitive Rivers Bure and Yare have high BFIs (0.83 and 0.65, respectively) Surface water features, small lakes close to the proposed route, abstraction in this area may be affected and groundwater flow disrupted	1 sw AL in study area Surface water features, small lakes close to the proposed route, water quality is sensitive
Attri bute	Quality	Quantity	Quality
Feat ure	Ground	water	Surface Water

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Signifi cance	Insignificant for original blue route	Insignificant for original blue route
Magnit ude	Local to regional (if River Bure impacted)	None for original blue route
Description of impact	<u>Construction</u> of bridges/road embank- ments may require temporary diversion of flow or operations within tributaries to River Bure – major obstruction to flow having long term effects on biodiversity and ecology and short term effects on quality, abstractions and discharges. <u>Operational</u> – minor effects on above factors if bridge/embankment obs- truction to flow is mitigated with sufficient openings	Obstruction of flood flows by bridges and road embankments; increase to flood levels upstream of river crossing; loss of storage on flood plain; impact of additional runoff from new road; effects on local drainage system – could destroy habitats, farmland, buildings and structures
Impact	<u>Construction</u> – adverse, major, long term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank- ment obstruction to flow is mitigated)	<u>Construction</u> – adverse, minor, short term effects. <u>Operational</u> – adverse, major, long term effects (unless bridge/embank- ment obstruction to flood flow is mitigated)
Importance	High – High quality; Fisheries; Ecology/biodiversity	High – flood risk impacts on nearby upstream woodland, agricultural land, urban areas and other road crossings
Sensitivity	High– Environmentally sensitive River Bure	High – affecting River Bure
Baseline	2 sw DCs in study area, many sw DCs in River Bure (outside defined study area). 1 sw ALs in study area	Route alternatives cross floodplains of tributaries to River Bure (outside defined study area). Original route does not cross any floodplains
Attri bute	Conveyance of Flow	Conveyance of Flood Flows
Feat ure		Flood-plain

5.11.4 Mitigation Measures

The following mitigation actions and systems are widely used for the reduction and control of pollution from road surface runoff to surface water and groundwater and are meant for guidance purposes only. Each route will require specific plans once they have been finalised and detailed surface water and groundwater assessments have been completed.

Following the Stage 2 assessments, a number of the western routes have been assessed to have potentially significant impacts on local flooding characteristics which will require separate mitigation planning.

The introduction of the road and associated drainage system will cause localised changes in sub-surface flows and recharge, but, in terms of the aquifer as a whole and the major receiving watercourses, these would not be significant.

The new carriageway will probably be drained by a system of surface water channels, carrier drains and swales. A number of detention/retention ponds are expected to be created. These should deal with runoff by means of infiltration and will provide a means of volume and pollution control.

(i) *Pollutant mitigation*

Pollution prevention measures should reduce the amount of pollutants reaching the final outfall point and the water body receiving the road runoff. Table 5.11.20 summarises the 'treatment' functions of the possible pollution prevention measures.

Measure	Function
Pollution Shut- off Valve	To enable spillages from accidents or fire wash water to be contained and prevented from entering the discharge facility
Petrol interceptor	Captures insoluble hydrocarbons, pollutants in first flush of rainfall events and minor spillages
Infiltration pond, to include	Provides storage of runoff to allow control of discharge and so prevent flooding
vegetative treatment	Reduces suspended solid concentrations through settlement and entrapment in vegetation.
Retention pond, to include vegetative treatment	Vegetative treatment captures hydrocarbon pollutants, reduces the concentrations of dissolved metals (such as copper and cadmium) through adsorption and uptake and reduces nutrients through uptake
Soakaway	Captures suspended solids and associated insoluble pollutants
Unsaturated zone of aquifer	Additional removal of dissolved pollutants
Receiving watercourse (for discharges to surface water)	Dilution of concentration in receiving water course (taken as zero in this scheme as streams are frequently dry in summer months)

Table 5.11.20: Function of Pollution Prevention Measures

Recent research has shown that interceptors are not very efficient at retaining either the soluble or particulate phase of highway runoff from normal runoff. However, petrol interceptors provide an important function when spillages occur. The pollution control points would allow discharge networks to be isolated but someone has to activate these. In the absence of petrol interceptors there is a risk that spillages could get through into the environment more easily. Petrol interceptors provide storage and the ability to intercept free phase liquids in the event of large spillages until the pollution control point is activated. It is for this reason that petrol interceptors should be included in the conceptual designs of the drainage networks. The effectiveness of petrol interceptors and the possibility of using alternatives will be considered in the detailed design phase.

(ii) Intercepted runoff mitigation

The design of the proposed carriageway drainage system would be based on the recommendation indicated in the Design Manual for Roads and Bridges (DMRB) and the requirements of the Environment Agency. The detention ponds will thus accommodate the increased runoff resulting from the replacement of agricultural land (or woodland, etc) by the impervious carriageway surface. Any outflow from the ponds to the surface water system will be controlled to an agreed "greenfield" runoff rate for rainfall events up to a 100-year return period. In the event of more severe rainfall there could be additional spillage from the ponds, though with freeboard allowances the effective return period may be more than 100 years. The design will consider the likely flow paths for such excess flow and the impact this may cause.

The volumes of water expected to run off from each of the drainage networks during different design rainfall return periods should be calculated using 'Micro Drainage'. This programme is an industry standard software for calculating road runoff volumes, and uses catchment characteristics as defined by the Flood Estimation Handbook (FEH). The volumes of surface runoff are calculated for the required design rainfall return period for a variety of rainfall storm durations. The largest volumes predicted by the calculations at the design rainfall return period specify the storage requirements.

Where the natural lie of the land slopes towards the road, drainage would have to be provided to prevent this run-off flooding the road. This would be collected in cut-off drains at the top and bottom of cuttings and embankments. This is natural run-off from the land. As such it would not require treatment or attenuation.

(iii) Floodplain interference mitigation

In this area the design of the road will have to ensure that there is no interference with the floodplain, or that appropriate compensating measures are taken. (Further guidance is available in the Highways Agency Design Manual for Roads and Bridges Volume 4, Section 2, Part 1 HA 71/95 'The Effects of Highway Construction on Floodplains'.)

In general a route which crosses the floodplain at a narrower section rather than at one of the areas of more extensive flooding would be preferable. A route which crosses the floodplain perpendicular to the direction of floodplain flow will also minimise the area of floodplain directly affected.

At each river crossing it will be necessary to provide sufficient capacity in the bridge opening for the design flood event, this can most effectively be achieved through the construction of viaducts. Where this is not possible it will be

necessary to design in flood culverts in locations where there will be significant floodplain flow in order to prevent a rise in flood levels upstream. Discussions will need to be held with the Environment Agency to assess their requirements on the acceptable level of afflux (rise in upstream water levels). This might vary according to the upstream conditions, for example it is likely that more afflux will be tolerated where the area upstream of the crossing is rural than when it is built up and residential.

The Environment Agency will also indicate whether there will be any need for compensatory floodplain storage to account for storage lost through construction of embankments and bridge/ viaduct piers in the floodplain. If this is requested it is usually required to be as close as possible to the proposed crossing and to have a similar volume/elevation relationship to the storage lost to construction. The availability of suitable sites for such storage should be a consideration during the route selection process.

Due to its alignment within the floodplain the green route would require the greatest area of compensatory land, in this case there is scope for providing land been the meanders in the river, subject to ecological constraints. Where as for the orange route this is more difficult as the surrounding land is composed mainly of woodland.

The selection of a bridge with embankments is likely to cause the greatest restriction to floodplain flows and reductions in floodplain storage. A viaduct will have less influence on both the flow volume and storage in the floodplain and so, in terms of flood risk alone, would be the preferred option. The Environment Agency have advised that any road crossing the floodplain of the rivers Wensum and/or Tud should be constructed as a viaduct in order to minimise the impacts on flood storage/conveyance.

Where existing watercourses or drains are crossed design measures should ensure that either a suitable flow path is provided or that the drain is diverted to an alternative route to the satisfaction of all parties involved to avoid causing localised flood problems.

(iv) Sustainable Drainage Options

The introduction of Sustainable Drainage Systems (SuDS) is widely encouraged by the Environment Agency to retain or detain storm flows as appropriate. By the use of SuDS, storm flows are temporarily or permanently taken out of the surface water circulation and hence help to manage flooding. An additional benefit is the containment, and to some extent treatment, of pollution (see Design Manual for Roads and Bridges, Environmental Assessment, Highways Agency 1995), thus ensuring that surface and groundwater in the area is not polluted. The following sections discuss some of the common options available.

(v) Filter Drains

Road-side drainage on many UK highways comprises filter drains which detain water as well as providing very effective filtering out of pollutants, in particular suspended solids, lead, zinc and oil (70-85% annually). The drain can serve as a soakaway as well as a conveyance channel. However, if accidental spillage is deemed a risk these drains can be made impermeable, thus avoiding any percolation into the ground.

(vi) Permavoid Systems

Permavoid systems are often combined with permeable paving or roadside drainage. Open voids are provided under permeable paving or under a filter drain running adjacent to the roadway. In this way the strata above the voids serves as a suitable filter, while the underlying voids provide for valuable detention of storm water. The system allows for percolation of water into the underlying ground, or as for the filter drains, percolation to the ground can be avoided.

(vii) Sedimentation Lagoons and Channels

Sedimentation lagoons provide detention of flood flows to allow settlement of suspended solids and removal of a large part of the main pollutants. The lagoon should be offstream of any contributing catchment, to ensure that settled solids are not subsequently washed away. Sedimentation lagoons can take various shapes including road-side excavations from borrow areas or long stretched out shallow ponds/channels with aquatic plants, which further contribute to filtering out any pollutants. The key to successful sedimentation lagoons is the flow velocity, which has to be low enough to encourage the deposition of sediments.

(viii) Balancing Ponds

Balancing ponds provide detention of flood volumes generated due to the increased impermeable area generated by the development. Typically these ponds are areas taken up in the landscaping and are unobtrusive. Outflow from balancing ponds is via a hydro break, which regulates outflow to an agreed 'greenfield' runoff. As for the sedimentation lagoons, balancing ponds should only pass flows from the development (i.e. road), which need to be balanced.

Where the underlying soils are permeable, it is likely that the balancing pond will also serve as a soakaway, allowing percolation into the ground.

Balancing ponds also provide some treatment capacity but perform significantly less well than filter drains, filtration basins and sedimentation lagoons. There may however be scope for combining sedimentation and balancing to make the scheme more cost effective.



Reed-beds as part of a balancing lagoon to filter out sediment and suspended solids.

(ix) Drainage Selection

The selection of appropriate drainage solutions for each respective section of the Northern Distributor Road depends on the vertical route alignments, topography, ground conditions, land availability, impact on the downstream catchment, extent of pollution control required, through life costs and general environmental impact of the proposed solution.

The specific details of the pollution prevention measures will be confirmed and developed in the detailed design phase, and shall take into consideration the recommendations made in the Highways Agency note HA103/01 "Vegetative treatment systems for highway run off", BRE Digest 365 "Soakaway Design" and CIRIA Report 142 "Control of pollution from highway drainage discharge", as well as the recommendations made from the water quality assessment.

