Safe roads, Reliable journeys, Informed travellers

HIGHWAYS AGENCY

A47 Acle Straight - Dual Carriageway Proposals

Environmental Assessment Report

Volume 1

January 2004

Report no: GD00555/RT/027 Revision 01

Hyder Consulting
The Surrey Research Park
Guildford
GU2 7AR

Hyder Consulting

Safe roads, Reliable journeys, Informed travellers

HIGHWAYS AGENCY

A47 Acle Straight - Dual Carriageway Proposals

Environmental Assessment Report Volume 1

Author: Richard Gwilliam

Checker: Guy Tanfield

Approver: Fraser Davidson

Report no: GD00555/RT/027 Revision 01 **Date:** January 2004

Hyder Consulting

A47 ACLE STRAIGHT –DUAL CARRIAGEWAY PROPOSALS
ENVIRONMENTAL ASSESSMENT REPORT, VOLUME 1
Report No GD000555/RT/027 Revision 01

Errata

Clause 1.1.1, First sentence:	Delete "propose to improve" and substitute with "have been asked to investigate potential improvements to"
Clause 7.6.17 Add to end of clause:	"Non water related mitigation measures described in Chapter 9 would reduce impacts on birds using Breydon Water."

Hyder Consulting

Contents

1 Introduction

1.1 The Scheme

1.1.1 The Highways Agency propose to improve a section of the A47 between Acle and Great Yarmouth a distance of approximately 11 km (see Figure 1.1). This study is part of a package of measures to tackle transport problems between Norwich and Great Yarmouth, which were announced by the Minster for Transport John Spellar on 22 August 2002. In particular Mr Spellar noted the need to investigate options for both single carriageway improvements and dualling of the A47 between Acle and Great Yarmouth, known as the Acle Straight. In recognition of the environmental sensitivity of the area, The importance of implementing a full environmental assessment on both of the options was stressed.

1.1.2 This Environmental Assessment report (EAR) considers a proposed scheme for a two-lane dual carriageway, involving widening of the existing carriageway, and the construction of a second carriageway. The new carriageway would be located to the north of the existing road on the west side of Halvergate Junction and to the south of the existing road on the east side of Halvergate Junction. The objective of this is to improve traffic flow and capacity and to improve safety for road users along the Acle Straight. The scheme is described in more detail in Chapter 2 of this report.

1.1.3 The Environmental Assessment Report provides a systematic and objective account of the environmental effects of the scheme and the measures proposed to mitigate them, that is to offset or reduce these effects. It does not aim to make judgements about the merits of the scheme but ensures that the likely effects on the environment are fully understood and taken into account before a decision on whether to proceed is made.

1.2 Report Structure

1.2.1 The Environmental Assessment consists of two volumes, along with supporting documentation. This written document is Volume 1 of the Environmental Assessment Report for the scheme. Volume 2 comprises supporting plans and cross sections. A glossary is provided at the end of Volume 1. Non-environmental issues are covered in the Scheme Assessment Report. The Environmental Assessment is supported by a number of detailed specialist reports. These are listed in Appendix 1.1 (Sources and references).

1.2.2 Following this introduction, Volume 1 is divided into the following chapters:

- Scheme Design includes a description of theoptions.
- This is followed by a number of chapters detailing the results of various specialist environmental studies. Each of these chapters presents the

existing conditions and the anticipated environmental effects that may result from the construction and operation of each of the options. The environmental effects have been assessed against a "do-minimum" baseline and likely mitigation measures. The assessment process has been closely integrated with design development to optimise the environmental performance of each option and the entire scheme.

- Following consultations with statutory consultees a conclusions section will be prepared to draw together the most significant environmental effects and issues, and consider the overall environmental impact of each of the options.

1.3 Legal Basis

1.3.1 The Environmental Assessment Report presents an assessment of environmental effects likely to result from implementation and operation of the scheme. Should one of the options be progressed following a ministerial decision, the EAR for that option could be used as the basis for an Environmental Statement. In order that the EAR is of a standard suitable for adaptation as an Environmental Statement, it has been prepared in accordance with the requirements of the Highways Act 1980, Section 105A, as supplemented by the Highways (Assessment of Environmental Effects) Regulations 1988 (and amended in 1994 and 1999), which implement EC Directives 85/337/EEC and 97/11/EC.

1.4 Methodology

1.4.1 Methods used are those set out in official guidance published by the Government.

1.4.2 The "Design Manual for Roads and Bridges (DMRB), Volume 11: Environmental Assessment"[1] provides detailed guidance on EIA for road schemes in the UK. Stage 3 assessment methodologies from this guidance have been used for all the work presented in this report. Volume 10 of the DMRB "Environmental Design"[2] provides detailed guidance on environmental mitigation for road schemes and has been used as the primary reference for environmental inputs to the Scheme design.

1.4.3 The methodology for appraising highway projects to take account of multi-modal transport issues is indicated in the "Guidance on the Methodology for Multi-Modal Studies" (GOMMMS - 2000). This type of appraisal is a separate exercise from the statutory requirements for EIA derived from the EC Directive, which the DMRB addresses. It is designed to assess the extent to which transport schemes meet Government and Highways Agency objectives on sustainable development. However the appraisal topics from the GOMMMS Environment, Accessibility and Integration

[1] Highways Agency. Design Manual for Roads and Bridges, Volume 11, June 1993 and revisions
[2] Highways Agency. Design Manual for Roads and Bridges, Volumes 10 and 10A, 1992 and revisions

objectives overlap with many of the topics in the DMRB. The GOMMMS assessment methods are largely derived from the DMRB Stage 3 assessments and the relationship between the two documents is described in the report "Applying the Multi-modal New Approach to Appraisal to Highway Schemes" (DETR, 2001). Although based on the DMRB, the EIA for this scheme will take into account the requirements of GOMMMS where relevant.

1.5 Environmental Impact Assessment Process

1.5.1 Diagram 1.5 illustrates the process of the Environmental Impact Assessment (EIA) process and its relationship with the development of the scheme design. It is an on-going process, the aim of which is to optimise the environmental performance of the scheme, within engineering and economic constraints.

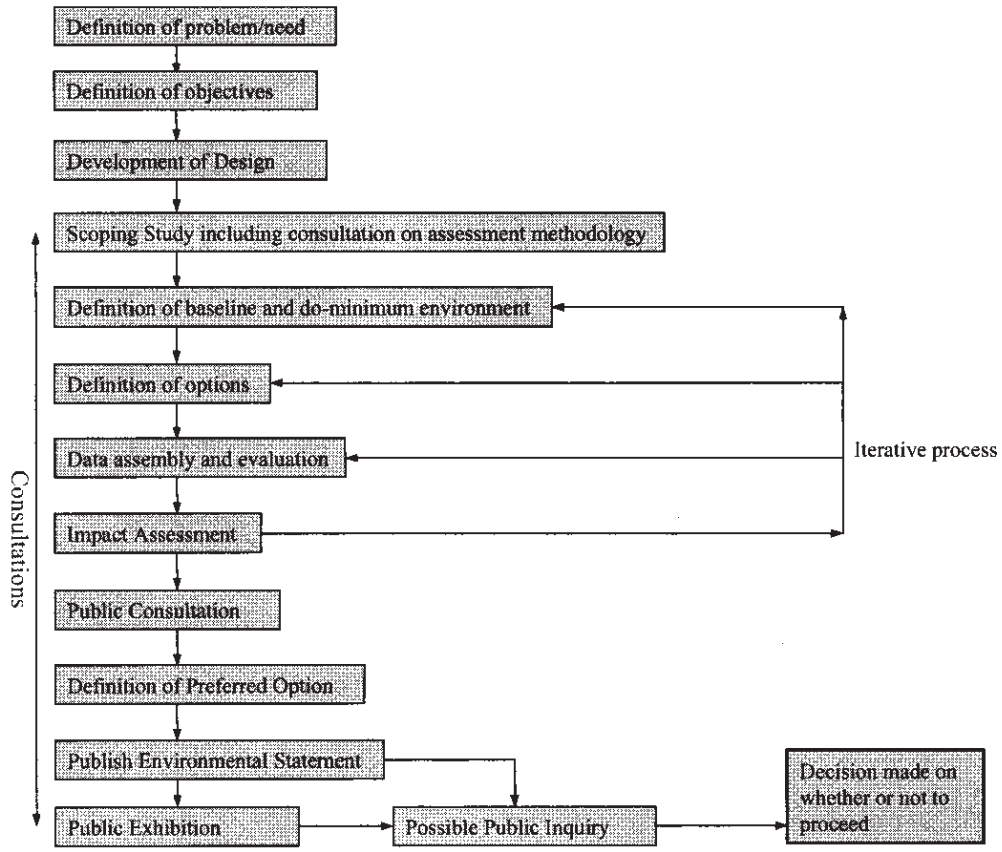


Diagram 1.5: The Environmental Impact Assessment Process for the A47 Scheme.

1.6 The Scope of the Environmental Impact Assessment

1.6.1 A scoping study of the potential environmental effects of the scheme was undertaken prior to the scheme design and presented in an Environmental Assessment Scoping Report published in October 2002[3]. The aim of the report was to set out the scope of the environmental assessment in line with the DETR's Good Practice Guide,[4] which indicates that the Scoping Report should define the following:

- the nature of the project;
- the breadth of the environmental assessment;
- the range of key issues;
- the extent to which each topic needs to be investigated, defining the study area, data collection and methodology.

1.6.2 A draft of the Scoping Report was circulated to statutory consultees and their comments were included in the final version.

1.6.3 The Scoping Report identified the following issues, which would be subject to more detailed environmental survey and assessment:

- Planning
- Land Use
- Accessibility
- Geology and Soils
- Water Environment
- Landscape
- Biodiversity
- Cultural Heritage
- Air Quality
- Traffic Noise and Vibration
- Journey Ambience
- Disruption due to construction

1.6.4 These issues have been assessed in this Environmental Assessment Report although the following chapter headings have been substituted in this report in line with current Highways Agency practice:

- Planning is renamed "Policies and Plans"

[3] A47 Acle Straight Study: Environmental Scoping Report (GD00555/RT/03)

[4] Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practise Guide. DETR 1995.

- Accessibility is renamed "Pedestrians, Cyclists, Equestrians and Community Effects";
- Water Environment is renamed "Water Quality and Drainage";
- Biodiversity is renamed "Ecology and Nature Conservation";
- Journey Ambience is renamed "Vehicle Travellers".

1.7 Consultations

1.7.1 Extensive consultations concerning the gathering of data and the assessment of environmental effects of the scheme have been undertaken since the early stages of the EIA process. The aim of this dialogue is to anticipate and mitigate any concerns early in the design process. Consultations have been undertaken with organisations with statutory obligations relating to the scheme (statutory consultees) as well as other organisations with an interest in the scheme (non-statutory consultees).

1.7.2 The statutory consultees comprise the following organisations:

- Broadland District Council
- Broads Authority
- Countryside Agency
- English Heritage
- English Nature
- Environment Agency
- Great Yarmouth Borough Council
- Norfolk County Council

1.7.3 The non-statutory consultees include the following organisations:

- British Waterways
- Broads Environmental Services Ltd
- British Trust for Ornithology
- DEFRA
- Great Yarmouth Bird Club
- Kings Lynn Consortium Internal Drainage Board
- Local Wetland Bird Survey (WEBS) counter
- Norfolk Landscape Archaeology
- Norfolk Wildlife Trust
- Meteorological Office
- Other local Wildlife Recorders

- RSPB
- Sustrans

1.7.4 Appendix 1.2 of this Environmental Assessment Report contains summaries of the views of the consultees relating to each specialist environmental topic assessed.

2 Scheme Design

2.1 Project Objectives

2.1.1 The main objectives of the dual proposals (Options 2 and 2A) are to improve road safety and reduce traffic congestion whilst minimising adverse effects on the environment.

2.2 The Route and it's Setting

2.2.1 The Acle Straight is a single carriageway section of the A47, which consist of two straights, 3.5km and 7.5km long respectively, connected by one short curve. The carriageway is constructed on embankment with a height of 1 to 1.5m above surrounding ground levels. The carriageway width varies between 6.8m and 7.3m. There are no metre strips and the road is bordered by drainage dykes located at the foot of the embankment for the vast majority of its length.

2.2.2 There is only one junction along the route, it comprises a T junction with the unclassified road from Halvergate. There are 84 direct farm / property accesses along the length of the route, of which 15 are paved access and the remaining 69 are minor unpaved accesses such as field gates. Five properties also have a frontage along the route, the Stracey Arms Public House (now Pontiac Roadhouse), Stracey Arms Mill – foot access, Scaregap Cottages, the railway sidings at Great Yarmouth and Vauxhall Caravan Park.

2.2.3 Proposed safety improvements resulting from the 2001 Road Based Study will be implemented within the next few years. This includes implementation of a 50 mph speed limit along the Acle Straight and improved variable message signage along the A47 corridor to help incident management.

2.2.4 There are currently five sub standard laybys on the A47 between Acle and Great Yarmouth. These facilities are on one side of the road only at each location and their layouts are only suitable for vehicles stopping in emergencies.

2.2.5 Footpaths are located either side of the River Bure and these are linked to a number of footpaths which connect to and across the A47. Cyclists share the use of the A47 and local roads with motorised vehicles and there are no specific cycling provisions along the existing route.

2.2.6 The existing A47 runs approximately parallel to the River Bure and crosses marshland tributaries to the river. The route also crosses a number of dykes which are important in draining or supplying water to the marshes.

Dykes also run parallel to both sides of the existing road and are located at the foot of the road embankment.

2.2.7 Most of the area through which the A47 Acle Straight runs is designated as part of the Broads Authority, which has equivalent status to a National Park and therefore the landscape is considered to be of national importance. This is a flat landscape, located below sea level with expansive wetland of which grazing pastures / marshes are particularly characteristic. The marshland is also designated as an Environmentally Sensitive Area, which aims to protect and where possible enhance the distinctive pastoral character of the Broads area.

2.2.8 Existing water levels within the marshes are artificially maintained through pumping which is carried out to accommodate individual farming requirements. The grazing marsh and ditches along the majority of the scheme are considered by English Nature to meet the criteria for designation as Site of Special Scientific Interest (SSSI), although much of it has not been designated. At its western end it abuts a component part of the Broadland Ramsar site and the Broads candidate Special area of Conservation (cSAC), this area known as Damgate Marshes, is also designated as a Site of Special Scientific Interest (SSSI). At its eastern end near Great Yarmouth, the scheme corridor passes close to Breydon Water Ramsar site and Breydon Water Special protection Area (SPA), which is also designated as an SSSI. These areas are of international ecological importance, primarily as wetland habitat of value to wintering, breeding and roosting birds

2.2.9 Near to Halvergate Junction there is a grade two listed building (a drainage mill) in close proximity to the road, and also two World War 1 pillboxes under consideration for listings as Scheduled Ancient monuments (SAMs) are located on either side of the road towards the eastern end.

2.3 Scheme Proposals

Option 2 – Dual Carriageway Improvement

2.3.1 This option would involve widening the existing single carriageway to dual carriageway (2 x 7.3m carriageway plus 2 x 1.0m hardstrips). One carriageway would be within the width of the existing road embankment. The proposal includes a central reserve width of 8 metres between the new and old embankments to preserve the existing ditch/dyke adjacent to the existing highway and to keep the old and new highway embankments separate. The height of the new embankment would be virtually the same as with the existing road (see Figure 2.2). The road would have a 70mph speed limit.

2.3.2 The layout of Option 2 is indicated on Figure 2.1. In order to avoid impact on the SSSI site at Damgate Marshes located to the south of the existing road the new carriageway has been located to the north of the existing road

between Acle and Halvergate Junction. On environmental grounds the new carriageway has been located to the south of the existing carriageway between the Halvergate Junction and Great Yarmouth.

2.3.3 In order to consolidate the number of field/minor accesses to the existing road, access tracks with an unsealed surface would be constructed parallel with the road, outside the roadside dykes. This would allow access for all owners/tenants to a limited number of junctions with the A47. A new roadside ditch would be provided between the foot of the new embankment and the farm access track. There would also be some limited relocation and/or piping of existing ditches affected by the proposal and this would be subject to confirmation following detailed design, however approximate lengths of diverted ditch are indicated on Figure 2.1.

Option 2A –Dual Carriageway Improvement- Narrow Central Reserve

2.3.4 Option 2A is a compact dual carriageway improvement option with the same carriageway and hardstrip width as option 2 but with a central reserve width of just 2.5m between carriageways resulting in a minumum footprint (see Figure 2.2). Option 2A would involve widening of the existing embankment rather than construction of a separate embankment and this would result in the loss of one of the existing ditches over the entire route length (see Figure 2.4). A new ditch would be provided at the foot of the widened embankment along the entire length of the scheme.

2.3.5 As with Option 2 the new carriageway would be located to the north of the existing road between Acle and Halvergate Junction and to the south of the existing carriageway between the Halvergate Junction and Great Yarmouth. The arrangement of access tracks and access track junctions would be similar to Option 2.

Halvergate Junction

2.3.6 Because of the higher levels of predicted traffic and higher design traffic speed associated with the dual carriageway options a higher level of junction provision is required at Halvergate than with the existing road. It is therefore proposed that a roundabout be incorporated at the Halvergate junction for options 2 and 2A.

Access Tracks

2.3.7 The access tracks would be single lane (4m wide) with passing places located strategically along their length. It is proposed that a minimum 2m offset be allowed between the access tracks and the edge of existing ditches. The proposed maximum distance between passing places is 500m. The access tracks would be simply constructed as near to existing ground level as drainage and ground conditions allow.

2.3.8 The proposed scheme layout drawings depict an arrangement for these access track junctions based on a simplistic assessment without consultation with landowners and other affected bodies. The number of accesses directly on to the trunk road has been limited to two/three junctions per straight section to minimise disruption to the A47 traffic flow and potential accident locations

2.3.9 Access tracks have not been provided to Acle Junction due to the difficulties and potential cost of constructing them through a wetland area known as the Acle Slough on the north side of the road and woodland carr to the south. Paths for pedestrians and equestrians are proposed to link the northern access track to Acle roundabout and Vauxhall Roundabout at the western and eastern extremities of the scheme as indicated on Figures 2.1 and 2.2. In rural areas these would be unsurfaced.

2.3.10 Where access tracks and link paths cross existing ditches, bridges would be provided and these would be designed to minimise effects on the profile of the ditch.

Lay-bys

2.3.11 Proposed lay-by locations are illustrated on the layout drawings (Figures 2.1 and 2.2). Between Acle and Halvergate an existing lay-by to the west of Tunstall Dyke would be upgraded to current emergency standard and a new emergency lay-by would be constructed for the opposing carriageway. The installation of an emergency lay-by arrangement has been proposed at this location due to geometric and environmental constraints, and the distance from rest facilities at the Acle Roundabout and the Stracey Arms. Minimum length, modified lay-bys would be provided at these locations.

2.3.12 Between Halvergate Junction and Great Yarmouth there are three existing lay-bys. The eastern most lay-by is in close proximity to the Great Yarmouth Roundabout and would be discarded. The other lay-bys would be replaced by a single pair of lay-bys located at a convenient location along the straight between the proposed access track junctions, as shown on the scheme layout plans. The addition of further lay-bys at 2.5km spacing in accordance with current standards would be damaging environmentally to this sensitive site and have therefore not been added.

Lighting

2.3.13 The existing street lighting consists of 10m high columns with 135W low pressure sodium lanterns at 35 to 40m spacing, located at the roundabouts at either end of scheme and at Halvergate Junction. An outline design has been prepared (see Figures2.1 and 2.2), which meets current trunk road design standards but attempts to minimise daytime and night-time visual impact. The location of proposed street lighting for Options 2 and 2A would be the same as the existing road, i.e. at Halvergate Junction and the approaches to the Acle and Vauxhall roundabouts. The lighting columns

would be the same height and at similar spacing to the existing situation. The lanterns would be 150W high pressure sodium, flat glass full cut-off lanterns which would substantially reduce the amount of light trespass beyond the road corridor and significantly reduce sky glare. However some additional lighting units would be required to light the additional road space.

2.3.14 The height of lighting columns could be reduced from 10m to 8m but this would result in closer spacing of lighting columns resulting an approximate a 20% increase in the number of units. In view of the sensitivity of the area through which this scheme passes, departures from standard such as dimming lighting late at night, low level lighting units etc, may be feasible, but this would be subject to further study and design.

Signage

2.3.15 A preliminary review of the existing signage indicates that directional informatory signs (advance direction signs and direction signs) are only provided at the three major junctions on this scheme, the Acle roundabout, Halvergate junction and the Vauxhall Roundabout at Gt. Yarmouth. The signs at the approach to Vauxhall Roundabout are located beyond the road scheme and would not be affected by the proposals. The advance direction signs are generally the largest signs and there are four within the area of the scheme, one at the approach to Acle roundabout and the other three located at each of the approaches to Halvergate Junction. These signs vary in size between approximately 3m and 4m high. Advance warning signs are also provided for these junctions along with "sharp bend" warning signs on the approaches to the Halvergate and the Gt. Yarmouth Junctions. None of the numerous access tracks that join the A47 along this stretch have any directional informatory signs or junction warning signs.

2.3.16 There are a number of lay-bys (6 eastbound and 2 westbound) along this stretch of road that are equipped with emergency telephones. Each of these has a sign at the entrance to the lay-by and an advance warning sign either a quarter or a half-mile in advance of the lay-by. A number of "slippery road ahead" signs have also been provided together with a number of warning signs for cattle and agricultural vehicles in the road ahead.