Runoff volumes and pollutants can however be minimised by the use of filter drains or swales, where appropriate. Subject to environmental restrictions imposed, sedimentation lagoons may be included and where possible integrated into the retention lagoons. Any lagoon with a discharge to surface water will be provided with a hydro-break to maximise the outflow from the lagoon to the Environment Agency approved flow. However, it is expected that all lagoons will be designed for infiltration, and that there would be no discharge to surface water unless the 100-year design standard is exceeded. Selected areas of hard-standing may be fitted with permavoid systems, providing additional in-line storage and thus reducing lagoon sizes and areas. The size of the lagoons depends on the achievable depth of live storage and the desirability of integrating the drainage provisions into the local landscaping.

Particular care should be taken to ensure that the proposed drainage system does not cause adverse drainage problems within the downstream catchment.

5.11.5 Conclusions and Recommendations

(i) Conclusions

All the proposed western routes have substantial potential impacts on surface waters and/or groundwater.

A comparison of the western routes reveals the purple variation is the most preferable, largely on account of its lack of impact on flood risk but also as part of the route uses existing roads. The purple route is, however, the longest route and cuts through a long area of countryside, which makes it less favourable in general terms.

The green route is probably the least favoured option for the western route. It entails four floodplain crossings, of which at least three are on the River Tud, although these are all at narrow points of the floodplains. It is a short route, cutting across areas which have already been affected by urban development, although approximately 50% of the route lies just within a source protection zone (III),. if the green route is selected serious consideration must, however be made of the close proximity of the route to the landfill site at its southern extent and whether its containment properties are likely to be disrupted during construction.

In terms of water impacts, the pink route is the best option for the eastern section of the NDR. The yellow route crosses a closed landfill site and the blue route indirectly impacts on the surface water feature 'The Springs'.

The specific details of the pollution prevention measures will be confirmed and developed in the detailed design phase, and shall take into consideration the recommendations made in the Highways Agency note HA103/01 "Vegetative treatment systems for highway run off", BRE Digest 365 "Soakaway Design" and CIRIA Report 142 "Control of pollution from highway drainage discharge", as well as the recommendations made from the water quality assessment.

Particular care should be taken to ensure that the proposed drainage system does not cause adverse drainage problems within the downstream catchment. Also the design of the road will have to ensure that there is no interference with the flood plain, or that appropriate compensating measures are taken.

(ii) Recommendation for Further Surveys Required

Water quality

Sampling and analysis of stream and spring flows to test for a range of inorganic and organic chemical parameters including potential pollutants and the review of water quality data held by the Environment Agency.

Drainage and hydrology

Recording of water levels from piezometers installed during the ground investigations;

- Review of results of permeability and infiltration tests undertaken as part of the ground investigations;
- An approximate indication of the current levels and variations in spring discharges.

(iii) Further data collection

Data currently available to the assessment have been sufficient to estimate approximate baseline conditions, however a more accurate baseline would need to be established from which impacts can be assessed at Stage 3. The following are major constraints of the data:

Existing monitoring sites are positioned to assess the quality of the river as a whole and are not focused on likely areas of impact from the proposed scheme

Data is not available for the tributary of the River Yare flowing across the southeast of the eastern Study area

A broad enough suite of chemical determinants has not been monitored to effectively assess impacts from the proposed scheme.

Due to these constraints and in order to obtain sufficient baseline information for the Stage 3 assessment of impacts, a baseline data collection strategy has been developed for water quality. In order to focus the baseline information on relevant impacts, monitoring locations will be selected to sample:

- Surface water downstream of proposed road runoff outfalls to surface water features, for the route options chosen
- Surface water downstream of watercourse crossing points or locations where the route may pass very close to a watercourse

- Groundwater from springs or boreholes which are located close to or down gradient of proposed road runoff soakaways
- Groundwater from springs or boreholes which are located close to or down gradient of the chosen routes

Precise monitoring locations are to be determined on development of a preferred route and drainage design. Two reconnaissance site visits, one during spring and one during autumn (i.e. at the wettest and driest times of year) will be necessary to identify suitable surface water and groundwater monitoring points. Flow must be inspected and access assessed for the surface watercourses which will be discharged into, crossed or in close proximity to the eastern and western routes chosen. It is estimated that around five surface water monitoring points would be appropriate. This number is dependent on the routes and how many runoff outfalls to surface water are proposed. Groundwater monitoring points will also be identified during the reconnaissance visits. It is anticipated that up to fifteen boreholes or springs should be monitored. This number is again dependent on the routes and drainage designs, but also on permission from landowners and access. All sites will be considered and rationalised individually.

Sampling is recommended on a monthly basis, with on site measurements and analyses for a basic suite of determinands to be carried out every month and analyses for a more extensive suite of chemical determinands to be carried out every quarter. This monitoring programme should run for a minimum period of a year in order to identify seasonal fluctuations in water quality associated with the volume of flow. Thus monthly flow measurements or estimates should be made at each surface water monitoring point and groundwater levels dipped in each borehole, during each monthly monitoring round. General site observations of weather conditions and aesthetics should also be made.

5.12 Geology and Soils

5.11.1 Introduction and Methodology

For its size, the UK has the most varied geology in the world. Soils and geology play an important part in determining the environmental character of an area. The nature and alignment of the rocks has a major influence on the landform. Rocks provide the parent material from which the soils are created and, through their constitution and chemistry, they influence the rate at which soils are formed. Soil chemistry and structure strongly influence the type of vegetation which occurs naturally in an area. The soil will also have a considerable influence on the types of agricultural and horticultural practices an area can support.

Road schemes can have an impact on both the geology and the soils of an area. It is therefore important that the potential impacts of development on both the soil and the underlying rocks are fully considered. The converse also applies in that existing soil conditions of a site can impose constraints on a proposed development for example, where land which has been contaminated by wastes from some previous industrial use.

In this assessment, three aspects are identified:

- The geology and soils of the area.
- Any potentially polluted areas
- Mineral and Waste Areas.

5.12.2 Baseline Conditions

Plans showing details of surface geology are shown in Part 3 of this report. The Norwich area is underlain by Cretaceous Upper Chalk beds up to 200m thick, which dip gently eastward. These beds are mostly covered by Pleistocene and Recent deposits. These deposits lie unconformably (i.e. they are no longer in their original sequence of deposition) on the Chalk surface, which is generally exposed in the river valleys.

The oldest Pleistocene formation is the Norwich Crag, extensive to the east but gradually disappearing to the west of Costessey. The Crag comprises interbedded sands and gravels with occasional lenticular clays. To the north of the River Wensum, crag is overlain by Corton Till comprising glacial deposits of intercalated, mainly unbedded clays and loamy sands. South of the Wensum, Corton Till is absent and Lowestoft Till lies directly on either the Chalk surface or the Crag. The Lowestoft Till extends north-west by Easton and Weston Longville.

Glacial Sands and Gravels occur as masses below, within and above the Lowestoft Till. These sands and gravels are extensive around the city area and are commonly up to 10m thick within the river valleys. Valley Gravels occur sporadically, with recent alluvium, mainly silty or fine sand, occupying the valley centres and the recent river terraces.

Catton Grove Chalk Pit, just south of Mousehold Heath (see Figure 11), is a Site of Special Scientific Interest (SSSI), notable for its Upper Chalk Catton Sponge Bed. This represents an important marker band in the chalk, the rare chalk exposure at the site revealing well preserved fauna (ammonites and numerous undefined sponges) in an early diagenetic hardground. However the site is remote from any of the route corridors and is unlikely to be affected by road development.

Away from the Wensum river valley, soils are sandy, or sand and coarse loamy, generally well drained and with a few stones. Water logging may occur where water tables are high. Soil associations (Soil Survey of England and Wales; Soils of Eastern England) are 541a (Bearsted 1) to the north-east. To the north the associations are 551e (Newport 2), 821c, 861a and 711a. To the north-west the associations are 551b, 551c, 572a and 861c. Along parts of the Wensum valley soils are silty and clayey, possibly with humus layering and a high water table, and are described as type 1024a (Adventurers 1).

Groundwater is known to occur in the superficial deposits, in the older Pleistocene deposits (Crag) and in the underlying Upper Chalk. As identified in the preceding section on water quality, the Upper Chalk bed is a major aquifer, comprising a soft white fine-grained Limestone with bands of flint nodules. Groundwater storage and flow occurs through the development of joints, fissures and along bedding planes. Fissure development is greatest in valleys and in the zone of water level fluctuation. To the south and west the Chalk groundwater may be confined by the Lowestoft Till which is absent in the north. The overlying sands and gravels of the Crag are defined as a minor aquifer, although this is largely due to their limited thickness and extent, rather than poor aquifer properties. The Crag may be highly permeable and is generally in hydraulic continuity with the underlying Chalk. Glacial Sands and gravels and River Terrace Gravels also comprise minor aquifers and may also be in hydraulic continuity with the Chalk below.

Apart from the Corton Till to the north of the area and the Lowestoft Till to the south and west, large areas of the surface are covered by relatively permeable deposits, allowing rapid infiltration to the underlying Chalk.

There are potentially polluted areas affecting the route options are at:

- The 'north of the Tud' development area, west of Costessey
- Marriotts Way former railway line
- Airfield west of Horsford
- Norwich Airport
- Norwich to Cromer railway line
- Broadland Business Park.

Landfill sites are found in the following locations:

- Longwater (active)
- Attlebridge Hills (active)
- Paine's Yard (closed)
- East of Dussindale (closed)

Mineral and waste consultation zones are located around the landfill sites at:

- Longwater
- Attlebridge Hills

Permitted waste and mineral sites are located at:

- Longwater
- North of the Tud development, west of Costessey
- Western Ringland
- Attlebridge Hills
- Mileplain Plantation
- North-east of Norwich Airport
- Area between A1151 and Salhouse Road

Norfolk County Council mineral plan consultation areas affecting the route options are:

- South-east of Weston Longville
- Airfield west of Horsford
- West and north of Horsford Manor
- North-east of Norwich Airport
- West of White House Farm

5.11.3 Assessment of Impacts

(i) Western Green

Geology

The green route crosses glacial sand and gravel, alluvium or terrace deposits, Corton Till and chalk. There would be negligible impact on these deposits. However, there is potential for voids within the chalk although they are not known to exist in this area.

The crossings of the Rivers Tud and Wensum have the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

The green route crosses Marriott's Way, which is a disused railway bed and as such, is designated as a potentially polluted area.

Mineral and Waste Areas

The southern end of the green route crosses Costessey active minerals site. Adjacent to this site is a local waste plan consultation zone. The route passes through part of this zone.

The eastern end of the green route passes through a mineral plan consultation area, west of the A140.

(ii) Western Orange

Geology

The orange route crosses glacial sand and gravel, alluvium or terrace deposits, Corton Till and crag. There would be negligible impact on these deposits. It also crosses chalk and made ground. There is potential for voids within the chalk although they are not known to exist in this area. There is potential for contaminated soils and settlement within the made ground.