2.3.17 A preliminary sign design has been prepared for the scheme which indicates the same four number of advance direction signs as the existing situation and these would be in similar locations to the existing road. To comply with current guidance these signs would be approximately 50-60% larger and the height of the signs would vary with one approximately 1.4m high and the others varying from 3.9m to 5.5m high.

2.3.18 In the proposed scheme a number (4 westbound and 4 eastbound) of the access tracks are linked together before joining the main carriageway. Junction warning signs on the main carriageway would be provided for these but this would be offset by a reduction in the number of warning signs required at present for individual access tracks and the reduction in the

number of lay-bys and associated signs from eight at present to four. However the lay-by signs would be larger than at present and overall there would be a small increase in the number of larger signs but a net reduction in the total number of warning signs.

2.3.19 The above sign design meets current trunk road design standards but attempts to minimise visual impact. In view of the sensitivity of the area through which this scheme passes, departures from standard such as reductions in mounting height and sign size, may be feasible, but this would be subject to further study and design.

Pavement

2.3.20 The existing road surface is conventional 'hot rolled asphalt' which is generally in a sound condition. However the skid resistance is poor in places and a new asphalt surface will be required along the whole route within the next few years prior to the year scheduled for completion of the proposals in 2012. It is Highways Agency policy that all new schemes shall be surfaced with a modern 'low noise surface' rather than a conventional road surface. Likewise it is policy to resurface existing trunk roads with 'low noise surface' as part of routine maintenance. Both the proposals and the existing road would therefore have a similar low noise surface by 2012.

Drainage

2.3.21 The existing road is cambered and there are currently no pollution control measures incorporated into the highway drainage system with runoff from the carriageway draining over the edge of the embankment into two ditches located on each side of the road at the foot of the embankment. The roadside ditches link into the surrounding system of dykes which have been developed over the centuries to drain this former area of marshland. At present there are no measures in place to deal with any accidental spills of hazardous liquids on the carriageway with consequential risk of contamination of the surrounding, ecologically sensitive dyke system.

2.3.22 The existing road incorporates two low bridge structures one crossing Tunstall Dyke and the other situated just east of Acle Roundabout. IDB drainage infrastructure maps indicate that seven main drains cross the Acle Straight, these are culverted and shown on Figure 7.1. The route of the road crossed many other dykes when it was built in the 19th century and a lot were blocked off at that time. Other dykes were culverted however these are in a varying state of repair and some of the culverts have collapsed so that not all remain fully operational.

2.3.23 The highway drainage for Options 2 and 2A would remain as over the edge runoff. The carriageways would have a crossfall sloping down towards the highway boundary and therefore all runoff from each carriageway would drain to just one adjacent ditch on the outside boundary. Any increased

runoff resulting from the scheme would be dealt with by additional pumping capacity to maintain water within the dykes at existing levels.

2.3.24 Option 2A would involve the complete loss of one of the existing roadside ditches and its replacement with a new ditch at the foot of the widened embankment. With Option 2 both existing roadside ditches would be retained and a further new ditch provided on the highway boundary, adjacent to the new embankment. There would be some minor alterations to existing ditches/dykes with Option 2, e.g. minor diversions at Halvergate junction and lay-bys and culverting/bridging of ditches crossed by the new carriageway and access tracks.

2.3.25 Where water connectivity remains between the dykes on each side of the existing road embankment, the collapsed culverts would be reinstated. Elsewhere otter underpasses would be provided at a minimum spacing of 500M to re-establish linkages for animals which were severed when the road was built in the 19th century (see Figures 2.1 and 2.2). These culverts/otter underpasses would be extended to accommodate the widened embankment in Option 2A and continued under the new embankment in Option 2. With Option 2 further culverts would also be provided so that every ditch/dyke crossed by the new embankment would remain connected. With both options the resulting design would give a minimum provision of culverts/otter underpasses at a spacing of 500m apart under all embankments. Where required all new and existing culverts would be provided with otter ledges which would be designed in line with current guidelines as far as is possible within the constraints of the scheme.

2.3.26 The biodiversity value of the Broadland dyke system is dependant on the quality of the water within them. In order to mitigate against potential adverse effects on water quality resulting from leachates entering the dykes, all embankment fill material and granular material used for construction of the farm access tracks shall consist of inert material. This material could be quartz or clay for the embankments or sands and gravels for the tracks. In addition all such material together with sub base material to be used for the construction of the road, would comply with leachate quality thresholds to be agreed with the Environment Agency.

2.3.27 Long term maintenance of the roadside ditches would be the responsibility of the Highways Agency for both options and would involve periodic clearance of ditch vegetation and silt as well as regular removal of rubbish. As a minimum the standard of maintenance would be the same as that currently implemented with the existing road but additional measures may also be implemented if it is considered that they would improve the biodiversity value of the ditches.

2.4 Construction of the Scheme

2.4.1 The actual construction width would be the same as the design width for both Options 2 and 2A so that the disturbed area would be restricted to

the footprint of any new embankment, ditch or access track. The proposed traffic management for Options 2 and 2A would involve construction of the new carriageway following which traffic would be diverted onto the new carriageway to enable work to proceed on the existing road.

2.4.2 There would be no night time working on either option 2 or 2A. The estimated construction period (excluding advance habitat creation works) for Option 2 would be 28 months and 22 months for Option 2A.

2.4.3 Construction of the new embankment would be subject to consolidation settlement loading and testing which it is estimated would take 6 – 9 months. This surcharge construction method would require removal and disposal of surplus material before carriageway construction. Access to farmland and all public rights of way would be maintained throughout the construction period.

2.4.4 All replacement dykes required as part of the proposals would be created before the existing dykes are disturbed. These new dykes would be constructed up to 3 years in advance of the destruction of existing dyke habitat in order to facilitate habitat creation which is likely to involve the establishment of plant and animal species translocated from the dykes to be removed.

2.4.5 In order to minimise adverse environmental effects during the construction phase there would be a contractual requirement for any additional compounds and storage areas, to be located outside the area administered by the Broads Authority. This restriction would also apply to any temporary access routes to such storage areas and compounds.

2.4.6 An environmental manager (EM) shall be appointed who shall be based on the site full time throughout the construction period. The EM shall be a qualified Member of the Landscape Institute, an ecologist who is a member of the Institute of Ecology and Environmental Management or an Environmental Manager who is a member of the Chartered Institute of Water and Environmental Management and have a minimum of 10 years site based, post qualification experience. The EM shall be supported by site based environmental clerks of works and other environmental specialists who shall visit the site on an as needed basis. The EM shall be responsible for producing an Environmental Management Plan (EMP) in advance of commencement of works, which shall identify standard environmental management procedures (induction of site personnel, meeting all relevant environmental legislation, etc.). It shall also indicate measures to be taken throughout the construction period in relation to all pertinent environmental issues identified in the Environmental Statement. Full records of the progress of environmental works shall be maintained which shall be held on site in a form suitable for review by the EM, such records and review shall form part of the EMP.

2.5 Traffic Issues

2.5.1 The Acle Straight suffers congestion from Monday to Friday throughout the year during both morning and evening peak traffic periods. Over the summer months, traffic flows in off-peak hours during the working week and on Saturdays and Sundays are swelled by trips made by holiday makers.

2.5.2 Traffic flows on the Acle Straight in 2000 were in the order of 8,800 vehicles per day eastbound, and 7,800 vehicles per day westbound. During the morning peak hour, the traffic flows were approximately 900 vehicles per hour eastbound, and 630 vehicles per hour westbound. By the year 2020, if the existing route is maintained at current standard, it is forecast that traffic flows on the Acle Straight would be between 11,300 and 13,500 veh/day eastbound, and between 10,900 and 12,700 veh/day westbound. Where the traffic falls in this range depends on whether low or high traffic growth is experienced in the area. During the morning peak, it would be expected that traffic flows travelling east would be between 1,000 and 1,200 veh/hr, and traffic flows travelling west would be between 900 and 1,000 veh/hr. By 2020, congestion at the Vauxhall Roundabout and slow speeds on the route would be expected to provide a real disincentive to use the Acle Straight, and some motorists would divert to routes to the north and the south.

2.5.3 If either Option 2 or 2A is implemented, by 2020 traffic flows using the Acle Straight would be expected to be between 14,700 and 17,800 veh/day eastbound, and between 13,500 and 15,200 veh/day westbound. This range indicates the spread of traffic flows that could be expected depending on whether low or high traffic growth is experienced in the area overall. During the morning peak, traffic flows travelling east are forecast to be between 1,300 and 1,700 veh/hr. Traffic flows travelling west are forecast to be between 1,200 and 1,300 veh/hr. In this case, the improved capacity of the Acle Straight would make the route an attractive option for east-west traffic, and a smaller proportion of motorists would use routes to the north and south.

2.6 Land Requirements

2.6.1 The existing road was constructed in the 19th century and it cuts across a pattern of drainage dykes which have been developed over the centuries and most of the roadside ditches were probably constructed at the same time as the road. However the current ownership of land occupied by the roadside ditches is complex with the Highways Agency (HA) owning some but not all of them. It is assumed that if Option 2 or 2A were constructed the HA would acquire all of the land occupied by both existing and new roadside ditches. However the measurements below do not include existing roadside ditches requiring acquisition but they do include all new ditches. The land required for Option 2 would be approximately 41 Ha of predominantly agricultural land and for Option 2A approximately 32 Ha would be required. Of this total approximately 8.8 Ha would be required for

the proposed access tracks which would run parallel to the road but would lie outside the highway boundary and following construction they would be handed back to the local landowners.

3 Policies and Plans

3.1 Introduction

3.1.1 This chapter assesses the extent to which options 2 and 2A are integrated with relevant planning, transport and other Government policies, distinguishing between the two options where appropriate.

3.1.2 The UK has a comprehensive planning system through which development and land use decision making is determined. This planning system operates on three levels: national, regional and local. National planning policy provides the overall framework, and contributes to the formulation of regional policy. Regional policy includes Regional Planning Guidance Notes (RPGs) and County Structure Plans. Local policies include borough and city level development plans formulated by Local Authorities in compliance with national and regional policies and strategic planning guidance.

3.1.3 The Government is currently pursuing reforms to the planning system, with Planning Policy Statements (PPSs) replacing Planning Policy Guidance (PPGs) at the national level, Regional Spatial Strategies (RSSs) replacing Regional Planning Guidance (RPGs), and Local Development Documents replacing County Structure Plans and Development Plans. However, at the time of writing, these proposals have not yet been through formal legislative or consultation procedures and have therefore not been included within this assessment.

3.1.4 The A47 Acle Straight lies within the County of Norfolk. It lies under the jurisdiction of Norfolk County Council and Great Yarmouth Borough Council and Broadlands District Council. In addition, most of the scheme lies within the Broads, an area with similar status to National Parks. The Norfolk and Suffolk Broads Act (1988) created the Broads Authority as a 'Special Statutory Authority' but with additional duties regarding navigation. The Broads Authority is required to produce a plan for its area and has planning powers delegated to it.

3.2 Methodology

3.2.1 The methodologies used in this chapter are derived from the DMRB Volume 11, Section 3, Part 12: Policies and Plans[5]. Additionally, where relevant and necessary, this has been supplemented with the

[5] Design Manual for Roads and Bridges, Highways Agency, June 1993.

methodologies given in the Guidance on the Methodology for Multi-Modal Studies[6] (GOMMMS), Section 8 Integration.

3.2.2 The GOMMMS section on transport interchange, which aims to assess how the scheme would affect transport interchanges for freight and/or passengers, is not relevant to this scheme and therefore has not been included in this assessment. Transport interchange is defined as the function of changing from one mode of transport to another, for example rail to bus.

3.2.3 Great Yarmouth Borough Council, Broadlands District Council, Norfolk County Council and the Broads Authority have been consulted regarding local and regional planning and the information that they have supplied has been used in this assessment.

3.2.4 Transport, land use and other relevant policies at national, regional and local levels have been assessed in terms of the possible impact of the scheme proposal on the achievement of the stated objectives of the policy. This assessment includes both formally adopted plans and any changes in policies that have occurred since the plans were adopted. In addition, other key policies or proposals from Government departments including the Departments of Health, Education and Culture have been reviewed and assessed.

3.2.5 The integration of the scheme with national, regional and local policies has been assessed using the significance criteria described in Table 3.1.

Table 3.1 Significance Criteria used in the Integration with Policies and Plans Assessment

Score	Contribution to Policies
Beneficial	The scheme contributes to or is consistent with policy
Neutral	The scheme does not affect the policy or equally benefits and hinders the policy.
Adverse	The scheme hinders or is inconsistent with the policy

3.2.6 For each group of policies, a final assessment is made by taking account of the balance between policies and proposals that are facilitated, hindered or are unaffected by the scheme. In accordance with GOMMMS recommendations (para 8.3.4), care has been taken to avoid duplication and policies are assessed at the most appropriate level, the weight attached to particular policies depending on their relevance to the scheme and the date and status of the plan being assessed.

[6] Guidance on the Methodology for Multi-Modal Studies, DETR, 2000.

3.3 National Policy and Guidance

3.3.1 Planning Policy Guidance Notes (PPGs) set out Government Policy on a number of different areas relating to planning. These policies must be taken into account during the planning process and may be material consideration in making decisions about road schemes.

3.3.2 The key PPGs of relevance to this scheme are as follows:

- PPG1 – General Policy and Principles (1997)
- PPG7 – The Countryside, Environmental Quality and Economic and Social Development (1997)
- PPG9 – Nature Conservation (1994)
- PPG13 – Transport (2001)
- PPG15 – Planning and the Historic Environment (1995)
- PPG16 – Archaeology and Planning (1991)
- PPG21 – Tourism (1992)
- PPG24 – Planning and Noise (1994)
- PPG25 – Development and Flood Risk (2002)

3.3.3 The advice contained within these PPGs has been taken on board in plan preparation at the regional and local level, as outlined in Table 3.2 below. Two PPGs require further elaboration.

PPG13 Transport

3.3.4 The current version of PPG13 was issued in 2001, after approval of Regional Planning Guidance, the Norfolk Structure Plan, the adopted Broadlands Local Plan, Great Yarmouth Plan and Broads Authority Local Plan. It advocates a safe, efficient and integrated transport system and an improved road network to support a prosperous economy, while recognising that the continued growth in road traffic can be detrimental to urban and rural areas and contributes to global warming. It attempts to integrate planning and transport policy at national, regional and local level, through:

- Promoting more sustainable transport choices for people and for moving freight;
- Promoting accessibility to jobs, shopping, leisure facilities and services by public transport;
- Reducing the need to travel, especially by private car.

3.3.5 The proposal to widen the A47 would improve the trunk road network and is also predicted to lead to:

- A reduction in traffic congestion;
- improved access to the port of Great Yarmouth;
- improved access to tourist area of Great Yarmouth and centres of employment;
- A slight improvement for an express bus route using the road from Peterborough to Great Yarmouth via Norwich due to reduced congestion and increased speed limit.

3.3.6 Conversely, the road improvements would also cause some increase in traffic along the A47 and would make no contribution towards discouraging people travelling by private car. There is presently no local bus service using this section of the A47 and no plans for a continuos, surfaced cycle lane along the route, although the farm access tracks could be used by pedestrians, cyclists and equestrians alike.

3.3.7 On balance the assessment in terms of PPG13 is therefore considered to be neutral

PPG25 Development and Flood Risk

3.3.8 PPG25, which sets out the Government policy on development and flood risk, was only adopted in 2001 and therefore was also not taken into account in relevant regional and local policy documents. However, flooding is not considered to be a significant issue within this scheme and the assessment in terms of PPG25 is therefore considered to be neutral.

Non-Planning National Policy and Guidance

3.3.9 National Transport Policy relating to road schemes is developed from the Integrated White Paper (1998), the daughter document relating to Trunk Road schemes (A New Deal for Trunk Roads in England, 1998) and the 10 Year National Plan (2000). The Highways Agency take the lead from these documents and subsequent Ministerial announcements in preparing their Strategic Plan for Improving the Network (Targeted Programme of Improvements). The A47 has not yet been included within the Targeted Programme of Improvements (TPI) and this report will aid the TPI decision-making process.

3.3.10 The Highways Agency also have Strategic Plans relating to Environment, Accessibility, Safety and Integration, which are assessed along with Other Government policies in Table 3.3 below. Other Government Policies relating to issues covered elsewhere in the assessment (eg National Air Quality Strategy, UK Climate Change Programme, Biodiversity Action Plans), are covered in the relevant chapters.

Summary

3.3.11 As outlined in Table 3.2 below, options 2 and 2A would affect the implementation of a wide range of national policies, creating a mixture of benefits, disbenefits and neutral effects. However, in the vast majority of cases, these can be considered to be regional and/or local effects. The two policy areas which can be stated to be of national significance relate to protection of the Broads (which is a national resource of equivalence to national park status, as set out in PPG7) and the ecological effects on SSSIs (also Ramsar, candidate SAC and SPA), which are national/international resources. Also of importance are protected species, as set out in PPG9. In terms of these particular aspects, as shown in Table 3.2 and in the landscape and ecology chapters, both options 2 and 2A generate adverse effects. Whilst option 2A generates the more significant ecological impact, on the three point assessment scale, both options 2 and 2A are considered to generate an adverse effect in terms of implementation of national policies.

3.4 Regional Policy and Guidance

3.4.1 The Regional policy framework for the scheme is set out in the following documents:

- RPG 6, adopted Regional Planning Guidance for East Anglia (Nov. 2000)
- Consultation on options leading to Regional Planning Guidance (RPG 14) for the East of England, (Sep 2002)
- East of England Regional Transport Strategy (April 2003)
- Norfolk Structure Plan (1999)
- Norfolk Local Transport Plan (2001/2-2005/6).

3.4.2 PPG11 (2001) outlines the current requirements for what should be included within Regional Planning Guidance (RPGs). In particular, RPGs should include a Regional Transport Strategy, setting out proposals for new infrastructure improvements in broad terms. Although the specific requirement for a Regional Transport Strategy was only introduced in 2001, strategic transport proposals have always been a central part of RPGs. Regional Transport Strategies are proposed to continue being a requirement within the emerging Regional Spatial Strategies (RSSs). Similarly, under s31(3) of the Town and Country Planning Act, Structure Plans should include policies and proposals in respect of the management of traffic.

3.4.3 The adopted RPG6 states that the improvement of the A47 between Norwich and Great Yarmouth should, along with completion of the dualling between the A11 to Norwich, be a top priority for improvements to the strategic road network in the East Anglian region (para 6.29). [Note in this document, the 'region' only refers to Norfolk, Suffolk and Cambridgeshire].

Para 6.33 goes on to state that the nature of such improvements is being considered within the Norwich to Great Yarmouth Study, one of a number of multi-modal and road based studies being taken forward in the region.

3.4.4 The Norwich to Great Yarmouth Study considered solutions to congestion and safety problems on the single carriageway sections of the A47 between Norwich and Great Yarmouth and the associated poor access/unreliable journey times to the ports of Great Yarmouth and Lowestoft. Reporting in October 2001, the Study indicated that existing accident problems on the A47 could provide sufficient public interest reason for overriding nature conservation interests in the Broads outlined in Section 3.3 above. Nevertheless, minimising environmental loss clearly remained a key objective and the Study's conclusions were therefore that the Acle Straight should not be dualled but widened to a modern single-two lane carriageway standard with an accompanying reduction in the numerous field accesses and frequent laybys.

3.4.5 Following recommendations by the Regional Planning Body/Government Office-East, in his August 2002 response to the Norwich to Great Yarmouth Study, the Minister for Transport announced the need to carry out further investigations into both the single carriageway and dualling options. This was to nclude the carrying out of full environmental assessments (the purpose of these two reports).

3.4.6 The consultation document on new Regional Planning Guidance (RPG14) in December 2002 set out two options for new transportation investment which can be summarised as major strategic investment or reduced road traffic growth. The results of the consultation were mixed and the resulting Regional Transport Strategy (April 2003) reflects this in its proposal for a balanced strategy between reducing the need to travel and the provision of new infrastructure to make travel easier. The results of the Norwich to Great Yarmouth Study and subsequent Ministerial decision are summarised in section 5.7 of the Regional Transport Strategy.

3.4.7 The County Strategy, as set out in Policy CS1 of the Norfolk Structure Plan is to provide for sustainable development in Norfolk. The County Transport Strategy (Policy T1) sets out to achieve a strategic transport network which will support sustainable development and the economic vitality and environmental assets of the County, a theme which is also reflected in the Norfolk Local Transport Plan.

3.4.8 Adopted in 1999, prior to the Norfolk to Great Yarmouth study, the Norfolk Structure Plan Policy T9 states that the Council will press for urgent studies of the A47 east of Norwich to Great Yarmouth and implementation within the Structure Plan period (ie before 2011). However, the policy goes on to state that the County Council supports dualling of the A47 between Norwich and Great Yarmouth.

Summary

3.4.9 In accordance with GOMMMS guidelines the same policies or proposals should not be included in more than one group. Therefore, although it is considered that options 2 and 2A generate adverse effects at the national level (due to the impacts on ecology and the Broads), at the regional level there is support for some kind of improvement. Moreover, whilst the County Structure Plan (and Regional Planning Guidance to a lesser extent) also includes a number of environmental protection policies, implementation of which the scheme may be considered to hinder. These are framework policies for implementation at the local level, and are therefore considered in section 3.5 below.

3.4.10 Although the County Council has been explicit in its support for dualling, Structure Plan Policy (T9) also recommends further study. Adopted and emerging regional policy is similarly supportive of the need for further work. However, whilst the Norwich to Great Yarmouth Study concluded that single carriageway widening should be the preferred option, this has not yet been incorporated into policy. On balance, it is therefore considered that dualling merits a neutral regional assessment score. At this level, there is no significant differentiation between options 2 and 2A.