The crossings of the Rivers Tud and Wensum have the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

The orange route crosses Marriott's Way which is a disused railway bed and as such, is designated as a potentially polluted area.

Mineral and Waste Areas

The southern end of the orange route crosses Costessey active landfill site. A northern extension of the active site forms a permitted minerals and waste site.

To the north of the River Tud the link also clips the corner of a second permitted minerals and waste site.

The eastern end of the orange route passes through a minerals plan consultation area, west of the A140.

(iii) Western Blue

Geology

The blue route crosses glacial sand and gravel, Lowestoft Till, alluvium or terrace deposits, Corton Till and crag. There would be negligible impact on these deposits. It also crosses chalk. There is potential for voids within the chalk although they are not known to exist in this area.

The crossings of the Rivers Tud and Wensum have the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

The blue route crosses Marriott's Way which is a disused railway bed and as such, is designated as a potentially polluted area.

Mineral and Waste Areas

The eastern end of the blue route passes through a minerals plan consultation area, west of the A140.

(iv) Western Red

Geology

The red route crosses glacial sand and gravel, Lowestoft Till, alluvium or terrace deposits, Corton Till and crag. There would be negligible impact on these deposits. It also crosses chalk. There is potential for voids within the chalk although they are not known to exist in this area.

The crossings of the Rivers Tud and Wensum have the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

The red route crosses Marriott's Way which is a disused railway bed and as such, is designated as a potentially polluted area.

Mineral and Waste Areas

The eastern end of the red route passes through a minerals plan consultation area, west of the A140.

(v) Western Brown

Geology

The brown route crosses glacial sand and gravel, Lowestoft Till, alluvium or terrace deposits, Corton Till and Crag. There would be negligible impact on these deposits. It also crosses chalk. There is potential for voids within the chalk although they are not known to exist in this area.

The crossings of the Rivers Tud and Wensum have the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

The brown route crosses Marriott's Way which is a disused railway bed and as such, is designated as a potentially polluted area.

Mineral and Waste Areas

The eastern end of the brown route passes through a minerals plan consultation area, west of the A140. It also runs through a permitted mineral and waste site at Weston Longville and adjacent to one north of Reepham Road.

(vi) Western Purple

Geology

The purple route crosses glacial sand and gravel, Lowestoft Till, alluvium or terrace deposits, Corton Till and Crag. There would be negligible impact on these deposits. It also crosses chalk. There is potential for voids within the chalk although they are not known to exist in this area.

The crossing of the River Wensum has the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

This section crosses Marriott's Way which is a disused railway bed and is designated a potentially polluted area.

Mineral and Waste Areas

The eastern end of the brown route passes through a minerals plan consultation area, west of the A140. It also runs through a permitted mineral and waste site at Weston Longville and adjacent to one north of Reepham Road.

(vii) Western Brown Variation

Geology

The brown variation crosses glacial sand and gravel, Lowestoft Till, alluvium or terrace deposits, Corton Till and Crag. There would be negligible impact on these deposits. It also crosses chalk. There is potential for voids within the chalk although they are not known to exist in this area.

The crossings of the Rivers Tud and Wensum have the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

The brown variation crosses Marriott's Way which is a disused railway bed and as such, is designated as a potentially polluted area. The section which follows the existing A1067 is immediately south and downhill of an active landfill site.

Mineral and Waste Areas

The eastern end of the brown variation passes through a minerals plan consultation area, west of the A140. It also runs through a permitted mineral

and waste site at Weston Longville and adjacent to a waste consultation zone north of the A1067.

(viii) Western Purple Variation

Geology

The purple variation crosses glacial sand and gravel, Lowestoft Till, alluvium or terrace deposits, Corton Till and Crag. There would be negligible impact on these deposits. It also crosses chalk. There is potential for voids within the chalk although they are not known to exist in this area.

The crossing of the River Wensum has the potential to affect the hydrogeology. If the crossings are built on embankments across the alluvium and terrace deposits, problems with settlement may also be encountered.

Contaminated Land

The purple variation crosses Marriott's Way which is a disused railway bed and as such, is designated as a potentially polluted area. The section which follows the existing A1067 is immediately south and downhill of an active landfill site.

Mineral and Waste Areas

The eastern end of the purple variation passes through a minerals plan consultation area, west of the A140. It also runs through a permitted mineral and waste site at Weston Longville and adjacent to a waste consultation zone north of the A1067.

(ix) Eastern Pink

Geology

The pink route crosses glacial sand and gravel, Corton Till, Lowestoft Till and Crag. These will have little impact.

Contaminated Land

The pink route passes close to Norwich Airport which is designated a potentially polluted site. It also crosses an active railway line and as such, is designated as a potentially polluted area.

Mineral and Waste Areas

The pink route clips a permitted mineral and waste site to the east of the airport, and an additional site north-east of Sprowston. Between the B1150 Wroxham Road and Salhouse road the route crosses two minerals plan consultation areas.

(x) Eastern Yellow

Geology

The yellow route crosses glacial sand and gravel, Corton Till, Lowestoft Till and Crag. These will have little impact.

Contaminated Land

The route passes close to Norwich Airport which is designated a potentially polluted site. East of Thorpe End, it also crosses an active railway line and as such, is designated as a potentially polluted area. Between the B1150 Wroxham Road and Salhouse Road, the yellow route passes through a closed landfill site.

Mineral and Waste Areas

The yellow route clips a permitted mineral and waste site to the east of the airport. Between the B1151 Wroxham Road and Salhouse road the route crosses two minerals plan consultation areas.

(xi) Eastern Blue

Geology

The blue route crosses glacial sand and gravel, Corton Till, Lowestoft Till and Crag. These will have little impact.

Close to Wroxham Road the route crosses a tributary of the River Bure. The hydrogeology of this area is particularly sensitive, construction of the road needs to consider these impacts.

Contaminated Land

The route passes close to Norwich Airport which is designated a potentially polluted site. East of Thorpe End, it also crosses an active railway line and as such, is designated as a potentially polluted area.

Mineral and Waste Areas

The blue route clips a permitted mineral and waste site to the east of the airport.

5.11.4 <u>Mitigation Measures</u>

Suggested mitigation measures for affected routes consist of the following :-

- Hazards associated with potentially polluted ground should be assessed.
- Consideration would need to be given to the realignment of routes where landfill sites and other areas of potentially polluted sites exist. Alternatively, in-situ treatment of contaminated land could be considered if sufficient land is available. Any alternative measures need to consider the possible hazards of gaseous emissions and leachates.
- Crossing river the Wensum and Tud floodplains on a viaduct may reduce the impacts.
- Mineral Plan Consultation and Investigation areas may be avoided by realigning the appropriate part of the route.
- If the preferred route impinges on the potentially contaminated ground at Marriott's Way further assessment of the possible hazards in this area would be required.
- Consideration should be given to the storage of materials including topsoil on site during construction. Appropriate measures should be taken by the Contractor to minimise compaction of materials, and also minimise import of materials from outside the local environment.

5.11.5 Conclusions and Recommendations

A detailed ground investigation survey should be carried out at the start of the Stage 3 detailed design in order to inform the design process. This will assist in determining possible contaminants along the preferred route corridor, and in addition will allow confirmation of embankment and cutting slope angles, which will in turn help determine land take. Ground investigation would also assist in determining suitability of soils, which would assist in determining earthworks balances for accurate costing of the preferred route. Any unsuitable material could be used for earthworks, rather than transporting offsite for disposal.

5.13 **Policies and Plans**

5.13.1 Introduction and Methodology

The development plan system provides the basis on which decisions about the development and use of land are made. Development plans are prepared by local planning authorities within the framework of national policies and regional and any strategic planning guidance.

In this section the NDR is assessed in terms of the wider context of national, regional, strategic and detailed planning **policies**. There are important interactions between transport and land use policy. It is therefore important to assess the impact of a proposed road scheme on land-use policies and proposals at all levels of the planning process.

5.13.2 Baseline Conditions

(i) *Planning guidance*

National guidance has, since 1988, been provided by the Government through Planning Policy Guidance notes (PPGs) and Minerals Policy Guidance notes (MPGs). More recently, Government has stated its commitment to replacing Planning Policy Guidance Notes by Planning Policy Statements. As part of its review of the planning system, it is giving priority to replacing with PPSs those PPGs which are most crucial to the reform of the planning system. The review and replacement of other Planning Policy Guidance notes will only take place as and when necessary in the light of their policy and strategic significance. In the meantime, the current PPG will remain in place.

Further national guidance is provided in documents such as the Rural & Urban White Papers (November 2000).

Regional Planning Guidance (RPG) for the Norwich area is currently provided by RPG6 "Regional Planning Guidance for East Anglia", which covers the counties of Cambridgeshire, Norfolk and Suffolk. New Regional Planning Guidance (RPG14) for the new East of England Region (covering the counties of Norfolk, Cambridgeshire, Suffolk, Essex, Hertfordshire and Bedfordshire) is being prepared. This is referred to as the Regional Spatial Strategy for the East of England (RSS14). It covers planning and transport policies up to 2021. Draft RSS has been 'banked' with the Secretary of State; there will be consultation on this in late 2004/ early 2005, with adoption expected in early 2006.

Strategic planning guidance at the County level is currently provided by the Norfolk County Council Structure Plan, which was adopted in October 1999. New developments and broad development constraints are identified in the Plan, within the framework of national and regional planning guidance. It includes a section of policies for the Norwich Policy area, recognising a need to plan for the growth of the City as close to its present boundaries as possible.

Planning Policy in the Norwich area is the responsibility of four planning authorities: Norfolk County Council at the strategic level, and Norwich City Council, Broadland District Council and South Norfolk District Council at the local level. The regional context for panning policy is set out in Regional Planning Guidance / Regional Spatial Strategy.

(ii) *Planning Constraints*

Statutory designations restricting or constraining development are listed below:

- Special Areas of Conservation (SAC) (to conserve species and their habitats)
- Conservation Areas (to protect areas of special architectural or historic interest)
- Listed Buildings (to protect buildings of special architectural or historic interest)
- Tree Preservation Orders (TPOs) (to protect trees of special importance)
- Sites of Special Scientific Interest (SSSIs) (to protect ecologically sensitive areas)
- Areas of High Landscape Quality (to protect areas of High landscape value)
- Historic Parklands (to protect historic parklands associated with large country houses)
- Wensum valley project (to protect the landscape character, wildlife and recreational value of the Wensum Valley area)

Committed Developments and Proposals also represent further constraints. Within the study area there are a number of sites proposed for comprehensive development. These sites are at various stages of implementation as follows:

- Local plan allocation. 2 housing allocations are adjacent to possible links; North of the River Tud (Longwater); Lodge Farm (Dereham Road) which one possible link would sever.
- *Planning application submitted*. None
- *Planning permission*. 2 housing allocations are adjacent to possible links, being; White Woman Lane (Old Catton); and Home Farm (Sprowston).
- *Implementation*. Broadland Business Park and Longwater Park are now being implemented and are directly affected by possible links.

Amendments to the boundary of proposed development sites would be necessary to accommodate routes.

5.12.3 Assessment of Impacts

The local and regional policies which are affected by an NDR are set out in full in Appendix J.

In general, the higher tiers of land use policies apply to the NDR as a whole, rather than distinguishing between the options. However, the more local policies, such as those relating to sites with specific environmental designations will be affected by some route options more than others.

(i) Regional Planning Guidance – RPG16

An NDR would support the vision of maintaining and improving economic opportunities but there is possible conflict with protecting and enhancing the environment. The individual policies within RPG16 which relate to an NDR are:

• <u>Policy 1 Urban renaissance</u>: NDR would enhance Norwich urban area by taking traffic out and providing the opportunity to implement measures such as removing through traffic from the city centre
- <u>Policy 13 Town centres and retail development</u>: NDR would enhance Norwich urban area by taking traffic out and providing the opportunity to implement measures such as removing through traffic from the city centre
- <u>Policy 16</u>: NDR would enhance Norwich urban area by taking traffic out and providing the opportunity to implement measures such as removing through traffic from the city centre. Possible conflict with protection of attractive areas around the periphery of the built up area. NDR will provide improved surface access to airport.
- <u>Policy 31 Reducing the impact of transport on the environment</u>: Policy conflicts with promoting new transport projects only where they respect the countryside, valued landscapes, natural habitats and mineral resources
- <u>Policy 37 General management principles for conserving and enhancing</u> <u>the natural, built and historic environment</u>: NDR conflicts with many clauses of this policy but supports others in relation to the built and historic environment within the city centre.
- <u>Policy 38 Protection of designated areas</u>: Conflict where NDR affects sites
- <u>Policy 39 Local environmental designations</u>: Conflict where NDR affects sites
- Policy 42 Safeguarding and creating habitats: Conflict where NDR affects habitats
- <u>Policy 53 Protection of water resources</u>: Potential conflict but can be mitigated.

(ii) Draft Regional Spatial Strategy

The NDR is included in the Draft Regional Spatial Strategy as a Regional Transport Scheme. Individual policies within the Draft Regional Spatial Strategy which relate to an NDR are:

- <u>Policy SS1 Achieving Sustainable Development</u>: NDR supports development in or adjacent to major urban areas where there is good public transport accessibility and where strategic networks (rail, road, bus) connect. NDR can also help deliver an urban renaissance by allowing through traffic to be removed from city centre
- Policy SS2 Overall Approach To The Spatial Strategy: NDR facilitates development in Norwich
- Policy SS6 Transport Strategy: NDR supports improved public transport facilities
- Policy SS8 Land In The Urban Fringe: Conflict with enhancing biodiversity
- Policy NSR4 Housing: NDR facilitates housing in Broadland fringe
- Policy NSR5 Transport Infrastructure: NDR identified as priority
- <u>Policy NSR6 Environmental Assets</u>: Conflict with the protection and enhancement of the environmental assets
- <u>Policy H1 Distribution Of Dwelling Provision 2001-2021</u>: NDR facilitates housing development in Broadland fringe
- <u>Policy T1 Regional Transport Strategy Objectives</u>: NDR supports development proposed in spatial strategy (clause 2) but there is conflict with clause 5 (minimising environmental impact)
- Policy T5 Airports: NDR supports access to Norwich airport
- <u>Policy T10 Sub-Regional Transport</u>: NDR supports development in Norwich growth area
- Policy T11 Environment And Safety: Conflict with minimising environmental impact

- Policy ENV3 Biodiversity And Earth Heritage: Conflict
- <u>Policy ENV4 Woodlands</u>: Conflict if NDR route crosses ancient woodland
- <u>Policy ENV5 The Historic Environment</u>: Conflict where NDR impacts on listed buildings, but will enhance the internationally renowned historic city of Norwich
- <u>Policy ENV7 Air Quality</u>: NDR would result in overall benefit in air quality

(iii) Norfolk Structure Plan – October 1999

The individual policies within the Norfolk Structure Plan which relate to an NDR are:

- <u>Policy CS.1</u>: NDR supports clauses (ii), (iii), (vi). In conflict with (i) and (ix)
- <u>Policy CS.2</u>: NDR supports new housing in Norwich area
- Policy EC.1: NDR helps to facilitate economic growth in Norwich area
- <u>Policy ENV.1</u>: General conflict due to environmental costs of scheme, although some mitigation may be possible.
- <u>Policy ENV.3</u>: Conflict river valleys/woodland etc although some mitigation may be possible.
- <u>Policy ENV.4</u>: Possible conflict affect areas other than 'special protection' areas although some mitigation may be possible.
- <u>Policy ENV.6</u>: Conflict routes may affect Special Protection Areas or Special Areas of Conservation – although some mitigation may be possible.
- <u>Policy ENV.7</u>: Conflict National Nature Reserves and SSSI although some mitigation may be possible.
- <u>Policy ENV.8</u>: Conflict need justify affect on conservation areas etc although some mitigation may be possible.
- <u>Policy ENV.9</u>: Mitigation measures needed
- Policy ENV.10: To consider in mitigation measures
- <u>Policy ENV.13</u>: Conflict affect on natural landscape, built environment, archaeologically important sites etc although some mitigation may be possible.
- <u>Policy T.1</u>: NDR policy supports overall strategy of Norfolk Structure Plan for Transport.
- <u>Policy T.4</u>: Support: NDR policy to include facilities for walking and cycling and facilitates improvements through other aspects of NATS.
- <u>Policy T.5</u>: Support, as NDR will release capacity for improved public transport
- <u>Policy T.7</u>: NDR supports this policy as complementary traffic management measures in residential areas can be implemented to reduce existing community severance. New road may be in conflict as it impacts on communities.
- <u>Policy T.9</u>: NDR not included as a strategic link.
- <u>Policy T.12</u>: The NDR policy will improve cycle and walking facilities and benefit urban regeneration or economic development.
- <u>Policy H.3</u>: NDR will facilitate additional housing in Norwich.
- <u>Policy RC.1</u>: Impacts from NDR will need to be mitigated
- <u>Policy N.1</u>: NDR can assist in achieving some of these (i), (ii), (iii), (iv) in part, (viii). Conflict, in part with (iv).
- <u>Policy N.6</u>: Potential conflict with some of these clauses

(iv) Broadland District Local Plan – Adopted July 2000

The individual environmental and transport policies within the Broadland district Local Plan which relate to an NDR are:

- <u>Policy ENV1</u>: Not necessarily conflict can seek to protect environmental assets as much as possible.
- <u>Policy ENV2</u>: Not necessarily conflict will need to address these points in design work.
- <u>Policy ENV3</u>: Not necessarily conflict will need to address these points in design work.
- <u>Policy ENV4</u>: Conflict need details of species surveys
- <u>Policy ENV5</u>: Conflict need consider mitigation measures for environmental damage
- <u>Policy ENV6</u>: Conflict where SSSIs affected by route
- <u>Policy ENV7</u>: Conflict where route may affect Local Nature Conservation areas (County Wildlife Sites, Ancient Woodlands, etc)
- <u>Policy ENV8</u>: Possible conflict see Proposals map online.
- <u>Policy ENV9</u>: Possible conflict see Proposals map online.
- <u>Policy ENV10</u>: Possible conflict see Proposals map online.
- Policy ENV12: Possible conflict listed buildings.
- Policy ENV14: Possible conflict listed buildings.
- Policy ENV15: Possible conflict other buildings.
- <u>Policy ENV17</u>: Possible conflict archaeological sites
- <u>Policy ENV18</u>: Possible conflict/mitigation needed– archaeological sites
- Policy ENV19: Possible conflict/mitigation needed– archaeological sites
- Policy ENV20: Possible conflict/mitigation needed– archaeological sites
- <u>Policy ENV21</u>: Possible conflict agricultural land
- <u>Policy ENV24</u>: Possible conflict in river valley areas water management issues
- <u>Policy TRA8A</u>: Junctions with the A47 are being considered.
- <u>Policy TRA9</u>: Junctions with principle roads are being considered.
- <u>Policy TRA13</u>: NDR proposals to include landscaping

(v) South Norfolk District Local Plan – Adopted March 2003

The individual environmental and transport policies within the South Norfolk district Local Plan which relate to an NDR are:

- <u>Policy ENV1</u>: Potential conflict Area of High Landscape Value.
- <u>Policy ENV3</u>: Potential conflict River Tud valley.
- Policy ENV5: Possible conflict but limited historic parkland in area
- <u>Policy ENV8</u>: Conflict mitigation needed.
- <u>Policy ENV9</u>: Possible conflict archaeological sites.
- <u>Policy ENV11</u>: Conflict where route crosses the river Wensum SAC.
- <u>Policy ENV12</u>: Conflict where SSSI affected by route
- Policy ENV13: Possible conflict where route may affect Regional or Local Nature Conservation areas
- <u>Policy ENV14</u>: Possible conflict/mitigation needed habitats.
- <u>Policy ENV15</u>: Possible conflict/mitigation needed species.
- Policy ENV18: New hedges/planting areas would be created with the NDR
- <u>Policy ENV19</u>: Possible conflict if trees with TPOS need to be removed
- <u>Policy ENV20</u>: Possible conflict agricultural land

<u>Policy TRA13</u>: NDR proposals will require accesses with 'corridors of movement'

(vi) Norwich City Local Plan – Adopted November 2004

Whilst the NDR does not pass through the Norwich City Local Plan Area, it will support the City's policies for:

- Preserving medieval streets
- Promotion of the airport
- Enhancement of the pedestrian environment
- Enhancement of cycling facilities
- Improving the efficiency of public transport services

5.12.4 Mitigation Measures

At a regional level, mitigation is generally not applicable. However, at a local level mitigation can be carried out through measures such as realigning the individual routes to avoid habitats, designated sites, archaeological sites etc.

5.12.5 Conclusions and Recommendations

The BDR supports many of the regional and local policies, but conflicts with others, mainly relating to the environment. However, careful alignment of the route should minimise the conflict with these policies.

6.0 TRAFFIC AND ECONOMIC ASSESSMENT

6.1 Introduction

The following text is a summary taken from the NDR Traffic and Economic Appraisal Report, January 2005, compiled by Mott MacDonald on behalf of the County Council. This section is not intended to provide a full transcript of the report, but give an overview of the pertinent points taken into consideration in route selection.

6.2 **Predicted Traffic Flows**

The new road is predicted to attract a significant volume of traffic under all options, with predicted traffic flows generally within the economic design range of a dual carriageway. All options attract orbital traffic that would otherwise route via the northern suburbs. All options provide an alternative north-south Norwich city centre bypass to routeing though the city centre. The projected traffic flows on the western side of the NDR, across the Wensum Valley, vary significantly depending on the option modelled, as the more western options are less attractive to north-south trips.

Figures A.1 and A.2 in Appendix K show the projected two-way Annual Average Daily Traffic (AADT) flows on key roads on the highway network in the do-minimum and do-something scenarios. **Figures A.3 and A.4** in Appendix K show the projected flows on the NDR itself for the different alignments. The flows on the western options are shown with the eastern yellow route with the eastern options shown with the western red route. The choice of the red and yellow routes is purely for illustrative purposes to allow a comparison of traffic flows between the different eastern and western options.