3.5 Local Policy and Guidance

3.5.1 Local planning and transportation policy is set out in the following planning documents:

- Broads Authority Local Plan (1997), (due to be reviewed in 2004)
- Broadland District Council Local Plan (2000)
- Broadland District Council Local Plan Replacement (First Stage Deposit Version 2002)
- Great Yarmouth Local Plan (2001)

3.5.2 In their adopted local plan, Broadland District Council note that proposals for A47 dualling were removed from the National Roads Programme in 1996. Their position, set out in paragraph 7.6 (paragraph 7.36 of their 1st Stage Deposit Local Plan) is that they recognise the inadequacy of the A47 in its present form with lengths of single and dual carriageways. Consequently they will continue to seek the reinstatement of proposals to bring the remaining single carriageway lengths within their plan area to dual carriageway standard.

3.5.3 Great Yarmouth District Council see the dualling of the Acle Straight as an essential part of their Plan's Strategy (Great Yarmouth Local Plan, para 3.1.3). Paragraph 3.1.4 goes on to state that there is an agreed, common position of the County Council, Great Yarmouth, Broadland Local Authorities and the Broads Authority. This supports in principle the dualling of the A47 Acle Straight subject to compliance with PPG13, PPG9 and

avoiding adverse ecological effects on Damgate Marshes SSSI and minimising any adverse effects on the Broads environment.

3.5.4 The Broad's Authority's overall view, as set out in their adopted Local Plan policy TC1 is that "the authority will object to road schemes which are likely to have a significant adverse effect on the landscape, wildlife, waterways or built environment of the Broads. Such schemes must be demonstrated to be in the public interest before being allowed to proceed."

3.5.5 However, aware of the benefits of dualling, in particular to Great Yarmouth's competitive position, the Broads Authority acknowledge in paragraph 8.8 that they did not object to the earlier inclusion of dualling within the previous Structure Plan. Nevertheless, paragraph 8.8 also states that "[The Broads Authority] wish to ensure that any damage to the Broads area is minimised by careful and sensitive design of this road scheme."

3.5.6 Policy TC2 goes on to state that when road schemes are being implemented, they will seek to liaise closely with the Highways Agency to ensure the highest standards of planning, design, means of construction and associated landscaping in order to minimise impact of the proposals on the Broads environment.

3.5.7 The relevant proposals maps show the Halvergate Marshes Conservation Area covering most of the route (see Chapter 10 for more details). At the western end of the scheme, the proposals include work on the roundabout at Acle, which is adjacent to the Acle settlement envelope. At the eastern end, approaching Great Yarmouth, the proposals pass through an area designated as a 'Landscape Important to the Broadland Scene' (Great Yarmouth adopted local plan, Policy NNV2) before passing through a 'Landscape Enhancement Area (Policy NNV9). To the north at this point is the Bure Loop employment area, where the Council expect landscape buffers alongside the A47 and other roads as part of any development proposals (BL3, BL4). These and other relevant policies are assessed in Table 3.2 below.

3.5.8 As part of the assessment, a review was undertaken of the Broadlands Local Plan First Deposit Draft. However apart from a new policy (ENV4) on protected species, this revealed no other major policy changes which need to be reflected in Table 3.2 below. Whilst, in paragraph 7.38, the Council acknowledge the conclusions of the Norfolk to Great Yarmouth Study (referred to in 3.4.4 above), they still support dualling of the Acle Straight. Similarly, a review of the Draft Broads Plan (2003) – the precursor to developing a new Broads Local Plan – revealed no major emerging policy changes which are considered necessary to be taken into account in this assessment.

Summary

3.5.9 As outlined in Table 3.2 below, options 2 and 2A would affect the implementation of a wide range of local policies. Whilst there are some neutral and beneficial effects particularly relating to the approach to Great Yarmouth, the statistical majority of policies will be adversely affected.

3.5.10 Nevertheless, the Broadlands and Great Yarmouth Local Authorities support dualling of the Acle Straight in the reasoned justification to their transport policies. Broads Authority Policy TC1 advises that there must be proven public interest reasons to proceed with road schemes which generate significant adverse effects. The Norwich to Great Yarmouth Study (see paragraph 3.4.4 above) has considered this issue and recommends that reducing accidents on the route could be such a public interest reason, although their overall conclusion was that, for environmental reasons, single carriageway widening rather than dualling should be preferred. Moreover, the 2001 adopted Great Yarmouth Plan reports a common position of support in principle for dualling amongst the local authorities.

3.5.11 The effects on ecology and the Broads have been assessed at national level and are therefore taken out of the equation for local policies and guidance. Of the remaining policies the specific support for dualling of the Acle Straight expressed by the Local Authorities can be considered to be offset by the adverse effects on other policies contained within the various plans as outlined in table 3.2 below. Options 2 and 2A attract the same adverse/neutral/beneficial ratings in table 3.2, and are both rated as neutral in relation to local policy.

3.6 Other Government and Agencies Policies and Plans

3.6.1 As shown in Table 3.3 below, Options 2 and 2A would help the implementation of two Other Government Policies. However, there are three adverse ratings and a number of neutral ratings. The overall assessment score is therefore considered to be neutral.

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
Broadland District Local Plan Great Yarmouth Local Plan Norfolk Structure Plan PPG7	ENV1 NNV7 CS7, ENV1	These policies seek to protect and enhance the character and appearance of the countryside for its own sake	Adverse	The opportunities to include mitigation measures to protect the character and appearance of the countryside are limited due to ecological constraints and the unique open character of the landscape. Consequently there would be adverse impacts, as outlined in Chapter 8.
Broadland District Local Plan Broads Local Plan Great Yarmouth Local Plan PPG1	ENV2 B11 BNV20	These policies promote a high standard of layout and design, for example giving regard to the scale, form, height, mass, density, layout, energy efficiency, landscape, access, lighting, setting and use of appropriate materials.	Adverse	The scheme design recognises that widening is taking place in an area of high environmental sensitivity and landscaping, materials, lighting and other considerations would be designed accordingly. However the opportunities to include many landscape mitigation measures ordinarily used for trunk road schemes are limited due to ecological constraints and the unique open character of the landscape.
Broadland District Local Plan Broads Local Plan	ENV4 C7, C9	These policies seek to protect and promote the establishment and appropriate management of natural or semi-natural features such as trees, woodland, hedgerows, heathlands, rivers, streams, lakes and ponds, river flood plain marshes and other areas rich in wildlife such as	Adverse	Fen and carr woodland would not be affected however the proposals would affect semi-natural features and some valuable wildlife habitats, particularly roadside dykes and adjacent permanent grassland. Option 2A would involve roadside dyke replacement and Option 2 would result in additional lengths of dyke, but it would not always be

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
Great Yarmouth Local Plan Norfolk Structure Plan PPG9	NNV14 ENV9	former railway land, meadows and roadside verges. Broads Policy C7 identifies Fen and Carr woodland as a particular example for protection.		feasible to completely re-instate the complex habitats lost as a result of the proposals. The adverse effects resulting from Option 2A would be slightly greater than Option 2 due to the complete loss of one of the existing roadside ditches.
Broadland District Local Plan Broads Local Plan Great Yarmouth Local Plan Norfolk Structure Plan PPG9	ENV 5, ENV6 C2, C3 NNV12, NNV13 ENV6 ENV7 ENV8	These policies seek to protect and enhance SSSIs, Local Nature Reserves and other statutory and non-statutory areas of ecological interest.	Adverse	The scheme's ecological effects are detailed in Chapter 9 as being Adverse. In particular because of direct and indirect impacts on roadside dykes all of which are of biodiversity value and some of which (together with permanent grassland) are within Damgate Marshes SSSI and candidate SAC and associated Ramsar site. The adverse effects resulting from Option 2A would be significantly greater than Option 2 due to the complete loss of one of the existing roadside ditches.
Broadland District Local Plan	ENV.13	These policies seek to prevent the demolition of, or intrusion into the setting of listed buildings.	Adverse	As identified in the Cultural Heritage chapter, chapter 10, Options 2 and 2A would have some impact on the setting of the Grade II* Listed Stracey Arms Drainage Mill which is located adjacent to the A47. There would be also be some

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
Broads Local Plan Norfolk Structure Plan PPG15	B1 ENV13			slight adverse effects on the settings of other listed buildings (such as other drainagemills) located within the study area but at a greater distance from the route.
Broadland District Local Plan Broads Local Plan Great Yarmouth Local Plan PPG16	ENV.18, ENV.20 B15-17 BNV2	These policies seek to preserve findings of archaeological interest, recommending evaluations of archaeological significance and the use of Watching Briefs where appropriate.	Adverse	An area of earthworks of possible Saxon origin has been identified adjacent to the south side of the road and Options 2 and 2A would directly affect part of this area. Archaeological works would be undertaken in agreement with English Heritage and the County Archaeologist and if feasible embankment construction methods would be employed which reduce destruction of the buried earthworks. Elsewhere a watching brief would be implemented where necessary during construction in accordance with the requirements of the aforementioned organisations.
Broadland District Local Plan Broads Local Plan Great Yarmouth Local Plan	ENV.21 C15 NNV16	These policies seek to protect development on the best and most versatile land (Grades 1, 2 or 3a) wherever possible. [It should be noted that the relevant section of PPG7, Paras 2.17 - 2.18, were amended in 2001 to effectively give less weight to protection of higher quality agricultural land in comparison with other countryside planning objectives]	Adverse	As outlined in the land-use assessment (chapter 4), approximately 34% of the scheme area falls within agricultural land Grade 3a. No Grade 1 or 2 land would be affected 1but approximately 7.5ha of Grade 3a land would be required for Option 2 and Option 2A would result in the loss of approximately 14.2 ha Grade 3a land.

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
PPG7				
Broadland District Local Plan Broads Local Plan Great Yarmouth Local Plan Norfolk Structure Plan PPG25	ENV.24 CS4 CS14 INF1, INF3, INF5 INF8 B13 RC1 RC4	These policies seek to protect the availability and quality of water resources (rivers, wetlands and estuaries – surface water and groundwater) having reference to the needs of abstraction, navigation, fisheries, recreation and nature conservation and flood defence, and promote good drainage design.	Adverse	The effects on the River Bure, Breydon Water (estuary) and floodplain would be negligible, however there would be impacts on the ecologically sensitive marshland dyke system in the immediate vicinity of the road. All dykes would be retained with Option 2 however a retained roadside dyke would be isolated in the central reservation and suffer from habitat degradation. One of the existing roadside dykes would be completely lost with Option 2A and a replacement dyke provided adjacent to the new carriageway. All dykes that are crossed by the new carriageway and access tracks would have culverts/bridges constructed to maintain connectivity of the dyke system. The increase in hard surfacing resulting from construction of an additional carriageway would increase surface runoff but the existing IDB pumping regime would be altered to avoid all but localised changes to water levels and flows in the dyke system. The existing system of runoff draining over the road edge directly into roadside drains would be retained with all options and there would be an increases in some in pollutants. Mitigation would include vegetative treatment systems and all receiving ditches would be provided systems to enable isolation of any length of ditch contaminated from accidental spills thus reducing the risk of contaminating the adjacent dyke system.
Broadland District Local Plan Broads	ENV.25	These policies advise against proposals which generate a significant adverse impact on the quality, character or setting of the Broads area. The Broads Local Plan Policy covers the entire area of the Broads and therefore the majority of	Adverse	Both Options 2 and 2A would impact on the quality and character of the Broads and opportunities to include many landscape mitigation measures ordinarily used for trunk road schemes are limited due to ecological constraints and the unique open character of the landscape. Further detail

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
Local Plan Great Yarmouth Local Plan Norfolk Structure Plan PPG7	B11 NNV2 T12	the area traversed by the scheme. The Great Yarmouth Local Plan Policy covers an area at the eastern end of the scheme (see Figure 3.1) described as being landscape important to the Broadland scene.		is provided within chapter 8 which describes the effects on the landscape.
Broadland District Local Plan Broads Local Plan PPG13	TRA.12 TC10	These policies seek for adequate provision to be made for cyclists	Beneficial	At present, cyclists have to use the A47. However, the scheme would allow cyclists to use the surfaced, segregated farm access tracks as a safer alternative along most of the route. Unsurfaced path links would provide a segregated alternative for cross country cyclists along the whole of the route.
Broadland District Local Plan Broads Local Plan Great Yarmouth Local Plan	TRA.14 C11 NNV10	These policies seek to ensure that new developments, including highway schemes incorporate appropriate comprehensive landscaping schemes, making use of native species where possible, protecting and complementing existing landscape and wildlife features.	Adverse	A landscape assessment has been undertaken and proposals, including the planting of native tree species, are outlined in Chapter 8. However the opportunities to include many landscape mitigation measures ordinarily used for trunk road schemes are limited due to ecological constraints and the unique open character of the landscape. Effects on wildlife and ecological mitigation measures are described in Chapter 9. Mitigation would include retention of existing dykes and the provision of an additional (third) roadside ditch linking into the dyke system with Option 2. In Option 2A a replacement roadside ditch

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
				would be provided to compensate for the complete removal of one of the existing roadside ditches.
Broadland District Local Plan Broads Local Plan Great Yarmouth Local Plan Norfolk Structure Plan	RL.8 TR27 REC14 T12	These policies seek to protect, improve and extend the public rights of way network, the network of permissive footpaths and bridleways and public access.	Neutral	Public rights of way and footpaths have been maintained. However 3 public footpaths cross the road and these crossings would be made more difficult as a result of increased traffic speeds and additional carriageway to be crossed. This adverse effect would be offset by access tracks and path links to be included as part of the proposals which would extend the network of paths for non motorised users. These would provide alternative segregated routes along both sides of the road for pedestrians, equestrians and cyclists thus improving safety and journey ambience for these users.
Broadland District Local Plan PPG24	CS.17	This policy seeks to prevent high noise generators being located in close proximity to existing noise sensitive areas	Adverse	The noise assessment (chapter 12) indicates that noise increases are likely to be moderate adverse for option 2 and minor adverse for Option 2A.
Norfolk Structure Plan PPG21	EC1, EC7	These policies seek to provide economic growth and provide employment opportunities for existing and future populations, giving particular priority to Great Yarmouth. Policy EC7 seeks do this through strengthening and diversification of the tourist industry.	Beneficial	As a result of improved access to Great Yarmouth, the proposals should generally strengthen employment and aid tourism in that urban area. However the Broads is a major rural tourist attraction within the region and the River Bure forms part of a waterway network which is used for recreation. The increased visual and noise intrusion resulting from the increased scale of the dual carriageway would reduce the tranquility of this part of the Broads and also downgrade the experience for:

Table 3.2: Schedule of planning policies				
Document	**Policy**	**Summary of Policies**	**Rating**	**Scheme Effects**
				boat users on the river, pedestrians using public rights of way and visitors to Stracey Mill. This could possibly be sufficient to alter visitor patterns particularly in the vicinity of Stracey Mill. The provision of segregated paths alongside the road would provide additional facilities for tourists within the Broads area. The beneficial effects on the large population in Great Yarmouth are on balance considered to outweigh the adverse effects on the rural area.
Broads Local Plan	C.14	This policy seeks to prevent development on drained marshlands, except for development which is essential for conservation management, agricultural or land drainage purposes and which cannot be located elsewhere.	Adverse	Some drained marshland would be acquired in order to widen the A47 route to dual carriageway status.
Broads Local Plan	C.18	This policy seeks to prevent new roads or tracks for agricultural/forestry purposes where there is visual intrusion into the Broads landscape or there would be significant adverse effects on wildlife and wildlife habitats.	Adverse	Two farm tracks would be constructed on either side of the A47 as part of the scheme proposal. The southern track would include some land-take from Damgate Marshes SSSI and candidate SAC and associated Ramsar site.
Broadland District Council (1st Deposit Draft) PPG9	ENV.4	This policy seeks to prevent proposals likely to result in harm to a protected species or its habitat, unless measures will be taken to ensure that the species or habitat is protected.	Adverse	Protected species and habitats within the study area include water vole habitat, otters, bats, Norfolk hawker dragonfly, reptiles, some wildfowl and other species of birds including barn owls. Options 2 and 2A would have potential adverse effects on protected species of breeding and wintering birds, due to increased disturbance and land take, with slight additional effects on barn owl due to increased mortality risk. As a result of mitigation screening a slight beneficial effect would result for wildfowl using

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
				Breydon Water post-construction, although adverse effects would be likely during construction. Options 2 and 2A are likely to have an overall adverse effect on the dragonfly due to loss of existing habitat and deterioration of retained habitat. Option 2A would have a predicted neutral residual effect on reptiles due to creation of replacement habitat and Option 2 would have a slight beneficial effect due to additional habitat provided on new embankment slopes. The provision of otter underpasses under new and existing embankments would provide safer crossings under the carriageways for otters and water voles with both Options 2 and 2A. However there would also be adverse effects resulting from loss of dyke habitat and the increased length of culverts with Option 2A and for otters the unsafe environment of the dyke isolated in the central reservation with Option 2.
Broads Local Plan Norfolk Structure Plan PPG15	B.7 ENV13	These policies seek to only allow development which would preserve or enhance the character or appearance or the Conservation Area. [Note protection of Conservation Areas is only part of Norfolk Structure Plan Policy ENV13.]	Adverse	As identified in the Cultural Heritage chapter, chapter 10, the character of the Halvergate Marshes Conservation Area (located entirely within the administrative area of the Broads Authority) would be adversely affected by both Options 2 and 2A.
Great Yarmouth Borough – Wide Local Plan	NNV.9	This policy states that within identified Landscape Enhancement Areas, Great Yarmouth Borough Council will promote, seek and secure improvements to the landscape through restoration and enhancement measures including the creation of wildlife habitats.	Neutral	As the A47 enters Great Yarmouth, it passes through an identified Landscape Enhancement Area. With bothoptions existing vegetation would be lost in this area and the proposals involve new roadside planting as mitigation.

Table 3.2: Schedule of planning policies

Document	Policy	Summary of Policies	Rating	Scheme Effects
Great Yarmouth Borough – Wide Local Plan Norfolk Structure Plan	BNV.8 ENV13	These policies provide a strong presumption against the demolition of any buildings which are of local importance, stating that every effort will be made to find alternative uses for these buildings whilst retaining their essential character.	Adverse	Two World War One pillboxes flank the road to the west of Gt Yarmouth and English Heritage have confirmed their intention to schedule them. Only 12 such structures exist in Norfolk. The pill box to the south of the road is in the direct path of the new carriageway for both Options 2 and 2A and would have to be relocated subject to feasibility studies on the practicalities of moving this structure.
Norfolk Structure Plan	T1	This policy sets out Norfolk County Council's transport strategy, to achieve a strategic transport network which will support sustainable development and the economic vitality and environmental assets of the County.	Neutral	Dualling the A47 supports economic vitality. However, this must be offset against the adverse effects on the County's environmental assets.
Norfolk Structure Plan	T9	This policy states that the Council will press for urgent studies of a number of routes including, as a priority, the A47 east of Norwich to Great Yarmouth. The policy goes on to state that the County Council supports dualling of the A47 east of Norwich to Great Yarmouth.	Beneficial	Dualling the A47 directly complies with this policy.
Broads Local Plan	TC1	This policy states that the Broads Authority will object to road schemes which are likely to have a significant adverse effect on the landscape, wildlife, waterways or built environment of the Broads. Such schemes must be demonstrated to be in the public interest before being allowed to proceed.	Adverse	The Norwich to Great Yarmouth Study recommends that reducing accidents on the route could be such a public interest reason, although their overall conclusion was that, for environmental reasons, single carriageway widening rather than dualling is preferred. In the reasoned justification to the policy, the Broads Authority note that they have not opposed dualling of the Acle Straight. A reduction of fatal accidents would also be achieved through

Table 3.2: Schedule of planning policies				
Document	**Policy**	**Summary of Policies**	**Rating**	**Scheme Effects**
				the do-minimum situation (i.e. without any of the proposed options). An adverse effect to this policy has been identified pending demonstration that there is a public interest for dualling the A47 (which may be to aid the economic regeneration of Great Yarmouth).
Broads Local Plan	TC2	This policy states that when road schemes are being implemented, the Authority will seek to liaise closely with the Highways Agency to ensure the highest standards of planning, design, means of construction and associated landscaping in order to minimise impact of the proposals on the Broads environment.	Adverse	Options 2 and 2A would have a greater adverse environmental impact than single carriageway widening.
Great Yarmouth Borough – Wide Local Plan	BL.3, BL4	As part of an enhancement programme for the Bure Loop Employment Area, these policies seek to provide landscaped belts alongside roads, including a landscape belt 30 metres in width incorporating an earth mound of no less than 20 metres width and 3 metres in height along the A47 site boundary, and along the northern boundary of the development area. Landscaped belts should use native shrub species indigenous to the Broadland scene.	Beneficial	The proposals incorporate limited planting of native species alongside the road within the urban fringe of Gt Yarmouth. This planting can be integrated with the Bure Loop landscape belt.