6.3 Predicted Journey Times

The NDR is predicted to have wide-reaching effects on traffic flows around the city, with associated changes in travel times. The NDR scheme would enable traffic calming to be introduced in some form on the residential streets of the northern suburbs and on the minor roads crossing the Wensum Valley. The provision of a high quality orbital route would provide an attractive alternative to the orbital residential and minor roads, relieving them of undesirable through-traffic, with the traffic calming 'locking in' the benefits of the NDR, and allowing additional benefits to arise from the Norwich Area Transportation Strategy. This has been reflected in the model for the do-something scenarios by reducing speeds on these streets, which increases travel times on these roads.

The travel time savings as a result of the NDR are predicted to be widespread. The east/west route across the city, including the Outer Ring Road, has been illustrated as a key route the NDR would relieve. This route is shown in Figure 6.1 overleaf.



Figure 6.1: Illustrative Journey Time Route

The predicted Do Minimum journey times are shown in Table 6.2 and 6.3 overleaf, together with the predicted journey times under the various schemes modelled. They show for illustration the predicted journey times on an east/west route across the city via the northern part of the existing outer ring road, as indicated in Figure 6.1. The predicted journey times are in hours : minutes : seconds.

These tables indicate that the NDR would reduce the average travel time compared with the Do Minimum case for an east-west journey in peak periods across the city on the illustrative main road route by around 10% in 2010, and 13% in 2025. This represents travel time savings of up to 5 minutes, whilst at the same time, through traffic is deterred from using residential roads in the northern suburbs and minor roads in the Wensum Valley.

	AM	Peak	PM	Peak		Change	%
Scheme	E'bound	W'bound	E'bound	W'bound	Average	vs. Do Min	Change vs. Do Min
Do Minimum	0:32:33	0:31:15	0:33:37	0:31:16	0:32:10	-	-
Green/Yellow	0:27:55	0:27:50	0:30:08	0:26:42	0:28:09	0:04:01	14%
Orange/Yellow	0:29:20	0:28:37	0:31:06	0:27:57	0:29:15	0:02:55	9%
Blue/Yellow	0:28:55	0:28:41	0:30:55	0:27:56	0:29:07	0:03:04	11%
Red/Yellow	0:29:27	0:28:37	0:30:59	0:28:02	0:29:16	0:02:54	10%
Brown/Yellow	0:30:06	0:28:54	0:31:24	0:28:05	0:29:37	0:02:33	9%
Brown Variation /Yellow	0:29:46	0:28:38	0:31:18	0:27:57	0:29:25	0:02:46	9%
Purple/Yellow	0:29:36	0:28:38	0:31:24	0:28:05	0:29:26	0:02:45	9%
Purple Variation /Yellow	0:29:33	0:28:32	0:31:03	0:28:00	0:29:17	0:02:53	10%
Red/Pink	0:29:35	0:26:53	0:30:11	0:27:41	0:28:35	0:03:35	12%
Red/Yellow	0:29:27	0:28:37	0:30:59	0:28:02	0:29:16	0:02:54	10%
Red/Blue	0:29:31	0:28:49	0:31:07	0:28:26	0:29:28	0:02:42	9%

Table 6.2: Predicted Journey Times on A1074/A1042 East/West Route IncludingOuter Ring Road Northern Sector, 2010

Table 6.3: Predicted Journey Times on A1074/A1042 East/West Route IncludingOuter Ring Road Northern Sector, 2025

	AM Peak		PM	Peak		Change	%
Scheme	E'bound	W'bound	E'bound	W'bound	Average	vs. Do Min	Change vs. Do Min
Do Minimum	0:39:10	0:35:21	0:40:56	0:37:25	0:38:13	-	-
Green/Yellow	0:31:31	0:31:41	0:35:04	0:31:37	0:32:28	0:05:45	17%
Orange/Yellow	0:34:18	0:32:27	0:36:03	0:33:24	0:34:03	0:04:10	11%
Blue/Yellow	0:33:29	0:32:31	0:35:55	0:33:11	0:33:47	0:04:26	13%
Red/Yellow	0:33:51	0:32:54	0:36:12	0:33:32	0:34:07	0:04:06	12%
Brown/Yellow	0:35:28	0:32:59	0:36:56	0:33:33	0:34:44	0:03:29	10%
Brown Variation /Yellow	0:34:47	0:33:00	0:36:50	0:33:39	0:34:34	0:03:39	11%
Purple/Yellow	0:34:43	0:32:52	0:36:49	0:33:42	0:34:32	0:03:41	11%
Purple Variation /Yellow	0:34:14	0:32:57	0:36:41	0:33:47	0:34:25	0:03:48	11%
Red/Pink	0:33:48	0:31:37	0:34:31	0:33:08	0:33:16	0:04:57	15%
Red/Yellow	0:33:51	0:32:54	0:36:12	0:33:32	0:34:07	0:04:06	12%
Red/Blue	0:34:37	0:32:59	0:36:25	0:33:48	0:34:27	0:03:46	11%

Examples of other travel time savings that could result from switching from existing routes to using the NDR have been provided for trips between the A47 east and west of Norwich, and the airport. Figure 6.4, overleaf, shows the assumed routings of these trips with and without an NDR assumed to be in place. The illustrative example used is the red-yellow route.

Figure 6.4: Assumed Routes Between A47 and Norwich Airport With and Without NDR for Journey Time Analysis



Table 6.5 provides a comparison of modelled journey times for the above routes, with and without the NDR for the AM peak period in the design year of 2025.

Table 6.5: Predicted Journey	Times Between	A47 and Norwich	Airport With and
Without NDR, 2025			-

	AM Peak		PM I	Peak		Change	%
Scheme	E'bound	W'bound	E'bound	W'bound	Average	vs. Do Min	Change vs. Do Min
Between A47 East and Airport							
Do Minimum	0:28:36	0:30:05	0:32:18	0:34:12	0:31:18	-	-
Eastern Yellow	0:13:08	016:53	0:22:44	0:16:31	0:17:19	0:13:59	45%
Between A47 West and Airport							
Do Minimum	0:28:13	0:29:49	0:27:03	0:25:22	0:27:37	-	-
Western Red	0:13:27	0:16:21	0:21:33	0:14:26	0:16:27	0:11:10	40%

The analysis indicates that the NDR could provide large travel time savings for trips between the A47 and the airport in excess of 10 minutes. Further analysis has been undertaken of the range of journey time savings that the NDR could provide for north-south trips between the A11 and the airport.

Figure 6.6, below, shows the assumed routings of these trips with and without a western section of the NDR assumed to be in place. The illustrative examples that indicate the range of journey time savings are for the western purple, red and green routes, modelled with the eastern yellow route.





Table 6.7, below, provides a comparison of modelled journey times for the above routes, with and without the NDR for the design year of 2025.

Table 6.7: Predicted Journey	Times Between	A11 and	Norwich A	Airport With	and
Without NDR, 2025					

	AM Peak		PM	Peak		Change	%
Scheme	N'bound	S'bound	N'bound	S'bound	Average	vs. Do Min	Change vs. Do Min
Do Minimum	0:27:13	0:26:23	0:28:01	0:25:01	0:26:40	-	-
Western Purple	0:24:28	0:22:58	0:22:08	0:28:20	0:24:28	0:02:11	8%
Western Red	0:20:11	0:17:36	0:18:37	0:24:57	0:20:20	0:06:19	26%
Western Green	0:16:51	0:15:56	0:19:05	0:20:58	0:18:12	0:08:27	42%

The analysis indicates that the choice of western option could have a significant bearing on the journey time saving for this illustrative north-south route. The western options are predicted to provide savings ranging from approximately two minutes for the least direct, purple route, through to over eight minutes for the most direct, green route.

The journey times in this section are not intended to illustrate all possible journeys or to suggest choosing on this basis between routes.

Overall travel time savings across the Norwich Area are predicted to yield significant economic benefits.

6.4 Effects on Accidents

From January 1998 to December 2002 there were 1207 accidents in the northern suburbs and 411 in the northern rural fringe.

A preliminary assessment has been made of the overall safety impact of the NDR over an area including the existing outer ring road and outwards towards Attlebridge/Felthorpe/Horstead/Salhouse/Plumstead. Within the area the effect on accidents of preliminary model flows has been assessed. All major radial and orbital routes and all other links and junctions subject to flow changes of more than 25% and more than 5 personal injury accidents in the 5 years to 2002 (average 1 pia/annum) have been included.

Accident calculation is based on COBA methodology in the Design Manual for Roads and Bridges (DMRB) and recent studies by the Transport Research Laboratory (TRL) in report TRL335 of accident rates on modern dual carriageway roads. Traffic flows (AADT) are factored from peak model flows using a locally derived factor. In the Reepham Road Drayton/Horsford, Felthorpe and Salhouse/Plumstead areas a more specific detailed assessment of access strategy and traffic management is included. The method used does not account for accident savings on the remaining minor roads which cannot be readily assessed, and 15% has been added to accident savings to allow for this.

Accident figures can be converted to casualties by multiplication by 1.4, the current casualty to accident ratio for Norfolk.

Category	Change in accidents
Change in link accidents over 5 yrs (sites >1 pia/annum and > <u>+</u> 25% flow change)	-214.4
Change in junction accidents over 5 yrs (sites >1 pia/annum and > \pm 25% flow change)	-106.9
Allow 15% for change in accidents on other minor roads over 5 yrs	-48.2
Total change in accidents on existing roads over 5 yrs (a)	-369.5
NDR accidents over 5 yrs (b)	149.9
Change in accidents over 5 yrs (a-b)	-219.6
Annual change in accidents (a-b)/5	-43.9
Annual change in casualties 1.4x (a-b)5	-61.5

Table 6.8: Summary of Changes in Accidents per annum

The NDR is predicted to bring about a reduction in accidents.

Subject partly to the effect of accidents on minor roads, a reduction in up to 44 personal injury accidents per year or, in terms of casualties, 62 casualties per year is estimated to be achieved.

Accident reduction benefits are subject to proportions of traffic transferred from existing roads to alternative NDR route options. Differences in accident savings between alternative NDR route options are likely to be small in comparison with the Transport Economic Efficiency benefits.

The Department for Transport's Transport User Benefit Appraisal (TUBA) software has been used to calculate impacts on Consumer Users, Business Users and Providers and Public Accounts.

Table 6.9 outlines the assumptions used in the appraisal. The economics data used in the appraisal is that from the standard economic parameters file in TUBA version 1.6a (16^{th} June 2004).

Assumption	Value
Price Base	2002
Current Year	2004
Discount Factor Years 1 to 30 (% p.a.)	3.5%
Discount Factor Years 31 to 60 (% p.a)	3.0%
Scheme Opening Year	2010
Scheme Design Year	2025
Evaluation period (years)	60 years

Table 6.9 Economic Appraisal Assumptions

The appraisal was carried out by analysis of scheme costs and predicted effects on travel times and distances in the area covered by the NATS traffic model for the average hours during the AM (0730-0930) and PM (1600-1830) peak periods. Annualisation factors of 506 (2 hours x 253 days) and 632 (2.5 hours x 253) were used for the AM and PM peak periods to calculate benefits for each period.

Given the results for the peak hours it is likely that there would be some positive benefits for interpeak period, and the appraisal therefore provides a conservatively low estimate of total benefits.

Trip, time and distance skim matrices for light and heavy vehicles for the dominimum and do-something scenarios were generated using SATLOOK for 2010, the scheme opening year, and the design year 2025, and input into TUBA. Benefits for the other years of the appraisal period have been derived in TUBA by interpolation and extrapolation of the benefits for the modelled years

Light and Heavy vehicle trip matrices were further disaggregated into the five user classes input in to TUBA using data from the 2002 NATS traffic surveys and the 'factor' option in the TUBA input matrices table.

No public transport benefits have been included in the economic analysis. However, the traffic model indicates a net reduction in travel times for buses in the Norwich area of approximately 5% with the NDR assumed to be in place. It is likely that wider opportunities would be created by the NDR to provide further bus priority measures for the core bus network without introducing delays for other traffic.

6.5 Capital Costs

The capital works and land costs of scheme options (September 2004) including a 15% allowance for contingencies are as follows in Table 6.10. Maintenance costs in this table are based on a 40 year period.

Scheme	Works	Land	Maintenance						
Western options									
Green	63,003	10,706	3,190						
Orange	58,552	7,675	4,861						
Blue	51,795	9,939	4,805						
Red	61,085	4,597	6,355						
Brown	73,092	6,439	7,665						
Brown Variation	72,540	6,439	7,699						
Purple	69,669	5,773	7,240						
Purple Variation	69,116	5,773	7,274						
Eastern options									
Pink	43,181	13,041	5,086						
Yellow	43,594	8,526	5,621						
Blue	43,504	6,702	5,994						

Table 6.10: Option Costs (£000's, September 2004 Prices, 15%Contingencies)

In accordance with Government Transport Appraisal Guidance and DMRB scheme assessment requirements, the above costs have been converted for economic assessment purposes.

The costs in Table 6.10 have been converted for use in the TUBA economic assessment, as follows:

- Costs expressed in 2004 prices, discounted to 2002
- Preparation fees of 9% of the costs of works and land added
- Supervision fees of 5% of the costs of works and land added
- Maintenance costs factored from 40 years to 60 years, for consistency with the appraisal period
- In accordance with the latest Government advice on economic appraisal, an additional 22% uplift in capital costs has been added to allow for Optimism Bias

It should be noted that Transport Assessment Guidance (TAG) requires Optimism Bias to be included in costs for economic assessment but offers of approval for schemes exclude Optimism Bias as an incentive to tight budget control.

The following assumptions have been made regarding the phasing of costs for the purpose of economic assessment using TUBA:

	2004	2005	2006	2007	2008	2009	2010	2011
Land						25%	75%	
Preparation	10%	20%	20%	20%	25%	5%		
Supervision						45%	45%	10%
Construction						35%	60%	5%

Table 6.11: Assumed Phasing of Costs

This phasing is simplified for economic assessment purposes based on DMRB advice. In practice, later compensation payments would slightly reduce discounted costs. Maintenance costs are assumed to be incurred in stages over the 60 years following opening of the road in 2010 as follows:

Table 6.12: Assumed Profile of Maintenance	Costs
--	-------

	2021	2033	2044	2056	2067
Maintenance	10%	35%	10%	35%	10%

6.6 **Results**

Table 6.13, below, provides a summary of the economic performance of the options tested. The TUBA outputs provide full details of the calculated costs and benefits.

Table 6.13: TUBA Economic Assessment Summary

	Scheme	PVB	PVC	NPV	BCR
Western Options Eastern Options	Orange/Yellow	634.1	164.5	469.5	3.9
	Blue/Yellow	621.9	157.8	464.1	3.9
	Green/Yellow	670.9	174.7	496.2	3.8
	Purple/Yellow	490.2	172.8	317.4	2.8
	Purple Variation/Yellow	482.3	171.7	310.6	2.8
	Brown/Yellow	517.0	179.0	338.0	2.9
	Brown Variation/Yellow	519.9	178.1	341.8	2.9
	Red/Yellow	579.2	162.4	416.8	3.6
	Red/ Blue	557.8	160.0	397.9	3.5
	Red/Pink	688.9	170.2	518.7	4.0

Note that the yellow and red routes have been selected to be modelled in combination with other options purely as examples, in order that a comparison between competing eastern and western options may be made.

The benefits calculated are based on travel time and vehicle operating cost savings and do not take account of any change in benefits associated with accidents.

6.7 Conclusion

Government guidance is that schemes with BCR over 2 represent high value for money. From Table 6.13 it can be seen that, in traffic and economic terms, all the route alternatives offer high value for money. However, guidance also says: "some road schemes with very high BCRs have been rejected because the negative environmental impacts are so big they end up being 'poor' value for money". This is discussed more in Section 8.

7.0 **PUBLIC CONSULTATION**

7.1 Introduction

In Autumn 2003, a consultation was held to determine whether the NDR should be adopted as part of a range of measures forming the Norwich Area Transportation Strategy (NATS). 16% of the 132,000 questionnaires distributed were returned, showing overwhelming support for the road, but no clear preference for the four western and three eastern corridor options suggested. Members of the public also supplied information on the issues connected with each of these seven route options.

As a result of the 2003 consultation, variations to the seven route options plus several new options were investigated. It was recommended to Norfolk County Council that the seven original consultation routes, with some modifications, plus four new western options, should be taken forward to a Stage 2 consultation.

This public consultation ran for just under 8 weeks, from 10 November 2004 to 31 December 2004. In addition, information was issued to the Statutory Environmental Bodies on 26 October 2004 so that they would be appraised of the issues before the main consultation.

7.2 Basis of the Consultation

With the 2003 consultation already having asked whether the public supported an NDR, the 2004 consultation had two main objectives:

- to advise the public of the progress made in the development of the eleven options;
- to ask the public to contribute to the selection of a preferred route from the eight western and three eastern route options.

It was considered important to find out from the public the following:

- Which of the western options they most and least prefer;
- Which of the eastern options they most and least prefer;
- What issues influence their decision;
- Demographic information including their postcode and their age;
- Whether they think their property would be seriously affected;
- Any other comments they may have.

These questions were laid out in a freepost questionnaire, which is included in Appendix L.

7.3 Consultation Aids

7.3.1 Brochure

A 20-page brochure was prepared detailing the major issues associated with each of the eleven options and the process involved in developing the route. This brochure, together with the freepost questionnaire, was mailed to approximately 130,000 households and businesses in the Greater Norwich area. Copies of the brochure and questionnaire were also sent to local authorities, statutory bodies, utility companies, local interest groups and other stakeholders, a list of which is included in Appendix L together with the brochure. Copies were also sent to a dozen schools in the area which requested them.

A supply of brochures and questionnaires was made available from the start of the consultation period at the Council Information Centres in Norwich, Gorleston, Fakenham and Wroxham. A copy of the brochure was also posted on the Norwich Area Transport website <u>www.norwichareatransport.org</u> and the questionnaire was available to complete online.

7.3.2 Exhibitions

A series of staffed and unstaffed public exhibitions took place during the first 6 weeks of the consultation period, so that any concerns and questions could be raised with Norfolk County Council officers.

The main staffed public exhibition took place in the Forum in Norwich from Sunday 21 November to Friday 26 November and was staffed between 1000h and 1900h every day. The display material was in the form of panels showing an aerial plan of the route options, the major issues with each option, environmental and planning constraints, traffic flows, implications for properties and what happens next.

Additional staffed exhibitions were held in the entrances to three local supermarkets. The Sainsburys store at Pound Lane, Thorpe St Andrew hosted an exhibition on Thursday 25 November and Sainsburys at Longwater, Costessey hosted one on Friday 3 and Saturday 4 December. The third exhibition was held in the Budgens store in Drayton on Friday 10 and Saturday 11 December. These exhibitions were staffed from 1000h to 1900h weekdays and 1000h to 1600h Saturdays.

Staffed exhibitions were also held at the University of East Anglia on 7 December 2004 and at Norwich City College on 16 December 2004.

In order to include those living outside the Greater Norwich area, a series of week-long displays were staged across key locations in the north Norfolk area. Due to limited resources, these exhibitions could not be staffed, but visitors were able to view large-scale plans and charts. Consultation booklets and questionnaires were available for them to take away.

These exhibitions were held at:

- North Norfolk District Council Offices, North Walsham: 15-22 November 2004
- Budgens, Fakenham:17-24 November 2004
- St Michael's Church, Aylsham: 22-29 November 2004
- Holt Library: 24 November 1 December 2004
- Sheringham Library: 1-8 December 2004
- Roys of Wroxham: 6-8 December 2004, 13-31 December 2004
- Sprowston Library: 8-13 December 2004
- Budgens, Cromer: 8-15 December 2004

7.3.3 Meetings and Presentations

In addition to the exhibitions, the County Council wrote to the each of the 20 Parish Councils affected by the route options, offering to attend one of its meetings to explain more about the route and the implications on the local area. The following 12 Parish Councils invited County Council officers to their meetings:

- Plumstead,
- Weston Longville,
- Spixworth,
- Drayton,
- Old Catton
- Thorpe St Andrew
- Costessey
- Felthorpe,
- Taverham,
- Hellesdon,
- Horsham St Faith,
- Postwick.

A meeting was also held with the Environment Agency and English Nature (the Countryside Agency and English Heritage were not able to attend).

7.3.4 <u>Telephone Helpline</u>

The County Council also set up a dedicated telephone number for inquiries about the NDR. The number came through to the Council's Customer Service Centre which dealt with simple queries. More complex inquiries were passed on to the NDR Design Team. During the consultation period, 153 inquiries were received on this helpline, and a further 45 calls were received directly by the NDR Design Team.

7.4 **Response to the Consultation**

7.4.1 Public Response

In total, 10086 responses were received, together with over 255 separate written responses (181 without questionnaire responses). 597 of the postal responses were from organisations and local councils (parish, town and district). 295 online questionnaires were received via the website. The response rate for the paper questionnaires was 7.5%.

A petition was received from the Wensum Valley Golf and Country Club. 42 signed responses were received from the "Too Far West" campaign group. 131 questionnaire responses were received on behalf of the Marriott Sprowston Manor Hotel and Country Club. 204 responses were received from named organisations. 71 responses were received from local councils.

27 blank questionnaires were returned and two responses were returned ripped up. Around 470 responses stated that there should be "No NDR" (4% of responses) in answer to Questions 2 and 3.

Question 1 asked respondents to consider which issues should influence the choice of route, and to select five from a list of fourteen issues. The most frequently selected five were:

- 72% selected "Taking traffic from residential/city streets"
- 52% selected "Improving journey times"
- 48% selected "Landscape and nature conservation
- 43% selected "Improving accessibility"
- 36% selected "Noise"

Question 2a asked which western option was preferred and why. The most favoured western route was green (22%), followed by orange (20%), and red (20%).