Table 3.3 Other Government and Agencies' Policies and Plans

Planning Authority	Policy	Objective	Impact	Comments
Highways Agency	Environmental Strategic Plan	Specific key environmental objective is "to minimise the impact of the trunk road network on both	Adverse	As outlined in the biodiversity, cultural heritage and landscape sections of this report, the proposals would generate significant effects on the natural and built environment, although these would be

Planning Authority	Policy	Objective	Impact	Comments
		the natural and built environment".		reduced through appropriate mitigation measures. On balance Option 2A would generate slightly greater adverse environmental impacts than Option 2.
Highways Agency	Accessibility Strategic Plan	The aim of the plan is to make best use of existing infrastructure and facilitate integration of roads with other transport modes.	Neutral	Although no specific pedestrian/cycle tracks are provided, the proposals do provide access tracks on either side of the Acle Straight which would be of benefit to cyclists, pedestrians and equestrians. Path links to the western and eastern ends of the scheme would give the option of a segregated route for non motorised users along the whole route. However this would be offset by increased difficulty for pedestrians crossing the wider and faster road at 3 locations where public footpaths cross the road.
Highways Agency	Integration Strategic Plan	The relevant key aims and objectives including co-ordinating policy and practice by fostering positive relationships with Government departments and other authorities to integrate policies, activities and responsibilities.	Beneficial	During the course of this scheme consultations have been carried out with government bodies such as English Nature, the Environment Agency and English Heritage and Local Authorities. English Nature has been consulted on a frequent basis due to the high environmental sensitivity of the area. At the present time, the scheme is not specifically designated within Local or Structure Plans, but then this is consistent with it not yet being part of the TPI.
Highways Agency DEFRA	HA Safety Plan Tomorrows Roads: Safer for Everyone	These documents promote road safety considerations.	Beneficial	It is predicted that the current road safety conditions along the A47 would be improved as a result of the scheme.
DEFRA	Rural White Paper; England's Rural Development Program 2000-2006	These documents seek to protect and enhance the rural economy and living countryside in ways which also protect and enhance landscape and biodiversity.	Adverse	Enhancing the route is of importance to the urban economy of Great Yarmouth. However, there would be adverse effects on local agricultural practices, rural landscape and biodiversity as detailed elsewhere within this assessment. Increased noise and adverse effects on landscape character and quality resulting from the dual carriageway may also result in this rural area of the Broads being less attractive for tourists.

Planning Authority	Policy	Objective	Impact	Comments
British Waterways	Environ-mental Code of Practice	This document aims to ensure that development near waterways enhances their environmental quality and long-term viability.	Adverse	There would be no direct impact on the waterways of the Rivers Bure and Yare, the long term viability of which would not be affected as a result of the scheme. Tunstall Dyke would be directly impacted with the need for an additional bridge crossing for Option 2 or a widened bridge with Option 2A, however in practice, this waterway is not navigable at present. Increased noise and adverse effects on landscape character and quality would also adversely affect views and tranquility experienced from parts of the River Bure and Tunstall Dyke and their adjacent footpaths.
Department of Health	Green Paper: Our Healthier Nation	Suggest social and environmental factors impact on health, including air and water quality and access to services, including transport.	Neutral	The road improvements would reduce congestion and although local air quality would be improved compared to the existing situation, on balance there would be a deterioration compared with the do-minimum scenario. The farm access tracks and bridleway links could be used by pedestrians, equestrians and cyclists, and accessibility between Great Yarmouth and Acle would be improved. There would be negligible effects on access to public transport. With mitigation water quality in the adjacent dyke system would improve slightly with Options 2 and 2A.
East of England Tourist Board	A Strategy for develop-ing tourism in the East of England	This regional policy document seeks to promote the perception of the East of England as the best region in England through developing and supporting tourism and employment initiatives in a sustainable manner.	Neutral	The widening of the A47 and the reduction in traffic congestion would increase accessibility to Great Yarmouth thus supporting the development of tourism in the urban area and assisting employment initiatives. However the Broads is also a major tourist attraction within the region and the River Bure forms part of a waterway network, which is used for recreation. The increased visual and noise intrusion resulting from the increased scale of the dual carriageway would reduce the tranquility of this part of the Broads and also downgrade the experience for boat users on the river, pedestrians using public rights of way including the paths alongside the Bure and visitors to Stracey Mill . This could possibly be sufficient to alter visitor patterns particularly in the vicinity of Stracey Mill.

Planning Authority	Policy	Objective	Impact	Comments
				The provision of segregated bridleways alongside the road would provide additional facilities for tourists within the Broads area.
Norfolk County Council	Norfolk Cultural Strategy	This sets out the Norfolk County Council proposals, in conjunction with the various Local Councils, for increasing visitor attractions and winning investment to help and spread the benefits of Norfolk cultural life.	Neutral	This scheme does not directly contribute to or hinder this policy.
Great Yarmouth Borough Council	Draft Cultural Strategy	The strategy aims to protect, invest in and enhance Great Yarmouth's cultural heritage	Neutral	The reduction in congestion as a result of the scheme may encourage more visitors to Great Yarmouth to enjoy the cultural heritage and the cultural scene. The scheme would have some adverse effects on the historic environment along the existing A47 but it would not effect historic environment of the town of Great Yarmouth.

4 Land Use

4.1 Introduction

4.1.1 Road schemes can have significant impacts on local communities, through property demolition, loss of agricultural and development land and community open space. This section assesses the potential impacts of land take resulting from the A47 Acle Straight proposals within the study area. National, regional and local land use policies relevant to the scheme are discussed in Chapter 3, Planning.

4.1.2 Unless stated otherwise, comments on the impacts on land use apply to both dual carriageway options.

4.2 Methodologies

4.2.1 The general methodologies used in this chapter have been based on guidance in the DMRB Volume 11, Section 3, Part 6: Land Use[7].

4.2.2 The assessment of the effects of land-take for a road scheme can cover a wide range of land values and primary uses. As recommended in the DMRB, this study has assessed impacts on:

- Private property (residential, commercial, industrial and other, excluding community facilities)
- Land used by the community
- Development land
- Agriculture

Private Property

4.2.3 Where properties need to be demolished for a scheme to be built, the environmental impact of their loss should be included in the assessment. Compensation due to owners and occupiers whose property is required to build the scheme is included in the economic appraisal. However, demolition can give rise to a range of other effects, including loss of facilities or amenities; loss of attractive buildings or townscape; and the opening up of views for other properties previously screened. These impacts are discussed in the other relevant chapters of this report. In certain cases there may also be employment implications arising from the loss of all or part of a business's premises.

[7] Design Manual for Roads and Bridges, Volume 11, Environmental Assessment. Section 3, Part 6.

Land Used by the Community

4.2.4 Information on Common Land, Town or Village Greens, Garden Allotments and Public Open Spaces was obtained from the local planning authorities and backed up by observations during site visits.

Development Land

4.2.5 Proposals maps from the following development plans were assessed, to determine if the scheme conflicted with proposed development.

- Broadland District Council Local Plan (2000)
- Broadland District Council Local Plan Replacement (First Stage Deposit Version 2002)
- Great Yarmouth Local Plan (2001)
- Broads Authority Local Plan (1997)

Agriculture

4.2.6 In broad terms, the agricultural assessment is intended to identify and predict the likely effects of the proposed development on agricultural resources and interests, and to recommend measures to mitigate such effects. This assessment covers two different aspects of agricultural impacts. The first is the loss of agricultural land and soils as in the context of "natural capital", i.e. as a change in land use. The other is the effect of the Scheme on agricultural units, or farm businesses.

4.2.7 The principal agricultural resource is the land, and the key agricultural land use consideration is to minimise the loss of best and most versatile agricultural land (Grades 1, 2 and 3a). National policy implies that, whilst the loss of any best and most versatile land is to be avoided where possible, the loss of more than 20 hectares of such land may be significant in the national interest. Similarly, the loss of agricultural land of poorer quality is unlikely to be regarded as significant in agricultural terms, unless it performs some particularly significant long-term role in the local context.

4.2.8 With farm businesses, there remains the objective of maintaining, as far as possible, a well-structured and organised farming industry in order that the nation's food supplies are produced consistently, efficiently and to appropriate standards of quality. To this end, considerable public resources have been devoted to ensuring that farms attained sizes and levels of capital investment commensurate with the nation's need for efficient food production. In the current era of agricultural surpluses, the objective of sustaining efficient production and safeguarding past investment has not been lost in the need to contain levels of output.

4.2.9 The impact on farm holdings can, individually or in aggregate, have the effect of rendering the land incapable of fulfilling its present functions, which

is the criterion for assessing the significance of environmental effect. It is recognised that the impact may have an economic effect on the holding and whilst this is not an environmental effect it may result in changes to the way in which the land is used, which may have an environmental effect.

4.2.10 This assessment therefore seeks to identify:

- the total quantity and quality of agricultural land that would be taken temporarily and permanently;
- the nature of the soil resource that would be affected;
- the impact of land loss and severance on agricultural holdings;
- the potential loss of agricultural buildings and other fixed farm capital;
- any loss of access to farmsteads or fields;
- construction impacts, such as disruptions to field drainage, nuisance from dust, construction traffic and general construction activities.

4.2.11 The general approach adopted by this study has been derived from the present planning advice from central and local Government on the treatment of agricultural issues in development affecting farmland. This approach accords with the advice in the DOE's Good Practice Guide 'Preparation of Environmental Statements for Planning Projects that require Environmental Assessment' (2000).

Agricultural Land Resources

4.2.12 Information on the extent and quality of agricultural land and the soils that would be affected by the proposed development has been collected from published material and a detailed field survey carried out along a 100m wide corridor either side of the existing A47. The ALC survey was carried out by an agriculturalist and the detailed methodology is described in a specialist report[8]. The ALC survey followed the methodology established by Ministry of Agricultural, Fisheries and Food in 1988 which requires an examination of published geological, topographical, soil and climatic information, and a detailed field survey using auger borings and soil observation pits.

4.2.13 The relative importance of agricultural land is scaled here according to Agricultural Land Classification (ALC), based on the Stage 3 guidance given in DMRB.

[8] A47 Acle Straight Improvement Single carriageway Option – Agricultural Assessment. September 2003

Table 4.1: Importance of Agricultural Land Based on Agricultural Land Classification	
Importance	**ALC Category**
High	Grade 1
Medium	Grade 2 and 3a
Low	Grade 3b
Negligible	Grade 4 and 5

4.2.14 There is limited guidance on what is considered to be significant in terms of loss of agricultural land of different grades. In DMRB consultation is required with MAFF (now DEFRA) for land take in England of Grade 1, 2 and 3a land greater than 20ha in extent. For this assessment the scale of impact has been assessed using the criteria indicated in Table 4.2.

Table 4.2: Guidance for Estimating the Effect on Agricultural Land.	
Scale of Impact	**Land Take of Agricultural Land Area (in ha)**
Major	> 20 ha
Moderate	5 – 20 ha
Minor	< 5 ha

4.2.15 Significance is then calculated by combining the scale of impact and importance or sensitivity. Neither DMRB nor GOMMMS specify how the significance of effect should be scaled with regard to agricultural or other land use. Hence a generalised approach has been taken, based on other topics in GOMMMS, as shown below in Table 4.3.

Table 4.3: Significance of Effect on Agricultural Land			
Importance of Agricultural Land	**Scale of Impact Upon Land Take on Agricultural Land**		
	Major	**Moderate**	**Minor**
High	Highly Significant	Significant	Low Significance
Medium	Significant	Low Significance	Not significant
Low	Low Significance	Not significant	Not significant
Negligible	Not significant	Not significant	Not significant

4.2.16 Impacts which are beneficial are regarded as positive, and impacts which are adverse are regarded as negative. Where no overall change results, impacts are regarded as neutral. Using this method for assessment would mean, for example, that land take of >20 ha Grade 1, 2 or 3a land would be considered to be highly significant or significant, but land take of a similar area of Grade 4 land would not.

4.2.17 All of the agricultural land that would be affected by the proposed scheme falls within the Broads Environmentally Sensitive Area (ESA), which has been designated to preserve and enhance the landscape and ecology of the marshland habitats. However the above matrices do not take account of the environmental capital of the ESA as the effects of the proposals on landscape and ecology are considered in Chapters 8 and 9 of this report.

Agricultural holdings

4.2.18 In terms of assessing impacts on agricultural holdings DMRB guidance indicates that the assessment should consider the impact on land use, severance and boundary impacts, as well as the effect on farm viability.

4.2.19 Viability is a term used to define the level of income derived from an agricultural business. In the context of this assessment, a viable business has been considered to be one offering a farmer the prospect of a reasonable return to land, labour and capital.

4.2.20 Interviews have been held with the majority of the owners of the land affected to establish the physical characteristics of the farm structure and to identify any adverse effects arising from the proposed development. Land boundaries in the vicinity of the Acle Straight were identified, along with principal access routes. Consideration was given to the main uses made of the land potentially affected, together with the potential impacts of the road's construction on the various units. Opportunities for mitigation of impacts were also explored.

4.2.21 Where the effect on farm business viability could be adversely affected, an assessment has been conducted based on simple gross margin analyses using standard published data (*Farm Management PocketBook*, 33rd Edition, (2003), Imperial College, Wye). This procedure is widely adopted by agricultural assessors and is a useful guide to possible farm profitability.

4.2.22 Various factors contribute to the categorisation of impacts including loss of land, severance, reduced convenience of access, increase in management requirements and/or costs, changes in cropping and stocking, loss in income and loss of viability. In assessing the impacts, account was taken of the type, duration and term of the tenure arrangements. The tenures include: owner occupation, full agricultural tenancies, Farm Business Tenancies (FBTs), and gentlemen's agreements or seasonal arrangements.

4.2.23 There is no standard assessment methodology for determining the magnitude of impacts, but the following classification system detailed in Table 4.4 has been used to assess the magnitude of effect.

4.2.24 Effects can be either adverse where the income or viability of the unit would be negatively affected (i.e. income derived would fall) or beneficial, where

new opportunities or improvements are likely to be facilitated by the Scheme.

Table 4.4: Guidance for Estimating the Effect on Farm Holdings	
Magnitude Criteria	**Definition**
Large Adverse	The impact of the proposal would be likely to render the whole farm non-viable.
Moderate Adverse	The viability of the business should not be threatened but significant changes in the day-to-day management may be required.
Minor Adverse	The viability of the business is not threatened: minor changes would be required to the enterprises and the type and range of enterprises is unaffected.
Neutral	The financial impact would be insignificant in relation to net farm income and no alteration to the farming system would be needed to absorb the physical impact.
Minor Beneficial	The potential profitability of the business would not be noticeably affected, but day-to-day management of the unit would be made easier by, for example, easier access to off-lying land or by "de-severing" land lying across busy roads that would experience reduced traffic flows.
Moderate Beneficial	The potential profitability of the business could be enhanced by, for example, an increase in the area of land farmed, a reduction in severance, or the removal of traffic from access routes.
Major Beneficial	The viability of the business could be enhanced by, for example, the introduction of new business opportunities as a direct result of the proposed new construction.

4.3 Baseline Conditions

Private Property

4.3.1 Most properties within the study area are located on the outskirts of Great Yarmouth and Acle at either end of the route (see Figure 4.1). These are found to the west of Acle Roundabout at the western end and to the north and east of Vauxhall Roundabout at the eastern end. On the approach to the Vauxhall Roundabout there is also a large caravan and mobile home complex called 'Vauxhall Holiday Park' which borders the northern side of the road and opposite on the south side of the A47 the road is bordered by some railway sidings.

4.3.2 Elsewhere along the route there are two properties located adjacent to the existing carriageway at Halvergate Junction, these are the Stracey Arms Public House and the drainage mill located beside Mill House Farm. To the east of this junction two isolated residential properties called 'Scaregap

Cottages' are located in a narrow gap between the present carriageway and a bend in the River Bure.

4.3.3 There are also a number of marsh farm houses and outbuildings, pumping mills and isolated dwellings scattered across the Halvergate Marshes, but within the study area these are either to the south of the railway line or over 300m to the north of the A47.

Land Used by the Community

4.3.4 The area through which the A47 passes is likely to be informally used by local communities of Acle and Great Yarmouth, as well as by recreational visitors to the area. Apart from the public rights of way network (addressed in the Accessibility Chapter), there are no areas that are specifically designated for community use (i.e. common land, town / village green / allotments or public open space) along the route. However the River Bure and flanking footpaths provides an important recreational resource, part of a network of waterways within the Broads which is used for recreational boating.

4.3.5 A number of privately owned facilities are present that are used by communities:

- A number of community facilities are present within Acle, as would be expected in a small town. None of these would be impacted by the scheme as the start of the scheme is on the outskirts of the town.
- A motel and vehicle service station are located adjacent to the Acle Roundabout.
- The Pontiac Road House Restaurant and Bar (formerly known as the Three Feathers PH and the Stracey Arms PH) and a Drainage Mill (open to the public) with associated shop are located on the north side of the road, opposite the Halvergate junction.
- The Vauxhall Holiday Park is located at the Great Yarmouth end of the scheme.
- Within Great Yarmouth (outside of the study area), community facilities are provided to serve residents and visitors, as would normally be expected of a large town.

4.3.6 The areas where these facilities are located are shown in Figure 5.1.

Development Land

4.3.7 In the development plans produced by the planning authorities, only one area was indicated as being designated for future development – the Bure Loop Development Area, designated for employment purposes (see Figures 3.1 and 4.1).

4.3.8 The Bure Loop area is situated north of the A47 and lies to the east of a future A47/A149 link. The link (which lies partly in the Broads Executive Area) will be the sole access to the development land. No further development will be allowed in the area (other than existing commitments) prior to the completion of construction of the link road and all access to the development allowed under the policy will only be permitted from the link road. The aim of the development area is to indicate existing land-use commitments; to put forward revised land allocations and to incorporate planning policies which will enable the creation of a well-landscaped development area on one of the main approaches to the town.

Agricultural Land Resources

4.3.9 The majority of the study area is a low-lying marshland with the Norwich to Great Yarmouth railway line to the south, and the River Bure to the north. The agricultural use of most of the land is pasture, supporting cattle, sheep and horses, both as grazing and for hay production with areas of arable land most of which are located towards the two ends of the road.

4.3.10 Figure 4.1 indicates the approximate extent and distribution of the different ALC grades and subgrades along the survey corridor which extend 100m either side of the existing road and the relative extents are tabulated below (Table 4.5). Further detail is given in the specialist report prepared by the agriculturalist[9].

Table 4.5: Agricultural Land Classification of the Study Area

Grade	Approximate Area (ha)	% agricultural land
1	--	--
2	--	--
subgrade 3a	40	38
subgrade 3b	60	55
4	7	6
5	1	1
Totals	108	100

Agricultural Holdings

4.3.11 In terms of agricultural utility, the land that would be affected is generally of reasonable quality and is capable of a range of cropping options though unsuited to top- or soft-fruit production or for growing potatoes.

4.3.12 In this part of the Broads the Government has established an Environmentally Sensitive Area (ESA) the boundary of which is indicated in figure 8.1. This is an agri-environmental scheme now part of the England Rural Development Programme which implements the Rural Development Regulation of the Common Agricultural Policy. Specifically it seeks to preserve and enhance the landscape and ecology of the marshland

[9] A47 Acle Straight Improvement Single carriageway Option – Agricultural Assessment. September 2003

habitats, by encouraging less-intensive, (generally permanent pasture) agricultural practices, and supports farmers to do this within a 10-year management agreement. Figure 4.2 indicates the farmland within the study area that is managed under the terms of the ESA agreements. Those agricultural areas which are not coloured are usually managed as arable land.

4.3.13 Table 4.6 identifies the holdings that would be affected with reference to Figure 4.1. Full details of the holdings are indicated in the specialist report prepared by the agriculturalist.

Table 4.6: Present occupiers: land holding size and main enterprise.

Holding ref. no.	Approximate Holding Size (ha)	Main Enterprise/Land use
1	n/a	Non-agricultural (Parish Council)
2	141.0	Permanent pasture for grazing
3	6.4	Permanent pasture (seasonally let)
4	1.4	Permanent pasture (seasonally let)
5	7.7	Permanent pasture (seasonally let)
6	4.5	Permanent pasture (seasonally let)
7	40.0 (2)	Dairy youngstock grazing
8	c.90.0	Arable and beef
9	104.0	Permanent pasture (seasonally let)
10	1214.0	Arable, dairy, poultry
11	c.1900.0	Arable, beef and sheep
12	525.0	Arable and sheep
13	0.2	Derelict land
14	92.2	Arable and beef
15	c.200.0	Permanent pasture (seasonally let)
16	1.0	Permanent pasture (non-commercial uses)
17	22.2	Permanent pasture (3)
18	28.0	Permanent pasture (seasonally let)
19	170.0	Permanent pasture (seasonally let)
20	c.20.0	Permanent pasture
21	10.0	Permanent pasture (seasonally let)
22	19.2	Permanent pasture (seasonally let)
23	283.3	Arable and seasonally let marshes
24	101.0	Arable

Table 4.6: Present occupiers: land holding size and main enterprise.		
Holding ref. no.	**Approximate Holding Size (ha)**	**Main Enterprise/Land use**
25	6.0	Permanent pasture (seasonally let)
26	273.0	Arable, beef and sheep
27	10.0	Permanent pasture
28	400.0	Permanent pasture (cattle grazing)
29	25.6	Permanent pasture (seasonally let)
30	11.5	Permanent pasture (seasonally let)
31	104.0	Arable

4.4 Assessment of Effects - Demolition of Private Property and Associated Land Take

4.4.1 No property demolition would occur as part of the proposals, although with both dual options one roadside property, a World War I pill box, is on the alignment of the second carriageway to the south of the existing road (see feature B17 on Figure 10.1). This structure is under consideration by English Heritage for scheduling and subject to further studies mitigation would involve moving it to a new location adjacent to the new carriageway (see Chapter 10).

4.4.2 Table 4.7 outlines those properties that would be subject to other land-use impacts as a result of the scheme. It also identifies their location, the type of property, and the nature of the impact.