Western green, orange and blue were chosen because of their "proximity to the city". Red was chosen because it was "not near housing and had the least effect on villages or communities". Purple and brown (and their variations) were both selected because they had "less environmental damage or pollution".

Question 2b asked which western option was least preferred and why. The least favoured western route was green (34%), followed by purple (33%) and brown (11%).

Western green, orange and blue were not favoured because of their "proximity to property/land/business/village or town". Red was not favoured due to its "impact on the environment/nature/landscape/river valleys". Purple and brown (and their variations) were considered to be "too far from the city".

Question 3a asked which eastern option was preferred and why. The most favoured eastern route was blue (41%), followed by pink (28%) and yellow (16%).

Eastern blue route was chosen because it had "less environmental damage or pollution" and "not near housing and had the least effect on villages or communities". Eastern pink was chosen because of its "proximity to the city" and eastern yellow was selected as it was "not near housing and had the least effect on villages or communities".

Question 3b asked which eastern option was least preferred. The least favoured eastern route was pink (39%), followed by blue (27%) and yellow (17%).

Eastern pink was not favoured as it was "too close to property/land/business/ village or town, and would cause disruption". Eastern blue was not favoured as it was "too far from the city/too long". Eastern yellow was not favoured due to its "impact on the environment/nature/landscape/river valleys".

Question 5 asked the respondent to indicate their age group. Of the individuals who responded:

- 48% were aged 36-60 years
- 35% were over 60 years
- 13% were aged 18-35 years
- 0% (21 responses) were aged under 18 years.

4% of individual responses declined to respond to this question.

For Question 7, the questionnaire asked respondents to select any of the transport modes and reasons for travel that applied from a list.

- 79% use their car for leisure purposes
- 55% walk
- 48% use their car for work
- 27% travel by bus
- 25% cycle
- 10% travel by train
- 8% use their car for a school run
- 7% use a vehicle to make deliveries
- 5% use a motorbike

- 42% use Pay & Display
- 30% use free parking
- 28% use Park & Ride

Question 8 asked if the respondent believed that one or more of the proposed routes would seriously affect their land or property. 841 (8%) respondents indicated one or more routes. The largest number, 293 (24% of these), identified the western green route; 59 (13%) identified the eastern pink route. All routes were identified, broadly following a trendline based on the number of properties within 300m.

Question 9 asked if there were any other issues that the respondent thought should influence the choice of route. 1041 (10%) responses were received to this question, and the most frequently mentioned remark was that "bus lanes/public transport/Park & Ride needs improving".

7.4.2 Responses from Local Councils

80 responses were received from local councils, 68 of which were Parish Councils. The preferences for western routes were: green (25%) and orange (25%), red (19%), blue (13%), purple (4%). Brown, and the purple/brown variations received no support.

11% of local council responses offered no response to this section.

The least preferred western routes were purple (24%), brown (14%), green (14%), red (7%), blue (5%), and orange (4%).

20% of local councils offered no response to this section.

The preferred eastern routes were blue (33%), pink (24%), and yellow (14%).

24% of local councils offered no response to this section.

The least preferred eastern routes were pink (21%), blue (17%), and yellow (10%).

43% of local councils offered no response to this section.

Two Parish Councils, Terrington St. Clement and Weston Longville, wished to make it known that they do not support an NDR, and Terrington St. Clement refused to choose a route on this basis.

Horsham St. Faith and Newton St. Faith did not express a preference on either the eastern or western routes, but noted that they were happier with the adjusted route round the airport following the consultation in 2003. Edgefield supports the NDR, with the routes that "are the most economic and cost effective". Postwick with Witton did not specify any particular routes, but wished to note that they supported the eastern link to the Broadland Business Park as in the consultation in 2003.

Of the 20 directly affected parishes (those with routes crossing land within their boundaries), 8 responded with route selections; this is summarised in Table 7.1

Great Yarmouth Borough Council responded with a letter of support for the NDR, but declined to select a route.

South Norfolk District Council supports the western orange route. They are least in favour of the western green route. No preference was stated for the eastern routes.

They also request that the County Council minimises the number of crossings of the River Tud, the NDR's impact on the river and valley area, and the NDR's impact on existing properties close to the route.

Table 7.1 Route	preferences	from the 2	20 directly	affected	parishes
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Parish Council	Favourite Western	Least Favourite Western	Favourite Eastern	Least Favourite Eastern	
Attlebridge	-	-	-	-	
Beeston	-	-	-	-	
Costessey	Orange	Green			
Drayton	Orange		Pink		
Easton	Orange	Blue, Red, Brown, Purple	-	-	
Felthorpe	Orange/Red	Green	-	-	
Great & Little Plumstead	-	-	-	-	
Hellesdon	Blue	Green	-	-	
Honingham	-	-	-	-	
Horsford	Green	-	-	-	
Horsham St. Faith & Newton St. Faith	-	-	-	-	
Morton on the Hill	-	Purple/Brown	-	-	
Postwick with Witton	-	-	-	-	
Rackheath	-	-	Yellow	Blue	
Ringland	Green	Red	-	-	
Spixworth	No preference				
Sprowston	Supports principle of NDR				
Taverham	Red	All others	-	-	
Thorpe St. Andrew	-	-	-	-	
Weston Longville	Orange	Purple/Brown	-	-	

Broadland District Council expressed a preference for the eastern blue route over the eastern yellow, and formally objects to the eastern pink route. For the western routes, Broadland preferred the orange, but would accept the western red. Objections were noted to the western green, purple, brown and blue.

No responses were received from North Norfolk District Council, Breckland District Council and West Norfolk & Kings Lynn Borough Council.

7.4.3 <u>Responses from Environmental Bodies</u>

Both statutory and non-statutory environmental organisations have expressed concern about an NDR. The primary concern is that all the western options cross the Tud and Wensum valleys. There has been both reluctance and resistance from most organisations to give a view on the differing environmental effects of the consultation options, with the four following exceptions.

Norfolk Landscape Archaeology believes the western red and eastern yellow routes to have the least damaging effects on the historic environment.

Wensum Valley Project commented that the "least destructive" were the western purple and brown variations. The "most destructive" was the western green. No comments were made concerning the eastern routes. Norfolk Bird Club preferred the western green and eastern pink routes, and least preferred the western red and eastern yellow route. This was based on research into the breeding grounds of several rare bird species.

The Countryside Agency gave a detailed report on all of the proposed options. They identified the eastern blue and eastern yellow routes as having the least landscape/severance impacts. Of the western options, the western purple variation was regarded to have the best outcomes for both rural communities (visual intrusion/severance) and landscape.

7.4.4 <u>Responses from other Organisations</u>

Most businesses and organisations stated their support for an NDR. However, Sustainable Transport for the East of England Region (STEER), and the Campaign for the Protection of Rural England (CPRE) restated their opposition to an NDR.

Norwich Airport favours the western green route, or the western orange and western blue routes. They prefer the eastern blue route, as there are concerns about the yellow and pink routes having an impact on any future extension of the runway.

The Consultation has drawn a significant response from landowners and businesses directly affected or in close proximity to routes. Discussions about alignments have helped clarify the issues and relative merits of the options.

The detailed comments and information, both for and against options or parts of options, have added much useful data to the Stage 2 Environmental Assessment, undertaken prior to the start of the consultation. For the most part, these comments were from people or organisations that would be affected by particular options.

8.0 **DISCUSSION**

8.1 Western Options

8.1.1 Natural Environment

All the western routes have been identified in the Stage 2 Environmental Assessment as having very large adverse environmental impacts. These impacts all relate to the fact that all the routes cross the Wensum Valley, and the Special Area of Conservation. Whereas it would be possible to mitigate some of these impacts it is unlikely that it will be possible to mitigate all of them. The actual impacts differ between the options, as there is quite a variance in overall character between the different locations where the western routes cross the Wensum Valley.

For most of the options, it has been assumed that a long open viaduct across the flood plain would be constructed. This would obviate the need for approach embankments to the river. A long span over the river itself would mean that construction activity can be restricted to small areas at the viaduct pier positions. Disturbance of the SAC which covers the immediate environs of the river, can thus be avoided. Issues then remain about the impacts of a viaduct on the landscape, as such a structure would in itself be a major intrusion into the Valley.

The brown and purple routes use the existing location where the A1067 crosses the river. Whilst in one sense these could be seen as having less impact than other options by avoiding a new crossing, in practice widening the road to dual carriageway standard could be as damaging. The existing road has a single span bridge with approach embankments rather than a multispan viaduct as envisaged for the other options. The need to widen the embankment for the second carriageway and the construction of a second bridge would involve major disturbance within the flood plain. The new carriageway embankments would cover a significant area of flood plain and the bridge construction would be potentially closer to the SAC than for other options.

The red route crosses the valley at an area of open landscape. The location is such that the viaduct could run at a slack gradient, relatively parallel to the ground. This gives some potential to design a viaduct in such a way as to blend into the landscape, reducing the impact. There is some leeway with this route to adjust levels across the valley and through adjacent cuttings to arrive at the best arrangement.

Both the orange and blue routes are more constrained, as they cross Ringland Hills, on approach to the Wensum Valley. The hills divide the Tud and Wensum valleys rising steeply between them. As a result, there is a difficult balance between deep cuttings through the hills and the height of a viaduct over the valley. The assessments have been made on an assumption of the right balance for these factors. However, this still indicates that particularly deep cuttings through Ringland Hills would be needed for these routes, in the order of 20 metres in the case of the orange route.

Both routes have to cross not only the Wensum, but Ringland Lane running close to the south bank of the river. These factors mean both routes are likely to require high steeply graded viaducts, that would cross unfarmed, less intensively managed, more natural parts of the valley. In the case of the blue route, there would also be a high approach embankment leading from Ringland Hills. These high viaducts could only be avoided by cutting deeper through the hills. It is

considered that mitigation of the effects of these routes, to an extent that they would become acceptable to the statutory bodies could be particularly difficult.

The green route, whilst crossing the Wensum river downstream of the most sensitive section, still impacts on the SAC. There is likely to be the need for a high viaduct so that the route can pass over Marriotts way, which runs adjacent to the river at this point.

Most of the routes also impact the Tud Valley. Whilst this does not have the designation and degree of protection of the River Wensum, it is nevertheless important to consider the impacts carefully.

The purple route, starting from a point where the Tud is running to the south of the A47 would not have any direct effects at all.

The brown, red and blue routes have not diverged far from each other where they cross the Tud and thus have similar effects. All three could follow the general ground contours fairly easily, and with a degree of flexibility about the height over the river. Whether there would be a bridge or a viaduct over the river would have to be considered during later stages of development.

The orange route crosses the Tud at a point close to the approved crossing the 'North of the Tud' development site it would also impact on the adjacent County Wildlife Site.