Table 4.7: Properties Impacted by the Scheme				
Property	**Location**	**Property Type**	**Nature of impact**	**Significance**
Pontiac Road House Bar and Restaurant (formerly Stracey Arms PH)	Halvergate Junction	Commercial (also recreational)	A very small amount of land may be required for construction of the access track, but this depends on the detailed design.	No significant land-take.
Stracey Arms Mill House, Drainage Mill and shop	Halvergate Junction	Residential, Commercial and Recreational	The road widening would require land-take of approx. 200m^2 from the grounds of the drainage mill and house.	Land-take would occur at the front of the property but would not require any demolition. Minor

Scaregap Cottages	Approach to Great Yarmouth, at bend in River Bure.	Resid-ential	The farm access track, drainage ditches and road widening would require land-take of approx. 300m^2 from the grounds of Scaregap Cottages	Land-take would occur at the front of the property but would not require any demolition. Minor
Vauxhall Holiday Park	Outskirts of Great Yarmouth	Comm-ercial / Recrea-tional	The road widening would require some land-take outside the front boundary fence of the Vauxhall Holiday Park.	The land-take would be in the landscaped area outside the front boundary fence of the park, and should not have a significant impact on its operation. Minor
Disused Railway Sidings	Outskirts of Great Yarmouth	Comm-ercial	The road widening would require land-take outside boundary fence fronting the road.	The land-take would be outside the front boundary fence, and should not have a significant impact on its operation. Minor

Note: Land-take areas have been based on a conceptual design using 2D OS mapping.

4.4.3 When developing a more detailed design for either of the dual carriageway options further consideration should be given to the alignment of Halvergate junction and the northern access tracks in order to reduce impacts on Stracey Arms Mill and the Pontiac Roadhouse. Also the location and/or layout of the access track junction should be considered in greater detail at Scaregap Cottages in order to mitigate the impact on these properties. However any such measures could have impacts in terms of landscape and biodiversity and these would have to be considered when developing a more detailed design.

4.5 Assessment of Effects - Loss of Land Used by the Community

4.5.1 The effect on land used by the community is likely to be limited to impacts on privately owned community facilities (addressed above under "Demolition of Private Property and Associated Land Take"). In addition, a small amount of land would be lost at the end of public rights of way where they abut the road. However, this impact is unlikely to be significant. There are also likely to be indirect impacts on users of the River Bure where it is situated close to the road but this is considered under landscape effects

(Chapter 8). Overall the scheme would have a neutral effect on development land.

4.6 Assessment of Effects - Development Land

4.6.1 The only development area identified in the study area is the Bure Loop Development Area. The scheme is unlikely to have any significant direct impact on the scheme in terms of land take. However, the improvement of the A47 would facilitate journeys to the area, and may therefore assist in its development. The proposals for the A47 / A149 link are not yet developed, but would involve some form of junction with the new scheme to the west of the Vauxhall Caravan Park. Overall the scheme would have a neutral effect on development land.

4.7 Assessment of Effects - Agriculture

4.7.1 A detailed description of effects on agricultural land resources and individual agricultural holdings is described in the specialist report prepared by the agriculturalist. The description below summarises the findings in that report.

Agricultural Land Resources

4.7.2 As far as the likely permanent effect on agricultural land is concerned, and based solely on the landtake requirements identified on Figure 4.1 for the single-carriageway option, the areas of the various grades that would be affected by Option 2 are indicated in Table 4.8 below.

Table 4.8: Quality of Agricultural Land Affected

	Area (hectares) affected	Percentage
Grade 1	0	0
Grade 2	0	0
Subgrade 3a	17.5	43
Subgrade 3b	19.4	47
Grade 4	2.3	6
Grade 5	0.2	0
Non-agricultural land	1.7	4
Total project area	**41.1**	**100**

4.7.3 Option 2, would result in the permanent loss of some 41ha of agricultural land, of which 17.5 ha are classified as best and most versatile land in subgrade 3a. Such a loss is assessed as a Moderate Adverse effect with

Low Significance. If the minimum-width central reserve option (Option 2A) is constructed the land take would be reduced to c.32 ha, of which c.14ha is classified as subgrade 3a. Provided that soil handling is carried out according to current best practice, soil quality should be maintained in the long term. There should be no significant residual impact on the soil resource, provided that any surplus generated by the scheme is used in an appropriate manner.

4.7.4 One additional impact of the development of the Acle Straight Improvement would be the loss of some land being managed in accordance with the requirements of the ESA and this has distinct policy implications. . However, no land would be rendered unfarmable by the scheme and thus the impact on the ESA, in agricultural terms, would be related solely to the loss of land to the construction programme.

Agricultural Holdings

4.7.5 The assessment that follows is based on the wide-central reserve option (Option 2). The physical impacts arising from the minimum width option (Option 2A) would be the same albeit the areas of land lost would be marginally reduced (by approximately 18 percent).

4.7.6 The main long-term effect of the development on the individual farming units would be the permanent loss of land from agricultural use. With this particular on-line scheme there would be no new severance effects to consider though the issue of access to already fragmented holdings would need further consideration. Generally speaking, however, the provision within the design of the farm access tracks along either side of the proposed scheme would ensure that all existing field entrances can be replicated, and all field entrances would be replaced.

4.7.7 It should be noted that land-take has been measured from the proposals indicated in Figure 2.1, but there may be further areas of land required for measures such as essential landscaping or ecological mitigationand no account is taken of this potential additional loss of land. If any such areas required are substantial the viability of some of the holdings would be further adversely affected.

4.7.8 None of the farms which appear viable on the basis of standard gross margin analyses are likely to be rendered non-viable by the scheme, though this statement might be qualified in the light of knowledge of actual farm circumstances.

4.7.9 One issue that that has become apparent is that to the north of the road and east of Halvergate Junction, there would be no access from the east without travelling to the proposed new roundabout at Halvergate Junction, and then returning along the eastbound carriageway. This would require many of the farmers and two industrial operators to incur up to a c.14km diversion for every vehicle movement made from the east and this needs

further examination. Similar access difficulties would arise to the south of the road for farmers wishing to travel to Great Yarmouth. There would also be significant access difficulties for users of land and property to the east of Halvergate Junction on the north side of the road. Here long diversions via Vauxhall Roundabout would be required for those wishing to travel westwards as a result of the discontinuous access track in the vicinity of Stracey Mill.

4.7.10 Overall, and in view of the potential difficulties arising as a result of limited access, especially to the land to the north of the A47, east of the Halvergate junction, the following impacts to owners or tenants would occur:

- 13 would experience Moderate Adverse effects due to loss of commercial land and disruption to access;
- 10 would experience Minor Adverse effects due to loss of commercial land and disruption to access;
- 7 would have a Neutral effect and
- 1 would not be affected by the scheme.

Short-term Effects on Agricultural Land Use During the Construction Phase

4.7.11 Certain agricultural operations, such as silage making and grain harvest are heavily constrained by timeliness and require an uninterrupted flow of activity. Unrestricted access to fields is crucial at many times of the year and would be an issue that requires consideration during the construction process.

4.7.12 No details are presently available regarding the siting of construction compounds, soil storage areas and soil transfer sites other than the fact that these would not be located within the area administered by the Broads Authority. These facilities can lead to potential short and medium-term effects on those farming alongside. Physical intrusion beyond the construction boundary can result in crop losses and potential harm to animals, whilst soil storage areas can develop into reservoirs of weeds. Appropriate control measures, good site practice and liaison between construction contractors and the local farming community can help minimise these potential problems.

4.7.13 Noise is occasionally a problem for housed livestock, however none are housed close to the road. The completed road would not cause or generate any noise effect that would have a direct adverse impact on livestock. Of more concern are the occasional significant noise events that may occur during the route construction. This is an issue which would need detailed consideration prior to the works.

4.7.14 Major construction schemes can generate dust and pollution that has an adverse impact on the local agricultural community. Whilst it is unlikely that excessive dust contamination of grazing, hay or silage crops would occur, it

should be noted that control measures are possible, such as the frequent use of watering during adverse conditions, and are matters of good site practice.

4.7.15 In addition to the permanent loss of land, there are potential temporary land effects arising from the construction activities which would be associated with the proposed development. In the event of a failure to protect agricultural soils within areas of temporary usage, there is a potential for a permanent or long-term loss of land quality in the event of its return to agricultural use. This would be avoided by meeting the requirements of accepted best practice (for example, The Code of Good Agricultural Practice for the Protection of Soils. MAFF 1998).

4.8 Summary

4.8.1 In summary, the scheme would have the following effects on land-use:

- One property of heritage value would require moving to a new locationand some properties would be subject to land-take. The Pontiac Roadhouse (formerly Stracey Arms PH), Drainage Mill and Mill House and Scaregap Cottages would all be affected.
- There would be no significant direct impact on land used by the community or land set aside for development.
- The loss of 41ha of agricultural land (of which 17.5 ha are classified as best and most versatile land in subgrade 3a) would have a Moderate Adverse effect on agricultural land resources. Of the 31 agricultural holdings assessed, 13 would have a Moderate Adverse impact on access from land-use by the scheme, and 10 are assessed as Minor Adverse. Effects on other agricultural holdings would be neutral.

4.8.2 Mitigation measures could involve realignment of the route slightly further south at Halvergate Junction to avoid direct impacts on these properties. A review of the junction location and layout at Scaregap Cottages could also reduce the impacts of the scheme. However, these measures could have additional impacts in terms of biodiversity and landscape and any beneficial effect for land use would have to be weighed against other adverse effects.

4.8.3 The most significant impacts would result from access problems resulting in the need for long detours to land and properties to the east of Halvergate Junction, particularly on the northern side of the road. It is therefore recommended that the following alternative access track designs should be considered to reduce the access problems of the scheme:

- Providing access from Gt Yarmouth to the track on the northern side of the road
- Providing a continuous access track near to Halvergate junction so that there is no break at Stracey Mill.

4.8.4 If these measures were implemented there could be implications with the effects on other issues, particularly biodiversity which would have to be considered, however it would change the assessment of impacts on agricultural holdings to:

- 1 would experience Moderate Adverse effects;
- 12 would experience Minor Adverse effects;
- 17 would experience Neutral effects and
- 1 would not be affected by the scheme.

4.8.5 There would be no difference between options 2 and 2A with regards to the effects on access however the amount of agricultural land lost with Option 2A would reduce to c.32ha, of which c.14ha is classified as subgrade 3a. This would not effect the estimated order of effects on the 31 farm holdings which would remain the same as Option 2.

5 Pedestrian, Cyclists, Equestrians and Community Effects

5.1 Introduction

5.1.1 This section assesses the potential effects on pedestrians, cyclists and equestrians within the study area resulting from implementation of the scheme and associated changes in land use.

5.1.2 This assessment investigates the ways in which the scheme would affect journey patterns, length, amenity and overall community severance within the study area, particularly for vulnerable groups such as the elderly, the disabled and children.

5.1.3 There is increasing recognition of the interrelation between transport, the environment and health. The Government's Transport White Paper sets the framework for a number of issues in relation to health and transport, including the encouragement of physical fitness by reducing reliance on private cars and making it easier to cycle and walk more. This chapter also includes a Physical Fitness Assessment, which investigates the health implications of the scheme in relation to impacts on personal activity.

5.2 Methodology

5.2.1 The methodology followed in this assessment is derived from guidance in the DMRB, Volume 11[10]. In addition, where GOMMMS[11] appraisal of accessibility provides relevant supplementary or more detailed assessment criteria or methods, these have been incorporated.

5.2.2 Community severance refers to the degree to which movement and activities within a community are affected by the presence of a major road, especially the degree of separation of residents from the facilities and services they use within their community. DMRB indicates that community severance should be measured in terms of either the creation of 'new severance' or 'relief from existing severance' arising from the construction of a new road scheme. In addition to community severance, provision of access throughout the Broads for recreational interests is an important factor in the assessment of accessibility, and this has also been addressed.

[10] The Design Manual for Roads and Bridges, Volume 11; Environmental Assessment, Section 3, Part 8. "Pedestrians, Cyclists, Equestrians and Community Effects" Highways Agency, incorporating 2000 updates.

[11] Guidance on the Methodology for Multi Modal Studies, Volume 2, Chapter 7. Department of Environment, Transport and the Regions, 2000.

5.2.3 Additional guidance has been taken from the GOMMMS Physical Fitness Sub-objective; recognising the health benefits of increased non-motorised travel, and assessing the potential impacts of the scheme on the extent of physical activity through cycling and walking.

5.2.4 The assessment of impacts of the scheme on severance follows a 3-step process according to guidance in GOMMMS:

5.2.5 Step 1: For both the existing situation and with the scheme in place, community severance and accessibility for non motorised users has been classified according to the following:

Table 5.1: Classifications for Community Severance	
None	Little or no hindrance to journeys
Slight	All people wishing to make journeys would be able to do so, but there would probably be some hindrance to movement
Moderate	Some people are likely to be dissuaded from making journeys as they would be longer and less attractive.
Severe	People are likely to be deterred from making journeys to an extent sufficient to induce a reorganisation of their activities. Those who do make journeys would experience considerable hindrance.

Source: From GOMMMS, Guidance on the Methodology for Multi Modal Studies. DETR (2000)

5.2.6 Step 2: Changes in severance caused by scheme implementation are assessed using significance criteria shown in Table 5.2.

Table 5.2: Significance Criteria for Assessing Changes in Community Severance				
Level of Severance for Existing Situation	**Level of Severance Following Scheme Implementation**			
	None	**Slight**	**Moderate**	**Severe**
None	Neutral	Slight negative	Moderate negative	Large negative
Slight	Slight positive	Neutral	Slight negative	Moderate negative
Moderate	Moderate positive	Slight positive	Neutral	Slight negative
Severe	Large positive	Moderate positive	Slight positive	Neutral

Source: From GOMMMS, Guidance on the Methodology for Multi Modal Studies. DETR (2000)

5.2.7 Step 3: The overall assessment for accessibility / severance is then based on the following guidelines which take into account the number of people

affected (in each case, the assessment is beneficial if severance is reduced, adverse if severance is increased):

- the overall assessment is likely to be Neutral if increases in severance are broadly balanced by relief of severance;
- the overall assessment is likely to be Slight where change in severance is slight *or* the total numbers of people affected across all levels of severance is low (e.g. less than 200 per day);
- the overall assessment is likely to be Large where change in severance is large, and affects a moderate or high number of people *or* the total numbers of people affected across all levels of severance is high (e.g. greater than 1000); and
- the overall assessment is likely to be Moderate in all other cases.

5.2.8 Guidance in GOMMMS for assessment of Physical Fitness is based on the estimation of changes in the extent of walk and cycling caused by implementation of the scheme. The assessment methodology considers both the journey times and the change in the demand levels. Available evidence indicates that the minimum time of beneficial activity is 30 minutes, therefore there are four levels of benefit which can be considered:

- for new walk and cycle trips where journey times are below this threshold, there will be some minor health benefits;
- for new walk and cycle trips where journey times are above this threshold, there will be significant health benefits;
- for existing walk and cycle trips, where the journey time remains above the threshold, health benefits will be largely unchanged; and
- for existing walk and cycle trips, where the journey time falls below the threshold, there will be minor reductions in health benefits.

5.2.9 It should be noted that the River Bure forms a natural barrier to the north of the scheme, therefore issues to the north of the River Bure are not relevant to this study.

5.3 Policy

5.3.1 Government policy (PPG13), attempts to integrate planning and transport at national, regional and local levels to promote more sustainable transport choices, promote accessibility to jobs, shopping, leisure facilities and services by public transport and to reduce the need to travel, especially by private car. In addition the Accessibility Strategic Plan[12] aims to support non-motorised elements of travel, address community severance caused by trunk roads, improve conditions for people accessing public transport services on or via trunk roads, and improve facilities and linkages for

[12] "Encouraging Sustainable Travel" Highways Agency (2000)

pedestrians, cyclists, disabled people and equestrians along and across trunk roads.

5.3.2 Sustrans is co-ordinating the development of the National Cycle Network, a Millennium Project to develop a network of 10,000 miles of high quality cycle routes throughout the United Kingdom. The aim of these routes is to create an environment where cycling is a safe and viable option, and to offer a serious alternative to using the car with its associated damage to the environment and the countryside. As part of the National Cycle Network, Sustrans have been liaising with Local Authorities to propose a number of options for a route between Norwich and Great Yarmouth.

5.3.3 The Broadland District Local Plan and the Broads Local Plan contain policies that seek for adequate provision to be made for cyclists (TRA.12, TC10). All local plans also seek to protect, improve and extend the public rights of way network, the network of permissive footpaths and bridleways and public access (RL.8, TR27, REC14, T12).

5.4 Baseline Situation

Community / Recreational Facilities

5.4.1 Community severance refers to the degree to which movement and activities within a community are affected by the presence of a major road, especially the degree of separation of residents from the facilities and services they use within their community. The following communities occur within the study area:

- The only major settlements in the area, Acle and Great Yarmouth, are situated at each end of the route on the outer extremes of the study area. Each contains a range of important community facilities, including schools, shops, Post Offices and doctors surgeries. Communities in these settlements are likely to use facilities within their respective towns, and are therefore unlikely to suffer community severance caused by the A47 Acle Straight.
- Halvergate and Tunstall communities have no significant facilities (schools, Post Office, doctor) of their own, and would need to travel to Acle to access their nearest facilities. Non-Motorised Users (NMUs) travelling to Acle would be likely to cross the A47 via the Reedham Road underpass (outside of the study area), and would therefore be unaffected by severance caused by the Acle Straight.
- Along the A47 Acle Staight route, community facilities are limited to the Pontiac Roadhouse Restaurant (formerly Stracey Arms PH) and the drainage mill shop (selling confectionary and refreshments) at Halvergate junction. The present access to these facilities is via the A47 road or the River Bure (on foot or by boat). Residents of the few properties along the route are likely to access the majority of their community facilities in Acle and Great Yarmouth. Although the A47 provides direct access to both of these settlements, the lack of NMU

facilities along the road deters use by NMU's. In practice, due to the remoteness of the area and the long distances involved, people are likely to use motorised transport for essential travel, rather than walking or cycling.

5.4.2 The locations of the facility groups described above are shown on Figure 5.1.

5.4.3 In addition to community severance, provision of access throughout the Broads for recreational interests (walking, cycling and horse riding) is also an important factor in the assessment of accessibility. As a wetland, the Broads offers fewer opportunities for land-based recreation than other nationally protected areas. However, the area governed by the Broads Authority is similar in status to a National park, so access is intrinsically important.

5.4.4 The main recreational interests within the area include the Norfolk Broads, the North Norfolk Coast and the holiday resort of Great Yarmouth. In the immediate area, Damgate Marshes, Breydon Water and the River Bure are attractions to those using the rights of way network. At Halvergate junction there are a small range of recreational interests including the Stracey Arms Drainage Mill, the Pontiac Roadhouse restaurant and bar (formerly Three Feathers PH) and the River Bure public moorings.

Routes open to the public

5.4.5 Information regarding Public Rights of Way and other routes open to the public have been taken from the 1:25000 Ordnance Survey Explorer OL40 map (The Broads), revised 2002. The Local Planning Authority was contacted to confirm that these were accurate at the time of this assessment. Figure 5.1 illustrates the Rights of Way network and other routes open to the public within the study area. The routes are described below in table 5.3, including observations on their estimated usage and their amenity from a visit to the site on Thursday 4th September 2003.

Table 5.3 Public Rights of Way

Route	Designation	Location and Description
Footpath along the A1064	Permitted Footpath	This footpath runs roughly parallel to the A1064, and joins the A47 about 100m east of the Acle roundabout.
Weaver's Way	Long Distance Trail / Recreational Path. In the area around the scheme, this is designated as a Public Footpath	Weavers' Way is a long distance footpath running for 61 miles between Cromer and Great Yarmouth. It is named after the once important weaving industry, which flourished in the Middle Ages around North Walsham. This path follows a complex route throughout the study area and the surrounding landscape. The

		sections pertinent to this scheme are: • Approximately 300m east of the Acle Roundabout, Weaver's Way crosses the A47 in a north-south direction. The path is well signed at the A47, but is overgrown in places, indicating a relatively low usage. • At the Great Yarmouth end of the scheme, the Weaver's Way runs along the northern edge of Breydon Water, south of the railway. This is a high value amenity area, and the path appears to be pleasant and well used.
Paths along River Bure	Public footpath	These footpaths run along both banks of the River Bure for the length of the A47 Acle Straight. This path is well maintained and appears highly utilised for recreational purposes and can also provide a link between Acle and Great Yarmouth.
Path along Tunstall Dike	Public footpath	These paths run along both sides of the Tunstall Dyke from the pumping station at the River Bure, and crosses A47 in a NE-SW direction. The path is not visibly signed from the road, and is not easy to find. Very little trampling of ground cover was visible, suggesting a relatively low utilisation around the road.
Path via Scaregap Farm	Public footpath	This apparently relatively well-used path runs along a dyke from the River Bure (opposite Mautby Marsh Drainage Mill) and terminates at the A47. Upon reaching the A47, users of the footpath can only turn along the road. However, there is a small area alongside the A47 where it appears that a vehicle could be parked in order to use the footpath.
Paddys Loke (Tk)	Public footpath	Path splits from the Weavers Way footpath at Breydon Water, crosses the railtrack and the A47 (with a "dogleg" of approximately 200m to the east along the road), and continues through the Industrial Estate before joining the River Bure footpath. The path is signed from the A47, but is not clearly visible from the road.

Note: Information on footpath usage has been gained from observations during site visits only.