The green route has a much greater impact on the River Tud. The route crosses and then runs parallel to the river for some 1.5 km. The crossing at Longwater Lane would have to be at the level of the existing bridge, although this would mean severing the lane, as a junction at this point would be difficult to provide without affecting property. To the south of Costessey, the road would have to be raised on embankment and viaduct to avoid the floodplain.

The responses from English Nature and Environment Agency indicate that, notwithstanding their concerns over proving need, the impacts of all routes are so significant that further work needs to be done to identify in more detail what the environmental constraints and detailed mitigation measures might be before a decision is made on a route across the Wensum Valley.

8.1.2 Built Environment

The green route passes close to the edge of the city, impacting on properties in Costessey Hellesdon and Drayton. Both the orange and blue routes pass close to Taverham, and the brown and purple routes pass close to Weston Longville and Attlebridge. As a result, the green route impacts on the greatest number of properties and the red route on the least.

The current alignment of the green route would sever Old and New Costessey, as Longwater Lane would be cut by the proposed NDR. This severance would also restrict access from residents to their local services. It would also sever Drayton and Taverham From Hellesdon. This would give rise to additional traffic on the A1067 through Taverham and Drayton, rather than relieving the situation.

In terms of cultural heritage, the orange route would have a substantial impact on setting and character of grade II listed building and the brown and purple routes and their variations would require the demolition of grade II listed building. On balance, the red, blue and green are the least damaging overall to cultural heritage. In terms of land use, all route options would result in the loss of agricultural land. However, the further away from the boundaries of Norwich the route options pass, the less affected potential development land would be. This is because all of the land allocated for potential strategic housing sites is situated on the outskirts of Norwich.

The orange and blue routes will have a substantial impact on the Wensum Valley Golf Course. The red route and brown and purple variations would also impact to some extent on the golf course.

8.1.3 Value for Money

In terms of value for money, all eight routes have very good benefit to cost ratios (BCRs) of more than 2. Government guidance is that schemes with BCR over 2 represent high value for money. At 3.9, the blue route's BCR is marginally higher than the green, orange and red routes at 3.8, 3.7 and 3.6 respectively. The brown and purple routes and their variations have lower BCRs of around 2.8. However, the guidance also states that if a route has a large adverse impact on the environment, then this high value for money may be diminished to reflect the loss and importance of this environment. The blue and orange routes, whilst having two of the best BCRs, also give rise to the greatest adverse environmental impacts. In terms of government guidance it is felt that these perceived impacts could diminish the value for money to such an extent that these two routes would not in reality give value for money.

8.1.4 Public Acceptability

It is recognised that there is public concern over the environmental impact of all the western routes. The public's responses to the consultation showed that the green route was the most favoured, followed by the orange and red routes and then the blue. The fewest number of people chose the brown and purple variations as their favourite route. The responses from Parish Councils also reflected this pattern.

The public's least favourite route was given as the green route followed closely by the purple route. The fewest number of people chose the brown and purple variations as their least favourite route. The responses from Parish Councils gave the purple route as the least favourite route followed by the green and the brown routes.

The popularity of the green route is because it is the shortest and most direct route, and best fits the continuation of the Southern Bypass northwards around to the Airport. The high negative feeling is probably due to its proximity to residences.

With respect to the directly affected councils, the green route is favoured by Horsford and Ringland Parish Councils; the orange route is favoured by Broadland District Council, South Norfolk District Council, Costessey, Drayton, Easton, Felthorpe and Weston Longville Parish Councils; the blue route by Hellesdon Parish Council and the red route by Felthorpe and Taverham Parish Councils. The red route would also be acceptable to Broadland District Council,

The Countryside Agency feels that the purple route and then the brown route are the least damaging with respect to landscape. The Environment Agency has confirmed that the purple and brown routes would have the least impacts, with respect to water quality, of the routes put forward. Their least favourite route is the green route due to its perceived impact upon rivers and floodplains. English Heritage favours the red route as least impacting on Cultural Heritage. English Nature gave no preferred option on the western side.

8.1.5 <u>Deliverability</u>

Although the BCRs (in the range of 2.8 to 3.9) would put the NDR in the very high value for money category, government advice recently published on value for money has a significant bearing on the overall value for money of the scheme as it would be seen by government in any bid for funding. The government advice states that:

- the environment impacts would need to be significant relative to costs to reduce its value for money category
- building new infrastructure through an environmentally sensitive area might be an example of this
- some road schemes with very high BCRs (as is the case with the NDR) have been rejected because the negative environmental impacts are so big they end up being 'poor' value for money.

In the case of the western routes, all have 'very large adverse' environmental impacts which is the highest category of negative impact a road scheme can have. Most of these impacts relate to the landscape and ecology of the section of road between the A47 (west) and the A1067 Fakenham Road across the Wensum Valley.

Whilst it is inevitable that any new rural road scheme will impact on landscape and ecology, it is part of scheme development that these impacts are mitigated as far as is reasonably possible until an acceptable level of impact is achieved. In this respect both English Nature and Environment Agency have key roles to play. Also important will be the response of the Countryside Agency and English Heritage, although at this stage these two statutory bodies have not raised fundamental concerns as EA and EN have.

The responses from English Nature and Environment Agency indicate that, notwithstanding their concerns over proving the need for the NDR, the impacts of all routes are such that further work needs to be done to identify in more detail what the environmental constraints and detailed mitigation measures might be before a decision on the preferred route is taken.

8.2 Eastern options

8.2.1 Natural Environment

In overall terms, the eastern routes pose fewer challenges than the western routes and do not affect any sites with statutory designations. However, the impacts on landscape and ecology are still assessed as 'large adverse' and therefore both English Nature and Environment Agency have declined to state any preference for the reasons set out previously.

Of the routes on the eastern side of Norwich, all are likely to generate adverse impacts in terms of ecology mainly due to the presence of great crested newts in a pond near Quaker Farm. The pink route has a large adverse impact on 2 County Wildlife sites and a moderate adverse impact on several TPOs and species rich hedgerow. The yellow route has a moderate adverse impact on several TPOs and species rich hedgerow. The blue route has a moderate adverse impact on species rich hedgerow. On balance, the blue or yellow route may have less adverse impacts than the pink route, which has a direct impact on Racecourse Plantation CWS and 2 sites with great crested newt populations.

In landscape terms, based on current information, there is no clearly preferable option between the blue, yellow or pink routes; each has some adverse effect in terms of both landscape character and visual intrusion. All the routes pass mainly through open farmland and will have a moderate impact on the general character of the landscape, although this impact will reduce over time. The pink route would have little impact on the historic landscape but would have a moderate impact on woodland near Thorpe St. Andrew. It will have a substantial visual impact on properties in Thorpe End and along Spixworth Road and a slight visual impact on properties on Norwich northern fringe. The yellow route would have a slight impact on the historic landscape around Beeston Hall and a moderate impact on woodland near Rackheath Hall. It would have a moderate visual impact on properties in Thorpe End and a substantial visual impact on properties along Spixworth Road. The blue route would have a moderate impact on the historic landscape around Beeston Hall and on woodland near Rackheath Hall. It would have a moderate visual impact on properties in Thorpe End and a substantial visual impact on properties along Spixworth Road and some properties in Rackheath. In terms of countryside severance the pink route would be preferable as it is the closest route to the existing urban edge and could be more readily assimilated into the urban fringe. Because they are further out, both the blue and yellow routes would cause fragmentation of relatively unified areas of rural countryside and introduce urban elements into the wider countryside.

In terms of geology, all the routes will have very little impact. In terms of contaminated land, all three routes cross Norwich Airport and the Norwich-Cromer railway line which are potentially polluted areas. However, the yellow route also passes through a closed landfill site between the B1150 Wroxham Road and Salhouse Road. The pink and yellow routes cross two minerals plan consultation areas site between the B1150 Wroxham Road and Salhouse Road. On balance therefore, the blue route has the least impact in terms of geology, soils and contaminated land.

In terms of water impacts, the pink route is the best option for the eastern section of the NDR. The yellow route crosses a closed landfill site and the blue route indirectly impacts on the surface water feature 'The Springs'.

On balance, in terms of the natural environment, the blue and yellow routes have less of an impact than the pink route, and of the two, the blue route is the marginally less damaging as the yellow route crosses a landfill site.

8.2.2 Built Environment

The pink route passes close to the edge of the city, particularly around Sprowston and Thorpe St. Andrew. Both the pink and yellow routes pass close to Thorpe End, and the blue route passes within 300m of New Rackheath. As a result, the pink route impacts on the greatest number of properties and the yellow route on the least.

All the routes will have a detrimental effect on the surrounding features of cultural heritage, such as Quaker Farm, Sprowston Manor Park, West Farm and the historic parkland of Beeston Park and Rackheath Park although none of these features is of international importance. On balance, the yellow route is probably the least damaging overall.

In terms of land use, all route options would result in the loss of agricultural land. However, the further away from the boundaries of Norwich the route options pass, the less affected potential development land would be. This is because all of the land allocated for potential strategic housing sites is situated on the outskirts of Norwich.

Whilst many consultation responses have raised the issue of 'urban sprawl' and the need for the NDR to be close in to the city edge to limit this, it is also recognised that the north-east of Norwich has been highlighted as an expansion and new housing area. The pink route may limit this expansion.

The yellow and pink routes cut through the Norwich Rugby Ground and run close to a sports playing field. The yellow route also cuts across the Sprowston Manor Golf Course. Furthermore, the pink and yellow routes may impact upon the current operation and future expansion of Norwich International Airport. On balance therefore, the blue route is the least damaging with respect to land use.

Taking all these factors into account, the pink route is the most damaging as it passes the highest number of properties has an impact on the airport and will impact on development. The yellow route has the least impact on properties and cultural heritage but has a large adverse impact on land use. Therefore the blue route is considered marginally less damaging.

8.2.3 Value for Money

In terms of value for money all three routes have very good benefit to cost ratios (BCRs) of more than 2. Government guidance is that schemes with BCR over 2 represent high value for money. At 3.9, the pink route's BCR is marginally higher than the yellow and blue routes at 3.6 and 3.5 respectively. It is not thought that the environmental impacts highlighted on the eastern routes would significantly diminish the value for money of each of these options.

8.2.4 Public Acceptability

All routes are thought, in broad terms, to be publicly acceptable. The public's responses to the consultation showed that the blue route was the most favoured followed by the pink route and then the yellow. The public's least favourite route was the pink followed by the blue and then the yellow. The responses from Parish Councils also reflected this pattern. Of the eastern directly affected Parish Councils, only Rackheath expressed a preference with yellow being their preferred route, and blue their least preferred. Broadland District Council would strongly oppose the pink route. The Countryside Agency feels that the blue route or the yellow route are least impacting and English Heritage favours the yellow route. English Nature and the Environment Agency gave no preferred option on the eastern side.

8.2.5 <u>Deliverability</u>

On the eastern side, all three routes contribute to very good benefit to cost ratios (BCRs) of more than 2, representing high value for money. However, once again, all the eastern routes have large adverse impacts but these are not considered insurmountable in mitigation terms. Therefore, although each of the eastern routes gives rise to its own particular environmental issues, all are thought to be deliverable.