Crossing the A47

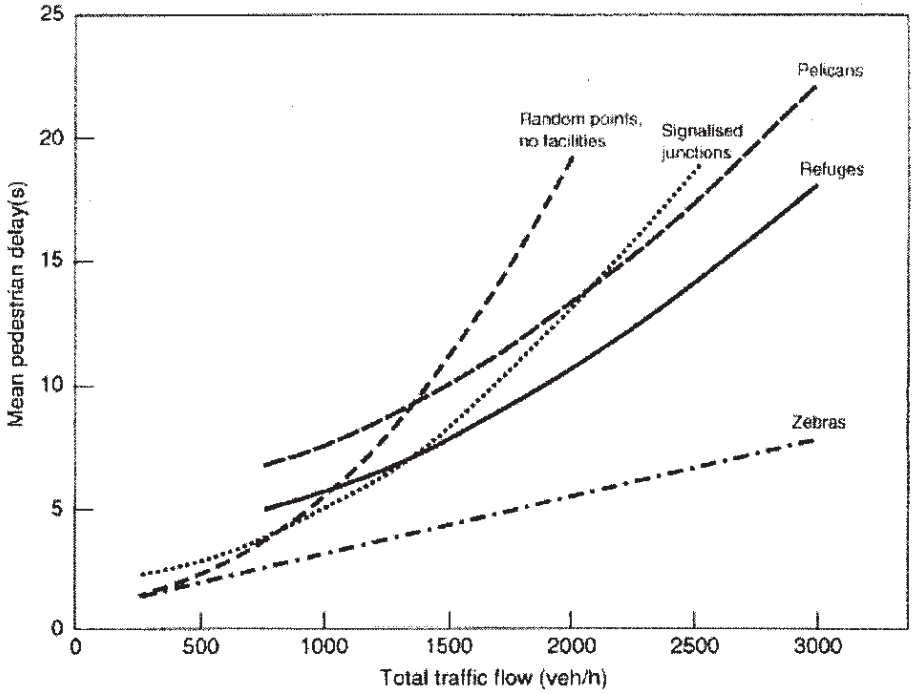
5.4.6 Although a number of Public Rights of Way pass across the road, there are no pedestrian crossing facilities provided on the A47 Acle Straight. Crossing this road is generally difficult and dangerous, and once the user of a footpath reaches the A47 they must decide whether to risk crossing the road, or to simply turn back. This poses a high safety risk to the user of the path and reduces the amenity of the route.

5.4.7 In addition to points where rights of way cross the road, pedestrians have been observed to cross the road at Halvergate Junction to access Halvergate Branch Road and the bridge over the railway for views of the windmills and marshes. They are also known to cross the road in the vicinity of the Vauxhall Holiday Park, possibly to access the railway land (information provided by the Highways Agency[13]).

5.4.8 The DMRB provides a methodology for determining the waiting time of pedestrians crossing a road at different types of crossing facility. On the A47, existing pedestrian crossing methodologies are equivalent to "Random points, no facilities" on the graph below (diagram 5.1).

[13] Non-Motorised Users Report, WS Atkins (Area 6 Highways Agency Maintaining Agent)

Diagram 5.1: Mean pedestrian delays associated with different road crossing situations.



Source: DMRB Vol. 11, Part 8 - Pedestrians, Cyclists, Equestrians and Community Effects

5.4.9 Traffic flows predicted for 2012 (opening year, assuming high traffic growth) show that pedestrians aiming to cross the road may have to wait for approximately 22 - 25 seconds before being able to cross the road in peak times (see table 5.4 below). However, observations during site visits suggest that in practice delays may be longer than this.

Table 5.4. Traffic flows and associated mean pedestrian delays

	Traffic Flows (vehicles / h)		Mean Pedestrian Delay (seconds)	
	Peak	**Off-peak**	**Peak**	**Off-peak**
A47, btwn Acle and Halvergate	2198	1839	22 - 23	16 - 17
A47, btwn Halvergate and A12	2288	1847	24 - 25	16 - 17

Traffic Flow source: SATURN model of existing and future network flows, based on 2002 traffic (Report no. GD00555/RT/014A, Hyder Consulting, May 2003)

Travelling along the A47

5.4.10 Along the A47 road between Acle and Great Yarmouth there is little pedestrian movement. Pedestrian footways are not provided along the route, and the verge width is below standard. In combination with the narrow carriageway width and 60mph speed limit (proposed to be reduced

to 50mph in due course), this makes it both unpleasant and dangerous for NMU's to use this road and therefore acts as a deterrent. Although there are few reasons for undertaking a journey on foot along the road, and the River Bure footpaths provide a much more amenable method of travelling east-west in this area, it is likely that there is suppressed demand for pedestrian use of the route.

Cyclist / Equestrian Journeys

5.4.11 At present there are no cycle or equestrian provisions along the existing A47 route. Cycling is permitted along the road, but the narrowness of the carriageway and the high traffic speeds and volumes are likely to discourage people, particularly inexperienced cyclists, from undertaking this journey. It is likely that there is suppressed demand for cyclist use of the route, more so than for pedestrians as the distances involved are less of a deterrent and the flat terrain is particularly attractive for cyclists. Horseriders are unlikely to use the road due to the safety implications of the narrow road width and high volumes of traffic (including a high proportion of large vehicles).

5.4.12 There are no bridleways within the immediate study area the nearest being on the north side of the River Bure, therefore cycling and horse riding in the area are likely to be limited.

5.4.13 Consultation has taken place with Sustrans (a sustainable transport charity which works on projects to encourage people to walk, cycle and use public transport in order to reduce motor traffic). They have outlined their existing cycle routes within The Broads (none of which lie within the study area), as well as a number of options proposed for travelling from Norwich to Great Yarmouth. They have expressed their concern as to the inadequacy of the existing A47 and the fact that it creates a barrier when routing cycle ways to reach Great Yarmouth. Correspondence from Sustrans is included in Appendix 5.1.

Physical fitness

5.4.14 Due to the nature of the study area, cyclist and pedestrian journeys are likely to be recreational, and are infrequent and irregular. Therefore, it has not been possible to estimate the number of cyclists and pedestrians making journeys of more than 30 minutes a day. However, the road does act as a deterrent to anyone walking or cycling in the area where they may be required to cross or use the roadand it is likely that the existing road has an adverse impact on physical fitness.

Summary

5.4.15 The community severance caused by the existing road is "slight" due to lack of community facilities on either side of the road combined with the distances involved which deter non motorised journeys. Due to the lack of

segregated footpaths / cycleways and the lack of crossing facilities at footpath junctions with the road it is likely that the existing road deters recreational use of routes in the area and has an adverse impact on physical fitness.

5.5 Environmental Impact

Scheme Proposals

5.5.1 The scheme design (for both dual carriageway options) includes proposals for 4m wide access tracks along both sides of the road. These could additionally be used by pedestrians, equestrians and cyclists who wish to use the road, and would be a large improvement to the existing situation (providing a safe, segregated system). Although the access tracks are not continuous along the entire length of the road, additional unsurfaced path link would be included at each end of the route. This would provide a continuous pathway along the entire length of the scheme on the northern side except for a break at Stracey Arms Mill. On the southern side of the road the route would discontinue in the area of the railway sidings and at the approach to the Acle roundabout. Subject to agreement with Local Authorities and land-owners, these would be designated as bridleways (Rights of Way). The access tracks and linking pathways would be physically separated from the road by drainage ditches and safety barriers, improving both the amenity and safety of this journey.

5.5.2 The provision of footbridges over the road has been discounted due to the visual impact these would cause within this nationally important landscape, and pedestrian underpasses would not be feasible due to ground conditions. It is not appropriate to provide signal controlled pedestrian crossings, due to the safety issues of stopping traffic on a road such as this, and the small number of pedestrians involved. Therefore, facilities would be provided at certain points to allow pedestrians to cross the safety barriers and drainage ditches, as well as provision of a waiting area and dropped kerb. In addition, road signs could be used to warn motorists of pedestrians crossing. These crossing facilities would be located to cater for desire lines at the crossing points of Public Rights of Way and at Halvergate junction. For Option 2A, the central reserve would need to be widened slightly to a minimum of 3.3 m in these locations to allow for the accommodation of pedestrian facilities.

Pedestrian journeys

5.5.3 Although the crossing points may increase the users' perception of safety, pedestrians must still wait for a gap in the traffic before crossing. The scheme would introduce a wider carriageway to cross, but allows the road to be crossed in two legs meaning that pedestrians only need to negotiate one traffic direction at any time. This is equivalent to the "Refuges" crossing methodology on Diagram 5.1 (see Baseline Conditions). Table 5.5 below shows the changes in pedestrian waiting times when crossing

the existing and new road, based on predicted traffic flows (assuming high growth) for 2012.

Table 5.5: Traffic flows and associated mean pedestrian delays

Link Description	Do Minimum - High Growth				Do Something - Dual C'Way High Growth			
	Traffic Flows (vehicles / h)		Mean Pedestrian Delay (seconds)		Traffic Flows (vehicles / h)		Mean Pedestrian Delay (seconds)	
	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak	Peak	Off-peak
A47, between Acle and Halvergate	2198	1839	22 - 23	16 - 17	2711	2123	15 - 16	11 - 12
A47, between Halvergate and A12	2288	1847	24 - 25	16 - 17	2683	2059	15 - 16	11

Traffic Flow source: SATURN model of existing and future network flows, based on 2002 traffic (Report no. GD00555/RT/014A, Hyder Consulting, May 2003)

5.5.4 This methodology implies that the dual carriageway options would lead to an improvement in the waiting times for pedestrian crossings, due to the refuge in the middle. However, the increased speed of traffic (speed limit increased to 70mph) is a significant additional factor, which would have an adverse impact on pedestrian crossings and safety.

Cyclist / Equestrian Journeys

5.5.5 The access tracks described above for use by pedestrians may also be used by cyclists and equestrians wishing to travel along the road (although the lack of a hard surface at the path links may make this difficult for some cyclists). The improved safety for cyclists using this path would encourage cycling along this route. Although this would go some way to fulfilling the aims of Sustrans, who have proposed a route that follows the existing A47 route, their aim was to have the route as far away from the road as possible to allow a more attractive environment. This option would therefore address their concerns to a large extent, but would still not provide a high amenity solution for cyclists travelling along the corridor.

Community Severance

5.5.6 Since the proposed options are on-line, the scheme would not create any new severance to communities. The provision of access tracks with path links would allow residents of properties along the route to travel to community facilities more safely at either end of the study area using non-motorised methods (particularly on the near continuous path on the northern side of the road). However, the number of people who would benefit by the improvement to access to community facilities would be small.

5.5.7 The community severance caused by the proposals would continue to be "slight", therefore, the proposals would have a neutral effect on community severance.

Physical Fitness

5.5.8 Due to the difficulty in estimating journey times in an area such as this, the changes in journey times in relation to physical fitness have not been estimated. It is considered that the proposals would encourage cycling and walking along the route (potentially releasing some of the previously suppressed demand). Overall, there would be some minor health benefits.

5.6 Summary

5.6.1 There are relatively few facilities/dwellings along the route these being mostly located at Great Yarmouth and Acle at each end of the road. The existing road is difficult to cross due to lack of crossing facilities and the volume/speed of traffic, it is also lacks segregated facilities along the route and is unsafe for use by pedestrian, cyclists and equestrians. However existing community severance has been assessed as "slight" due to the lack of facilities along the route and distances involved which deters non motorised journeys. It is likely that the existing road deters recreational use of routes in the area and has an adverse impact on physical fitness.

5.6.2 The proposed access tracks, path links and crossing facilities described for Options 2 and 2A above would have a beneficial effect on accessibility along the route and crossing waiting times, but the wider carriageway and faster traffic speeds would adversely effect safety for non motorised users of the route and users crossing the route. Therefore on balance community severance would remain "slight" after the proposals were introduced and the overall impact would be Neutral.

5.6.3 The improvement in facilities for travel along the road, particularly for cyclists would encourage recreational use and lead to some minor health benefits with both dual options.

5.6.4 Additional mitigation could include surfacing the path links to access tracks so as to facilitate use by cyclists and the disabled and redesign of the road alignment in the vicinity of Stracey Arms Mill to enable provision of a continuous path for non motorised users. However, this would have additional impacts on other environmental factors (biodiversity, landscape etc) which would need to be assessed.

6 Geology and Soils

6.1 Introduction

6.1.1 This chapter assesses the potential effects on the geology and soils within the study area resulting from the implementation of the dual carriageway options. Soils and geology play an important role in determining the environmental character of an area. The nature and alignment of underlying rock strata has a major influence on local topography, and soil characteristics help to determine local vegetation types and the quality of agricultural land.

6.1.2 Road schemes can have an impact on both the geology and soils of an area. Conversely, existing soil conditions (particularly where soil has been contaminated), or the presence of scientifically important geological features can impose constraints on road design.

6.1.3 The following chapter describes the geological character and soils of the study area, and includes the identification of potentially contaminated land. This is followed by an assessment of the likely effects of implementing Options 2 and 2A.

6.1.4 The study area for the assessment of geology and soils comprises the footprint of the proposed construction area for each option of the single carriageway scheme.

6.2 Methodology

6.2.1 The methodology followed in this assessment has been carried out in accordance with the requirements of the DMRB[14]. Consultations were carried out in order to obtain data with regards to the geology and soils within the study area as follows:

- English Nature were contacted to identify any geological or geomorphological Sites of Special Scientific Interest (SSSI), in the study area;
- Norfolk Wildlife Trust was contacted to identify the existence of any Regionally Important Geological (or Geomorphological) Sites (RIGS);
- The Environment Agency, Great Yarmouth Borough Council and Broadland District Council were contacted to identify the existence of any contaminated or potentially contaminated sites in the study area.

[14] Highways Agency. Design Manual for Roads and Bridges, Volume 11, Section 3, Part 11. August 1994

6.2.2 Further geological details of the study area have been taken from the following British Geological Survey Map and accompanying information:

- Sheet 162 (Great Yarmouth) 1:50,000 scale, Solid and Drift edition (1990)[15];
- Memoir for 1:50,000 geological sheet 162 (1994)[16];
- Reports on previous ground investigations carried out for Norfolk County Council Highways Department[17] and The Department of Transport[18].

6.2.3 Further details of potential contamination sources within the study area have been taken from the following resources:

- Compass Consulting Ordnance Survey and County Series historical maps[19];
- Sitescope Technical Report of Statutory Registers[20].

6.3 Legislation

6.3.1 The primary legislation that makes the environmental assessment of soils and geology necessary relates to contaminated land and the import / export, and disposal of soils.

6.3.2 Contaminated land legislation is covered by Part IIA of the Environmental Protection Act 1990, which was inserted by Section 57 of the Environment Act 1995, and implemented in April 2000 (Contaminated Land (England) Regulations 2000 (S.I. 2000/227)). This legislation is not intended to prevent environmental pollution, it aims to remediate historical contamination and does this by requiring the polluter or currently liable person to pay for clean up costs.

6.3.3 Section 34 of the Environmental Protection Act 1990 (Duty of Care Regulations 1991) (Ref 7) places a Duty of Care to anyone who produces or imports, keeps or stores, transports, treats, or disposes of waste.

[15] British Geological Society. Sheet 162 (Great Yarmouth) 1:50,000 Solid and Drift edition (1990).

[16] British Geological Society. Memoir for Sheet 162 (Great Yarmouth) 1:50,000 Scale, Solid and Drift edition (1994)

[17] Norfolk County Council. A47 Acle Straight Improvement Desk Study. December 1990.

[18] The Department of Transport. Main Ground Investigation for A47 Acle Straight Improvement, LTG Ground Engineering.

[19] Compass Consulting. Ordnance Survey and County Series Historical Maps.

[20] Sitescope Technical Report of Statutory Registers.

6.3.4 The Waste Management Licensing Regulations 1994 require all waste material to be disposed of to a suitably licensed waste facility.

6.4 Baseline Situation

6.4.1 The geological succession within the Great Yarmouth District and study area is described below and summarised in Table 6.1. Surface geology is presented in Figure 6.1.

Breydon Formation

6.4.2 The length of the A47 runs along the flat floodplain of the Rivers Bure and Yare and the near surface geology consists of recent alluvial deposits belonging to the Breydon Formation

6.4.3 The Breydon Formation occupies a buried valley system. The formation can be up to 22m thick but thins out altogether at the margins of the marshland. It overlies and overlaps the Yare Valley Formation, which forms the buried valley floor.

6.4.4 This formation directly underlies the topsoil for much of the scheme. The formation consists of silt and clay and includes shelly marine fauna. The silt and clay is interrupted by widespread though locally impersistant layers of peat of freshwater and brackish origins which occur both at the base of the formation and within it and divide the alluvium into upper and lower horizons

6.4.5 The Breydon Formation consisting of upper alluvium, an intercepting peat layer, and lower alluvium was identified beginning from the Acle Slough and along the remaining length of the A47 route during the Main Ground Investigation for the A47 Acle Straight Improvement (Main Ground Investigation)[21] . The formation was found to extend to an approximate average depth and thickness of 18.5m. The intercepting layer of peat was encountered at an approximate average depth of 6.5m with an approximate average thickness of 0.5m.

6.4.6 The British Geological Society (BGS) Memoir for 1:50,000 geological sheet 162 for Great Yarmouth (1994) (BGS geological sheet 162)indicates that the approximate thickness of the Breydon Formation ranges from 0-22m across the district.

[21] Statutory Instrument 1991 No.2839 The Environmental Protection (Duty of Care) Regulations 1991.

Other Peat Deposits

6.4.7 A deep channel exists at the Acle Slough and has been completely in-filled with waterlogged peat. The channel sits between an outcrop of the Yare Valley Formation to the west and the Breydon Formation to the east. The Main Ground Investigation found that the peat channel was close to the surface and extends down to the solid geology (Crag) to a maximum depth of 10m. It is likely that the channel was formed by the River Yare eroding down to the Norwich Crag deposits.

Yare Valley Formation

6.4.8 Below the alluvium lies the Yare Valley Formation, a sandy fine to coarse flint gravel of fluvial origin. For most of its distribution within the district it rests upon the Crag. BGS geological sheet 162 indicates that the approximate thickness of the Yare Valley Formation ranges from 0-11m across the district. Yare Valley Formation was encountered below the Lower Alluvium during the Main Ground Investigation at an approximate average depth of 18.5m with an approximate average thickness of 3.5m. The shallowest encounter was at an approximate depth of 14m.

Lowestoft Till

6.4.9 Lowestoft till forms a widespread but extensively dissected, undulating sheet over much of the district. The most continuous outcrops are present to the south and south-west of the scheme. It was not encountered during the Main Ground Investigation.

Corton Formation

6.4.10 The Corton Formation comprises tills, sands and subordinate gravels. The formation is not present beneath the A47 route and was not encountered during the Main Ground Investigation for A47 Acle Straight Improvement.

Kesgrave Formation

6.4.11 The Kesgrave Formation comprises pebbly sands, gravels and silts which unconformably overlie the Crag. The formation was not encountered during the Main Ground Investigation, however the formation crops on the lower slopes of the valleys of the Yare and Bure, and their tributaries, and in patches north of the River Waveney around Blundeston.

Norwich Crag Deposits

6.4.12 At a greater depth lies the Norwich Crag Deposits which consist of yellowish to reddish brown sands, laminated clays and pebbly gravels. Crag deposits were encountered during the Main Ground Investigation at an approximate average depth of 22m with an approximate average thickness of 4m. The shallowest encounter was at approximately 13m depth. The BGS geological sheet indicates that the approximate thickness of Crag deposits extends up to 60m.

London Clays

6.4.13 Geological records indicate that London Clay underlies the Norwich Crag and this has been confirmed by information obtained from exploratory holes along the route of the A47[22]. London clay was found to have an approximate average depth of 26m. The shallowest encounter was at approximately 23m depth.

6.4.14 The British Geological Society (BGS) Memoir for 1:50,000 geological sheet 162 for Great Yarmouth (1994) indicates that the approximate thickness of London Clay ranges from 0 to 91m.

Ormesby Clay (Thanet Formation)

6.4.15 The Ormesby Clay unconformably overlies the Upper Chalk and is thought to be continuous east of a line between South Walsham and Seething, which includes the study area. The BGS geological sheet 162 indicates that the approximate thickness of the Ormesby Clay ranges from 0 to 27m.

Upper Chalk (Chalk Group)

6.4.16 The Chalk is mainly white, though it has locally been described as yellow at outcrop and it is conspicuously rich in flint. The chalk group appears to slope upwards from East to West towards Norwich. The BGS geological sheet 162 indicates that the approximate thickness of the Upper Chalk ranges from 285-370m.

6.4.17 The geological succession within the Great Yarmouth District and study area is summarised below in Table 6.1.

[22] The Department of Transport. Main Ground Investigation for A47 Acle Straight Improvement, LTG Ground Engineering.

Table 6.1: Geological Succession within the Great Yarmouth District and Study Area					
Stratum	**Age**	**Approx Average Thickness (m)**	**Approx Average Depth Encountered (m)**	**Approx Minimum Depth Encountered along route (m)**	**Presence in Study Area**
Upper Alluvium (Breydon Formation)	Pleistocene and recent – Flandrian	6.5*	0.5*	0.0*	Identified
Peat (Breydon Formation) – excluding Acle slough.	Pleistocene and recent – Flandrian	0.5*	6.5*	4.0*	Identified
Lower Alluvium (Breydon Formation)	Pleistocene and recent – Flandrian	11.50*	7.0*	5.25*	Identified
Yare Valley Formation	Pleistocene and recent - ?Devensian	3.5*	18.5*	14.0*	Identified
Lowestoft Till Formation	Pleistocene and recent – Anglian	-	-	-	Not Identified
Corton Formation	Pleistocene and recent – Anglian	-	-	-	Not Identified
Kesgrave Formation	Pleistocene and recent – Pre-Pastonian *a* to Cromerian	-	-	-	Not Identified
Norwich Crag Deposits (Crag Group)	Pleistocene and recent	4.0*	22.0*	13.0*	Identified
London Clay (London Clay Formation)	Eocene	0-50 (Ref 1)	26.0*	23.0*	Identified
Ormesby Clay (Thanet Formation)	Palaeocene	0-27 (Ref 1)	-	-	Indicated on geological map
Upper Chalk (Chalk Group)					
*Data collected from previous investigation (Ref 9).					

Sites of Special Scientific Interest (SSSI) and Regionally Important Geology (RIGS)

6.4.18 There are no Geological Sites of Special Scientific Interest (SSSI) or Regionally Important Geological (or Geomorphological) Sites (RIGS) within the study area.

Historical and Present Day Potential Contamination

6.4.19 The A47 Acle Straight runs between Acle town and Great Yarmouth. The majority of its route passes through flat agricultural land that was initially formed by the development of the floodplains of the Rivers Bure and Yare. However, water levels on the marshes have been controlled by man-made dyke systems for hundreds of years. Historical maps dating back to 1890 show very little change in this respect. The present route of the A47 and the railway have remained the same since 1890.

6.4.20 Areas of made ground are associated with development at Acle and Great Yarmouth. The desk study did not identify any areas of contaminated land that would be disturbed by the scheme options. However areas of potentially contaminated land and landfill within the study area are shown on Figure 6.1. The scheme alignment runs very close to railway sidings near Great Yarmouth an area that is not known to be contaminated. However railway land has often been used in a way that has caused ground contamination.

6.4.21 Information regarding the source and type of materials used during the construction of the road and developed areas is unknown.

6.5 Predicted Impacts

6.5.1 A detailed description of the dual carriageway options is provided in Chapter 2. Both options would involve the importation and placement of foreign materials used in the construction of the new or widened embankment, the carriageways, bridges, culverts and access tracks. Table 6.2 shows the amounts and types of material to be imported in order to construct the scheme.

6.5.2 Both proposals would also involve the excavation of ground some of which may be reused in order to construct the scheme. Excavated material may be of unknown composition or natural soils from the excavation of new ditches that cannot be reused on site. These waste materials may be reused off-site or disposed of at landfill.

6.5.3 It is unlikely that significant amounts of contaminated land exist on the route of the proposed scheme. However, the composition of much of the made

ground on the schemes is unknown. Therefore there is a small possibility that the construction works would impinge on contaminated soils. Option 2 and 2A would cut across an area of the railway land near Great Yarmouth.

6.5.4 Agricultural land would be lost as a result of the land take necessary to build the new carriageway, access track and associated features (see Chapter 4).

Table 6.2 Estimated Quantities of Materials Involved with Construction of the Scheme (cubic metres)

	Option 2 M3	Option 2A M3
Materials Required:		
Earthworks mainline		
Import fill including capping	240000	193000
Pavement	86200	99000
Access Tracks		
Import fill including capping	84000	84000
Pavement	12600	12600
Surplus Materials:		
Earthworks mainline		
Excavation	95500	85500
Access Tracks		
Excavation	97000	97000
Pavement waste for disposal		
New ditches		
Excavation	216000	216000

6.5.5 Construction of the new embankment area would cause settlement of the ground in the vicinity of the embankment. At the current time trial embankment studies are underway to determine the scale of ground settlement. The settlement of the ground would cause a small amount of groundwater flow from beneath the embankment as pore water pressures are dissipated. However the amount of groundwater flow is likely to have an insignificant long term impact on surrounding groundwater levels.

6.5.6 The proposals have no appreciable effect either positive or negative on geology and soils. The importance of the geology and soils directly underlying the scheme is low and both options would have a minimal effect therefore the effects have been assessed as neutral.

6.6 Mitigation

6.6.1 The route passes through important ecological habitat much of which is water related(see chapter 5). In order to minimise pollution of surrounding wetland all embankment fill and granular material used for the construction

of the farm access track should consist of inert material so as to minimise adverse effects from leachates. All such materials, together with the sub base material would comply with leachate quality thresholds to be agreed with the Environment Agency.

6.6.2 Soils excavated during the construction of the ditches would be re-used on-site for temporary surcharging of the new embankments only. However the quality of most of the excavated material would be poor or too variable to be used in construction of the permanent works. Therefore excavated material would be transported off site. All waste materials arising as a result of the improvement scheme would be transported in accordance with the Duty of Care Regulations[23] and disposed of at an suitably licensed waste facility site in accordance with the Waste Management Licensing Regulations[24].

6.6.3 The possibility of encountering contaminated land is thought to be small but if contaminated soils are discovered then further investigation and remediation may need to be carried out.

6.7 Summary

6.7.1 The scheme traverses a sequence of alluvial floodplain deposits. The surrounding land is flat and mostly under agricultural land use. Drainage of land is by pumping and man-made dyke systems.

6.7.2 There are no Geological SSSI's or Regionally Important Geological (or Geomorphological) Sites (RIGS) within the study area and the effects on geology have been assessed as neutral for both dual carriageway options.

6.7.3 Construction of both option 2 and 2A would involve the placement of foreign materials for localised widening of the embankments and construction of access tracks, and the excavation of ground for the construction of new ditches.

6.7.4 Made ground of unknown composition is likely to be encountered during excavation works at the eastern and western extremes of the scheme. Therefore there is a small possibility that contaminated soils would be encountered.

6.7.5 Waste materials may be reused off-site or disposed of at a waste facility site.

[23] Statutory Instrument 1991 No.2839 The Environmental Protection (Duty of Care) Regulations 1991.

[24] Statutory Instrument 1994 No. 1056 The Waste Management Licensing Regulations 1994

6.7.6 Mitigation measures include using inert fill materials, re-using excavated materials where possible, transporting and disposing of waste materials in accordance with relevant legislation, and further ground investigations and remediation if required.

Predicted Construction Impacts and Mitigation

6.7.7 Contamination of surrounding agricultural soils may occur from construction activities however some mitigation of construction impacts are described in chapter 2 and mitigation of impacts from dust are described in chapter 10.

6.7.8 Construction would be restricted to the footprint of any new embankment, ditch or access track and there would be a contractual requirement for any compounds and storage areas required in addition to the footprint of the proposed road embankment, to be located outside the area administered by the Broads Authority. This restriction would also apply to any temporary access routes to such storage areas and compounds.

7 Water Quality and Drainage

7.1 Introduction

7.1.1 This chapter assesses the potential effects on the water environment within the study area resulting from implementation of the scheme. The water environment includes the rivers, streams, canals, pools, floodplains and groundwater resources in the study area.

7.1.2 The scheme options would involve widening the existing single carriageway to dual carriageway. One carriageway would be within the width of the existing road embankment. Option 2 includes a central reserve width of eight metres between the new and old embankments to preserve the existing ditch/dyke adjacent to the existing highway. Option 2A would involve widening of the existing embankment rather than the construction of a separate embankment and this would result in the loss of one of the existing ditches over the entire route length.

7.2 Methodology

7.2.1 The methodology followed in this assessment has been carried out in accordance with the requirements of the DMRB Volume 11[(App 7.1,ref. 1)]. Additionally, where relevant, this has been supplemented by the methodologies given in the Guidance on the Methodology for Multi-Modal Studies[(App 7.1,ref. 2)]. For the purposes of this assessment, the impacts on the water environment have been split into water quality, spillage risk and the effect on drainage flow. These have been assessed separately, as described below.

Water Environment Baseline

7.2.2 Water quality baseline conditions have been established using Environment Agency information including water quality data, abstraction licenses, discharge consents, pollution incident data, source protection zone maps, and groundwater vulnerability maps.

7.2.3 Site investigations of the water quality were carried out in January, April/May and August 2003 to determine the effect of the existing road drainage on water quality in the ditches and dykes adjacent to the scheme. A water quality prediction assessment has been carried out in accordance with the DMRB Volume 11[(App 7.1,ref. 1)]. The study area for other topics in this report is generally defined as 500m from the road. However the water monitoring work has required that the study area for the water environment be somewhat larger extending 800m approximately in places. In some

cases, for example of groundwater abstractions, it is sometimes necessary to include features that are some kilometres from the road.

7.2.4 A spillage risk assessment was conducted to determine the risk of a traffic related accidental spillage of a polluting substance reaching a watercourse. The assessment was carried out in accordance with guidance in the DMRB, (see Appendix 7.2).

Consultations

7.2.5 Consultations have been carried out with a number of consultees. These are English Nature, Environment Agency and the King Lynn Consortium of the Internal Drainage Board (IDB). Great Yarmouth Borough Council and Broadland District Council were contacted to identify the existence of any contaminated or potentially contaminated sites in the study area.

7.2.6 Water quality reports information has been received from the IDB, Broads Authority and Environment Agency.The Environment Agency Website, Groundwater Vulnerability Map of East Norfolk and the Hydrogeology Map (sheets 1 and 2) for Northern East Anglia have also been used in the assessment

7.2.7 The significance of different types of impact on the water environment have been assessed in general accordance with GOMMMS. The assessment of effects on the water environment is based on a combination of the importance of each water feature (Table 7.2.1) and the magnitude of the impact (either positive or negative) of the scheme on those features (Table 7.2.2). These are assessed by means of a matrix to estimate the significance of each impact on each water feature (Table 7.2.3). Finally the overall impacts of the proposals are summarised using the guidance in Table 7.2.4.

Table 7.2.1: Guidance for Estimating the Importance of Water Environment Attributes		
Importance	**Criteria**	**Examples**
Very High	High quality and rarity on a regional or national scale and with limited potential for substitution	Aquifer supplying a large population EC designated salmonid fishery
High	High quality and rarity on a local scale and limited potential for substitution or medium quality and rarity on a national or regional scale and limited potential for substitution	GQA[1] Grade A reach of river aquifer providing potable water to a small population EC designated cyprinid fishery
Medium	Medium quality and rarity on a local scale and limited potential for substitution or low quality on a regional or national scale and limited potential for substitution.	GQA[1] Grade B/C reach or river aquifer providing abstraction water for agricultural or industrial use
Low	Low quality and rarity on a local scale and limited potential for substitution	Floodplain with limited existing development
Note: [1] General Quality Assessment Based on the Guidance On the Methodology for Multi-Modal Studies, DETR, 2000.		

Table 7.2.2: Criteria for Determining Impact Magnitude		
Magnitude	**Criteria**	**Example**
Major	Results in loss of attribute	Loss of EC designated salmonid fishery Change in GQA grade of river reach Compromise employment source Loss of flood storage/increased flood risk Pollution of potable source of abstraction
Moderate	Results in impact on integrity of attribute or loss of part attribute	Loss in productivity of a fishery Contribution of a significant proportion of the effluent in the receiving environment, but insufficient to change its GQA grade Reduction in the economic value of the feature
Minor	Results in minor impact on attribute	Measurable change in attribute, but of limited size or proportion
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use/integrity	Discharges to watercourse but no significant loss in quality, fishery productivity or biodiversity, no significant impact on the economic value of the feature, no increased flood risk
Note: Based on the Guidance On the Methodology for Multi-Modal Studies, DETR, 2000.		

Table 7.2.3: Criteria for Estimating the Significance of the Potential Impacts				
Magnitude of potential impact	**Importance of attribute**			
	Very high	*High*	*Medium*	*Low*
Major	Very significant	Highly significant	Significant	Low significance
Moderate	Highly significant	Significant	Low significance	Insignificant
Minor	Significant	Low significance	Insignificant	Insignificant
Negligible	Low significance	Insignificant	Insignificant	Insignificant
Note: Based on the Guidance On the Methodology for Multi-Modal Studies, DETR, 2000.				

Table 7.2.4: Definitions of Overall Assessment of the Effects of the Scheme on the Water Environment	
Score	**Comment**
Large Beneficial Impact	It is extremely unlikely that any proposal incorporating the construction of a new transport route would fit this category. However, proposals could have a large positive impact if it is predicted that it would result in a 'very' or 'highly' significant improvement to a water feature with insignificant impacts of the other water features.
Moderate Beneficial Impact	Where the proposals provide an opportunity to enhance the water environment, because it results in predicted: ▪ significant improvements for at least one water feature with insignificant impacts on other water features; ▪ very or highly significant improvements, but with some adverse impacts of a much lower significance The predicted improvements achieved by the proposals should greatly outweigh any potential negative impacts
Slight Beneficial Impact	Where the proposals provide an opportunity to enhance the water environment, because they provide improvements in water which are of greater significance than any adverse effects
Neutral	Where the net impact of the proposals is neutral, because: ▪ they have no appreciable effect, either positive or negative on the identified water features; ▪ the proposals would result in a combination of effects, some positive and some negative, which balance to give an overall neutral impact. In most cases these will be slight or moderate positive or negative impacts. It may be possible to balance impacts of greater significance, however, in these cases great care will be required to ensure that the impacts are comparable in terms of their potential environmental impacts and the perception of these impacts.
Slight Adverse Impact	Where the proposals may result in the degradation of the water environment, because the predicted adverse impacts are of greater significance than the predicted impacts.
Moderate Adverse Impact	Where the proposals may result in the degradation of the water environment, because it results in predicted: ▪ significant adverse impacts on at least one feature, with insignificant predicted improvements to other features; ▪ very or highly significant adverse impacts, but with some improvements which are of a much lower significance and are insufficient positive impacts to offset the negative impacts of the proposals.

Large Adverse Impact	Where the proposals may result in a degradation of the water environment, because it results in predicted: ▪ highly significant adverse impacts on a water feature; ▪ significant adverse impacts on several water features.
Very Large Adverse Impact	Where the proposals may result in a degradation of the water environment, because it results in predicted: ▪ very significant adverse impacts on at least one water feature; ▪ highly significant adverse impacts on several water features.
Note: Based on the Guidance On the Methodology for Multi-Modal Studies, DETR, 2000.	

7.3 Legislation and Guidance

7.3.1 The main legal framework is set by the following:

- The Highways Act 1980, as amended
- Water Resources Act 1991, as amended
- Land Drainage Act 1991, as amended
- Environment Act 1995, as amended
- The EC Freshwater Fish Directive 78/659/EEC transposed by The Surface Waters (Fishlife) (Classification) Regulations 1997 (amended 2003)
- The Surface Waters (River Ecosystem) (Classification) Regulations 1994
- The EC Groundwater Directive 80/68/EC transposed by The Groundwater Regulations 1998 as amended
- The EC Dangerous Substances Directive 76/464/EEC (and daughter directives) as transposed by The Surface Waters (Dangerous Substances) (Classification) Regulations 1998

7.3.2 The principle item of policy guidance produced by central government on the impact of development on water quality and drainage is Planning Policy Guidance note 25 (PPG25) "Development and Flood Risk". This guidance note outlines the measures required to satisfy government policy on flood risk. It outlines the conditions that schemes should meet if their location within the functional floodplain cannot be avoided.

7.3.3 In addition, non-statutory Pollution Prevention Guidance Notes (PPGN) produced by the Environment Agency (EA), the Scottish Environmental Protection Agency (SEPA) and the Environment and Heritage Service (Northern Ireland) provide guidance on good environmental practice for the prevention of pollution from certain activities. Those PPGNs of particular

relevance to the assessment of both the construction and operation impacts of the proposed scheme include:

- PPGN01 General guide to the prevention of water pollution;
- PPGN02 Above ground oil storage tanks;
- PPGN03 The use and design of oil separators;
- PPGN04 Disposal of sewage where no mains drainage is available;
- PPGN05 Works in near or liable to affect watercourses;
- PPGN06 Working at construction and demolition sites;
- PPGN07 Fuelling stations: construction and operation;
- PPGN08 Storage and disposal of used oils;
- PPGN10 Highway depots;
- PPGN022 Dealing with spillages on highways; and
- PPGN23 Maintenance of Structures over Water.

7.3.4 The non-statutory guidance provided in the EA's Groundwater Protection Policy provides details of groundwater vulnerability classification and source protection zones. Statements on groundwater protection policy which relate to groundwater abstractions, physical disturbance of aquifers and groundwater flow, and threats to groundwater quality provide guidance on activities which may or may not be permitted in sensitive areas.

7.4 Baseline Situation

7.4.1 The A47 Acle Straight runs between the small town of Acle and seaside town of Great Yarmouth. The majority of the route traverses flat lying agricultural land which is a mixture of arable fields and pasture. The land was originally formed as the flood plains of the River Bure and the River Yare. However, water levels on the marshes have been controlled by man-made dyke system for hundreds of years.

Surface Water Features

7.4.2 The scheme runs approximately parallel to the River Bure and crosses marshland tributaries to the river. It also crosses a number of dykes, which are important in draining or supplying water to the marshes. Dykes also run parallel to both sides of the existing road and are located at the foot of the road's embankment. Water levels and flows in the area are controlled by the Internal Drainage Board (IDB). The marsh is reclaimed land and is typically at the elevation of sea level. Water levels in the ditches are often lower than that of the rivers and sea level.

7.4.3 There are three main rivers in the area, the Rivers Bure, Yare and Waveney which are managed by the Environment Agency (see Figure 7.1). The River Yare and its tributary the Waveney flow eastwards into Breydon Water several kilometres to the south of the scheme. The Bure flows in a meandering course west to east, approximately parallel to the scheme. The Bure flows within a few tens of metres of the Acle Straight at Halvergate Junction but elsewhere is up to 1km to the north of the road. The Tunstall Boat Dyke which runs south west from the Tunstall Pump at the River Bure is no longer hydraulically connected to the River Bure and is in fact dry for most of the year, and therefore not navigable. However it is important to note that the Tunstall Boat Dyke is still classified as part of the main river of the Bure.

7.4.4 Both the River Bure and the Yare (including Breydon Water) are navigable and are of importance for leisure boating. They also have public footpaths on both banks and are important recreational resources within the area administered by the Broads Authority. Both the Rivers Bure and Yare are important elements of the historic landscape of the Broads forming important lines of communication in the past and the Bure lies within the Halvergate Marshes Conservation Area. The River Bure is also of value as a fishery being classified as an EC Cyprinid fishery (one of two classifications the highest being a Salmonid fishery). Breydon Water as part of the Yare estuary meets the Environment Agency's highest water quality classification for estuaries. Breydon Water is also of very high importance for bird-life, particularly over-wintering birds.

7.4.5 Parts of the study area have ecological habitats of national and international importance recognised through the designation of several protected sites. These are shown in figure 9.1 and are described in full in Chapter 9: Ecology and Nature Conservation, section 9.4. The study area supports Halvergate Marshes, Damgate Marshes and Decoy Carr ecological Sites of Special Scientific Interest (SSSI), which are components of two Special Protection Areas (SPA's), a candidate Special Area of Conservation (cSAC) and two Ramsar sites(App 7.1, ref. 7,8 and 9). The two Ramsar sites- Breydon Water and Broadland, are wetlands of international importance. Most of the route is also within the area administered by the Broads Authority (of equivalent status to a National Park) and the Broads Environmentally Sensitive Area (ESA).

7.4.6 The ESA has been designated to preserve and enhance the landscape and ecology of the marshland habitats by encouraging less-intensive agricultural practices. The mechanism through which this main aim is delivered is through financial compensation and payments made to farmers with Tiers 1,2,3,4 and 5 available, each with increasing payments allied to progressively less-intrusive agricultural practices. Tier 1 has few water level requirements and little consequential ecological benefit, but high landscape value. Tier 2 requires high water tables in summer and has significant benefit for dyke communities and for breeding wetland birds. Tier 3 requires temporary shallow flooding over winter and spring. This is

attractive to the RSPB as it provides maximum ecological benefit for wintering and breeding marshland birds. Tier 4 relates to arable reversion to permanent grassland or maintaining grassland margins to arable land and as with tier 1 has few water level requirements. Tier 5 involves management of fen, little of which is located within the study area.

7.4.7 The Environment Agency uses the General Quality Assessment (GQA) shown in Appendix 7.2 to classify different quality of rivers. All rivers are sub-divided into stretches (or reaches), each characterised by a single water quality monitoring site. Routine water quality samples are collected over a three year period and the results used to establish the GQA class. The river stretch will fall into one of five grades ranging from Good to Bad. Water quality data is available from the Environment Agency for three points in the vicinity of the scheme. The first is at Acle Bridge in Acle, the second at the A47 Bridge at the Great Yarmouth end of the scheme, and the third is at Landspring, Damgate near Acle. The sampling locations are shown on Figure 7.1. Although these sampling locations are not classified under the Environment Agency reach GQA system the data provided by the Environment Agency has been analysed and compared with the GQA criteria.

7.4.8 Table 7.4.1 summarises the water monitoring data for the three monitoring points and gives a comparative GQA grade for the monitoring points.

Table 7.4.1 General Quality Assessment Chemical Grading for River Bure and Acle Landspring.							
River or water stretch	**Grid Reference of monitoring point**	**Dissolved Oxygen % Sat 10%ile**	**Water Quality Grading for Dissolved Oxygen**	**Biochemical Oxygen Demand (5 day 0.5 ATU)mg/l 90%ile**	**Water Quality Grading for Biochemical Oxygen Demand**	**Ammonia mgN/l 90%ile**	**Water Quality Grading for Ammonia**
River Bure (Acle Bridge - Acle)	TG4140011700	73.95	A/B - Good	3.54	A - Good	0.1912	A - Good
River Bure (A47 Rd Bridge – Great Yarmouth)	TG5220008200	79.6	A - Good	2.6	A - Good	0.1211	A - Good
Landspring (Damgate)	TG4096209729	41.28	D/E – Poor to Fair	-	-	0.1741	A - Good

Flood Plains

7.4.9 The A47 route lies directly on a coastal floodplain and is within a flood warning area (App 7.1,ref. 4). The floodplain is classified as being in a coastal area so the flood plain area is defined by the 1 in 200 year flood level. The flood plain covers the whole of the marshes in the Acle and Halvergate marshes. The present elevation of the highway is below that of the 1 in 200 years flood level.

Groundwater Vulnerability

7.4.10 The Environment Agency classifies groundwater by their vulnerability to pollution. The importance of the groundwater resource is classified in terms of Major, Minor and Non-Aquifers(App 7.1,ref. 3). The vulnerability of these aquifers are determined by the leaching potential of the soil overlying them. Soils are classified into High, Intermediate and Low Leaching Potential.

7.4.11 Major aquifers are highly permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstraction for public supply or other purposes. The scheme is underlain by the Crag group which is a Major Aquifer. The Crag comprises reddish brown sands, laminated clays and pebbly gravels. A detailed description of the geology beneath the site is given in chapter 6. A second Major Aquifer the Chalk is present beneath the scheme but this is at some depth (approximately 100m) and is protected from discharges at the surface by the London Clay which directly overlies it in the vicinity of the scheme. The London Clay is greater than 50m thick at this point(App 7.1,ref. 5 and 6). The groundwater table lies very close to the surface in most areas being approximately 1m below ground level. In areas of arable farming the water table has been lowered to approximately 2m below the fields surface.

7.4.12 The soils overlying the aquifer are classified as H1 soils. These types of soil are most vulnerable to pollution because they readily transmit liquid discharges and are either shallow, or susceptible to rapid flow directly to rock, gravel or groundwater. The geology overlying the Crag group include Yare Valley Gravels overlain by the Breydon Formation comprising alluvial deposits of silt and clay, and peat. The Acle slough, close to the Acle roundabout, comprises a channel of peat extending down from the surface to the Crag.

Groundwater Protection Zones

7.4.13 Groundwater protection zones are regulated by the Environment Agency and are defined for pubilc water supplies, other private potable supply or commercial food and drink production. The zones are defined as follows:

Zone I (Inner Source Protection Zone) – immediately adjacent to source. 50 day travel time from any point below the water table. Minimum of 50 metres radius from the source.

Zone II (Outer Source Protection Zone) – 400 day travel time from any point below the water table to the source or 25% of the source catchment area where this is greater.

Zone III (Source Catchment) – This zone covers the whole catchment area of a groundwater source. It is defined as the area needed to support abstraction from long term annual groundwater recharge (effective rainfall).

7.4.14 The orientation, shape and size of the zones are determined by the hydrogeological characteristics of the strata, abstraction volume and the direction of groundwater flow.

7.4.15 The proposed scheme does not traverse any groundwater protection zones. The nearest groundwater protection zone is located 5km to the south west of Acle. (App 7.1,ref. 4). There are no abstractions from or dicharges to groundwater in the vicinity of the scheme. There is however likely to be hydraulic continuity between surface water and groundwater. Therefore abstractions and discharges to surface water would affect groundwater.

Landfill Sites

7.4.16 Landfill sites are a potential source of water pollution. There are no former landfill sites recorded immediately adjacent to the A47 route. However two former landfill sites were identified within 100m south of the A47 at Damgate Lane, Acle (Grid References 640735E 309945N and 640731E 310046N). These are shown on Figure 6.1. The waste types received are unknown for both sites.

Abstraction licenses

7.4.17 Two abstraction licenses were identified within 1km of the A47 route, these are summarised in Table 7.4.2. The location of the abstractions are shown on Figure 7.1. Certain private water supplies (<20m^3/day) do not require a license and therefore may not be known to the Environment Agency, and are not included on the drawing.

Table 7.4.2 – Abstraction Licenses

	Grid Reference	Operator	Licence Number	Source of Supply	Use	Status
1	643710E 309970N	E Jones and Partners	7/34/10/* S/0070	Surface Water	Spray Irrigation – direct	Current
2	650000E 309290N	CW Wharton	7/34/10*S /0084	Surface Water	Spray Irrigation – direct	Current

Discharge Consents

7.4.18 Environment Agency records show sixteen discharge consents within 1km of the scheme. Many of these comprise discharges of treated sewage effluent to the River Bure. Twelve of the discharge consents are located at the Great Yarmouth end of the scheme. One is located in Acle. Three are located near Halvergate Junction where the River Bure runs close to the scheme. Table 7.4.3 below summarises the operational discharge consents, which are on or close to the scheme. These are also shown on Figure 7.1.

Table 7.4.3 Operational Discharge Consents

	Grid Reference	Operator	Permit Number	Discharge Type	Receiving Water Course	Consent Status
1	640560E 310000N	Anglian Water Services Ltd	AETF1000	Sewage – Final/treated effluent – water company	River Thurne/Lower River	Issued 1989
2	643500E 309400N	Mr S Offarell	PRENF13449	Final/treated effluent – not water company	Marsh Dyke, Tributary of River Bure	Issued 2001
3	643900E 309000N	Grs Inn (Pontiac Roadhouse/ Three Feathers/ Stracey Arms)	PR4TF527X	Sewage – Final/Treated effluent – not water company	Tidal River Bure	Issued 1993
4	643900E 309000N	Nr N Ayton	PR4TS527X	Sewage – Final/Treated effluent – not water company	Tidal River Bure	Issued 1993

Pollution Incidents

7.4.19 The Environment Agency was contacted to provide records of pollution incidents along the length of the proposed scheme. If an incident falls within the responsibilities of the Environment Protection function, and results in environmental damage, an impact Category is assigned for each environmental media – water, land and air. The Environment Agency classifies pollution incidents into four categories of incident severity. These are listed in Table 7.4.4 below.

Table 7.4.4: Environment Agency pollution incident categories for water	
Category 1	Persistent and/or extensive effects on water quality. Major damage to aquatic ecosystem. Closure of a potable water abstraction point. Major impact on amenity. Major damage to livestock and/or commerce. Serious impact on man.
Category 2	Significant effect on water quality. Significant damage to aquatic ecosystem Non-routine notification of potable abstractors Reduction in amenity value Damage to agriculture/commerce Impact on man.
Category 3	Minimal effect on water quality. Minor damage to aquatic ecosystem Amenity value only marginally affected
Category 4	No damage (impact) to water.

7.4.20 A number of pollution incidents have been recorded along the road or close to it. The pollution incidents are focused at two locations on the road, Halvergate junction and where the River Bure meanders close to the road slightly west of Ashtree Farm. Table 7.4.5 summarises these incidents close to the A47.

Table 7.4.5: Pollution incidents close to the A47 Acle Straight				
Date	**Grid reference**	**Location**	**Pollutant type**	**Category / cause**
17/04/00	TG43850900	Three Feathers (Pontiac Roadhouse/ Stracey Arms) Acle Straight	Organic chemicals – minerals & synthetic oils – diesel fuels	-
17/02/99	TG43900900	Halvergate Road/Acle Straight	No pollutant	Minor – 3/ Deliberate action
27/07/98	TG43900900	Reedham/River Bure.	Organic chemicals – minerals & synthetic oils – diesel fuels	No impact – 4/ Un-consented works
15/01/97	TG44200900	Stracey pump/R. Bure	Organic chemicals – minerals & synthetic oils – diesel fuels	Minor – 3/ Other
02/02/96	TG43800900	Stracey Arms/R. Bure marsh system.	Organic chemicals – minerals & synthetic oils – Diesel fuels	Minor – 3/ Deliberate action
06/10/94	TG43800900	Stracey Arms (Three Feathers) Public House/R. Bure – Marsh dyke.	Organic chemicals – minerals & synthetic oils – Petroleum spirits	Minor – 3/ Accident
28/08/92	TG50100900	Acle New Road – Scargegap Cottage – marsh dyke	Other Pollutant	Minor – 3/ Unconsented works
13/07/92	TG50100900	C. C. Cottages – River Bure – tidal.	Other Pollutant	Minor – 3/ Unconsented works

7.4.21 All the recorded pollution incidents are category 3 or 4 or uncategorised. Five of the pollution incidents are recorded as petroleum spills. However only one of these is reported as an accident, the rest are from deliberate action. It is not possible to tell whether these events occurred on the A47 road itself or in areas adjacent to the road such as the carpark of the Pontiac Roadhouse (Stracey Arms public house). Other incidents were at

Halvergate junction and near Ashtree Farm, no pollution incidents are recorded along the remaining length of the road.

Management of Dykes and Ditches on the Marshes

7.4.22 There is a complicated water management system on the marshes to provide for all the differing requirements of arable farmers and grazers and this needs constant monitoring and attention to prevent flood or drought. The main water management problem arises from insufficient freshwater to maintain high water levels in the marshes and ditches during the summer(App 7.1,ref. 9 and 10).

7.4.23 Water levels on the Lower Bure, Halvergate Fleet and Acle Marshes are controlled by the Kings Lynn Consortium of the Internal Drainage Board (IDB). The hydrology of the area is not precisely understood but in general the current system appears to rely mostly on rainfall and abstraction from the River Bure, supplemented by groundwater discharge along the western highland margin. Currently water supply is out stripped by evapotranspiration in the summer and exacerbated by leakage to arable areas where drainage levels are lower. The existing water management infrastructure is inadequate to make the best of what water is currently available or to cope with additional water should it become available in the future. Detailed investigations have been undertaken on behalf of the IDB and three phases of work have been proposed to solve the water management problems.

7.4.24 Phase 1 – Includes the following measures that make best use of the available water resources:

- Development of a water management manual
- Employment of a water manager
- Improved monitoring and data collection
- Improved dyke management
- Automation of the Stracey Inlet
- Improved feeder dykes
- Use of the Fleet for storage

7.4.25 Phase 2 – Includes the following measures aimed at increasing available resources:

- Enlarge the Stracey Inlet
- Enlarge feeder dykes

7.4.26 Phase 3 – Includes the following measure aimed at increasing available resources through storage of winter water:

- create a storage reservoir to meet the summer demands for water.

7.4.27 The IDB management plan aims to provide the required water so that ESA Tier 2 and 3 objectives are met over 80% and 10% of the project area respectively. Progressing from Phase 1 to Phase 2 and then to Phase 3 increases the probability that the ESA objectives can be achieved. There will be an increase in retained water levels of approximately 0.25m across the marsh if the objectives are met.

Existing Road Drainage

7.4.28 The existing carriageway is cambered and there are currently no pollution control measures incorporated into the highway drainage system. Drainage of the roadside ditches is an over the edge configuration to both roadside ditches which run parallel to the road embankment. A simple arrangement of drainpipes spaced at approximately 7m intervals hang over the edge of the ditch from the roadside.

7.4.29 When the road was built in the 19th century many of the dykes crossed by the route were blocked off. Where drainage ditches cross the road they pass through culverts which are in a varying state of repair. Some of the culverts have collapsed so that not all remain fully operational. IDB drainage infrastructure maps indicate that seven main drains cross the Acle Straight these are shown on Figure 7.1. Two bridge crossings are present on the scheme these are at the Tunstall Boat Dyke and in the vicinity of the Weavers Way near Acle Roundabout.

Water Quality Monitoring Surveys

7.4.30 Water levels and flows in the vicinity of the Acle Straight are controlled by the Internal Drainage Board (IDB) and their strategy for water level management is described in a report entitled Water Level Management plan for the Lower Bure, Halvergate Fleet & Acle Marshes IDB(App 7.1, ref. 6). Water quality monitoring data in the form of conductivity meter measurements is available from this report. The data was collected in Summer 1997 and covers the entire Acle and Halvergate marshes.

7.4.31 A water quality monitoring survey was also carried out by Hyder Consulting (UK) Ltd during 2003. In January 2003 a first monitoring reconnaissance visit was carried out and the data is provided in factual report(App 7.1,ref. 11) . Further, more detailed monitoring visits were carried out in April/May of 2003 and August 2003 following the methodology set out in the Methodology for Water and Sediment Monitoring Programme(App 7.1,ref. 12) . The results of this work are presented in the factual reports on the

April/May 2003 and August 2003 monitoring[App 7.1,ref. 13&14]. The monitoring work is synthesised and interpreted in the Interpretative Report on water quality monitoring and sediment sampling – January to August 2003[App 7.1,ref. 15]. The monitoring work and its interpretation are summarised below.

7.4.32 Electrical Conductivity (EC) measurements have been taken over the wider area of the marshes in the vicinity of the A47 Acle Straight road. Data exists for four time periods, summer of 1997, January 2003, April/May 2003 and August 2003. The data indicates that salinity has changed little between 1997 and 2003. Inspection of the EC maps indicates that in general the ditch water is fresh in the west generally more saline towards the east. However this general trend is broken up by areas, which are more or less saline than would be expected by such a simple trend. These small-scale variations in salinity are probably the result of the pumping that takes place at various points around the edges of the marshes. Other small scale variations in salinity towards the western side of the marshes are attributed to freshwater springs at or close to the interface of the high ground and marshes.

7.4.33 There appears to be a general seasonal variation with ditch water most fresh in January and becoming most saline in April/May. Salinity in August 2003 is intermediate between levels in January and April/May. This change is probably related to rainfall. EC measurements collected during January 2003 indicated that salinity of the ditch water might increase as a result of road gritting (de-icing). However the variation in salinity observed during gritting was much less than the variation in salinity seen between January and August 2003. Therefore the relative effect of road gritting may not be that significant in comparison to the natural salinity seen in this environment which is close to the sea. It should also be noted that only a few EC data points were collected during road salting and this may not representative of the true effects of road salting.

7.4.34 None of the samples analysed for Cadmium gave concentrations above the Environment Agency Environmental Quality Standards (EA EQS[App 7.1,ref. 8]). Copper concentrations were above the EA EQS at a roadside location near Falklands Farm and the Five Mile Pump control area which is located approximately 1km from the road. Therefore it is difficult to attribute high copper concentrations in the Falklands Farm ditch to road runoff pollutants.

7.4.35 All the dissolved lead concentrations measured are below the EA EQS. Two samples, one at Falklands Farm in April and one at Damgate in January 2003 exceeded the EA EQS for zinc. With the available information it is not possible to rule out that these concentrations are from road runoff.

7.4.36 Organic analyses were carried out to detect Extractable Petroleum Hydrocarbons (EPH), Gasoline Range Organics (GRO) and Polycyclic Aromatic Hydrocarbons (PAH). Detectable EPH concentrations were

recorded at Damgate and Falklands Farm however these concentrations are close to background levels and can probably be attributed to naturally occurring humic acids. GRO compounds were only detectable in samples collected in January 2003 at Falklands Farm at which time of year it is possible that the cold winter temperatures do not allow these volatile organic compounds to evaporate off the road surface before they run off into the ditch. Microbial activity would also be very low at this time of the year and so, such contaminants would not be broken down as quickly as would be expected during the warmer months of April and May. The average GRO concentration recorded in the Falklands Farm ditch in January 2003 was 52.4µg/l, which compares with a UK Drinking Water Standard of 10µg/l.

7.4.37 In summary the conclusions of the monitoring work are:

- There is a general trend of increasing salinity towards the coast.
- Conductivity is controlled locally by rainfall and IDB pumping; close to the road, road runoff contributes freshwater to the ditches.
- Analysis for metals and organics in water indicated insignificant concentrations of cadmium and lead when compared with Environment Agency Environmental Quality Standards; some copper and zinc was evident at low concentrations; gasoline range organics were detected at low concentrations at one roadside location in winter.
- Analysis of sediments did not indicate the presence of contamination by road pollutants.
- The ditches are periodically disturbed by vegetation clearance and pumping.

Summary of Attributes

7.4.38 Table 7.4.4 below summarises the attributes of the different water environment features that may be impacted by the scheme and their importance.

Table 7.4.4: Summary of Attributes

Feature	Attribute	Importance
River Bure	Water supply	Very high
	Transport and dilution of waste products	High
	Biodiversity	High
	Cultural heritage	Very high
	Recreation	Very high
	Value to economy	High
	Conveyance of flow and material	High
Breydon Water (estuary)	Water supply	Low
	Transport and dilution of waste products	High
	Biodiversity	Very high
	Cultural heritage	High
	Recreation	High
	Value to economy	High
Ditches	Transport and dilution of waste products	Very high
	Biodiversity	Very high
	Aesthetics	Very high
	Conveyance of flow and material	Very high
Groundwater	Water supply	Low
	Transport and dilution of waste products	Low
	Biodiversity	Medium
	Conveyance of flood flows	Medium
Floodplain	Conveyance of flood flows.	Very high
	Biodiversity	Very high
	Aesthetics	Very high

7.5 Predicted Impact

7.5.1 This section assesses the predicted impact of Options 2 and 2A on water resources. Impacts relating to the construction phase are discussed in Chapter 14 Disruption Due to Construction. Both Options 2 and 2A are dual carriageway schemes and are described in Chapter 2. Option 2 includes a central reserve width of eight metres between the new and old embankments to preserve the existing ditch adjacent to the existing highway keeping the old and new highway embankments separate.

7.5.2 Option 2A is a compact dual carriageway improvement with the same carriageway and hardstrip width as Option 2 but with a central reserve width of just 2.5m. Option 2A would involve widening of the existing embankment rather than construction of a separate embankment and would result in the loss of one of the existing ditches along the entire length of the scheme. A summary of changes to the water environment is presented in Table 7.5.1 below.

7.5.3 Both scheme options have a similar road drainage system to that of the existing scheme. The flat topography of the area prevents use of drainage pipes due to the lack of fall and therefore the drainage would flow into the ditch adjacent to the carriageway. Since Options 2 and 2A require the upgrade of single to dual carriageway the proposed improvements would approximately double the quantity of road runoff. Each of the carriageways would be constructed with a crossfall (rather than a camber as with the existing single carriageway road) and therefore as there would only be two roadside ditches with Option 2A all of one carriageway would drain to a single roadside ditch. With Option 2 there would be three roadside ditches and the carriageway crossfall could be directed to concentrate runoff in the retained dyke within the central reservation. Alternatively runoff could be directed to two of the three dykes or the direction of crossfall could vary along the route with all three dykes receiving a proportion of the runoff. The current outline proposals indicate a crossfall to the two outer ditches so that the existing ditch within the central reservation would no longer receive any roadside drainage.

7.5.4 Access tracks with unsealed surfaces would be constructed on either side of the road for Option 2 and 2A. The access tracks would not carry a significant traffic load being primarily for use by farm vehicles. Existing ditches, which are crossed by the access tracks would be culverted or bridged.

7.5.5 Although two major water features, the River Bure and Breydon Water are close to scheme they are not directly impacted by the scheme. They are impacted indirectly through the ditch network and pumps of the marsh. In this assessment only the direct impacts on ditches, floodplain and groundwater have been considered. With suitable assessment and mitigation of the impacts to the ditch network, floodplain and groundwater the consequential impacts to the River Bure and Breydon water will be accounted for.

Table 7.5.1: Changes to water environment arising from dual carriageway improvement.

Road layout	Option 2	Option 2A
Ditch alongside road	Existing ditches retained but not receiving road runoff. New ditch created.	One existing ditch lost and new ditch created.
Runoff	Increased road area and equivalent loss of direct recharge area.	Increased road area and equivalent loss of direct recharge area.
Culverts	Replace existing culverts and build new culverts.	Replace existing culverts and build new culverts.

Flooding

7.5.6 The existing embankment height would be retained with the proposed options. However this is below that of the current 1 in 200 year flood level. Therefore the road link along the A47 to Great Yarmouth would not be

maintained during times of severe flooding. This is contrary to planning policy guidance which states that infrastructure should be designed and constructed so as to remain operational even at times of flood[App 7.1,ref. 17]. However, in this case it is considered that the visual and biodiversity impacts resulting from construction of a high embankment would be sufficiently adverse as to outweigh the requirement for the road to be operational during a 1 in 200 year flood.

7.5.7 The new embankment would result in a small net loss of flood plain storage area. However it is considered that this would be an insignificant amount. The percentage decrease in flood storage area of the Halvergate and Acle marshes is approximately 0.5%.

Water Quality

7.5.8 An existing and predicted water quality and spillage probability assessment was carried out in accordance with the DMRB Volume 11 based on the year 2000 traffic flow and traffic flow predictions for the main carriageway[App 7.1,ref. 19]. Traffic flow has been modelled in the traffic forecasting study. For comparison the assessment has been carried out for a base year (2000) which gives an indication of current spillage risk and pollutant loads and also a forecast year known as the design year (2020) which represents a forecast year where traffic levels have grown to a high level. A detailed description of the assessment methodology is given in Appendix 7.2 The assessment was carried out to model a discharge to the roadside ditches. These ditches have very small flow and so it is assumed that no dilution of road runoff occurs within in the ditches. Such an assessment is similar to the groundwater assessment described in the DMRB. Since the ditches are in direct contact with the water table, groundwater is also at risk. Therefore the DMRB predicted water quality assessment for discharge to aquifer has been applied.

Predicted annual average pollutant runoff

7.5.9 Table 7.5.2 shows the predicted annual average pollutant runoff concentrations for water draining half of the dual carriageway road surface to one ditch at any point along the road. The Environment Agency Environmental Quality Standard (EA EQS) for soluble copper and total zinc are given in Table 7.5.2. All of the predicted pollutant concentrations exceed the EA EQS. This includes the predicted load for the existing situation, which not only exceeds EQS but is approximately 10 times greater than measured concentrations of copper and zinc as no allowance is made for attenuation or dilution on passage through the drainage system. The pollutant load running off the road increases in the design year 2020 for Option 2 and 2A because the Annual Average Daily Traffic (AADT) flow is predicted to increase.

Table 7.5.2: Predicted annual average pollutant runoff concentration, EA EQS and Actual Ditch Pollution Concentrations.		
Assessment	**Concentration**	
	Soluble Copper (µg/l)	**Total Zinc (µg/l)**
EA EQS*	10	75
Actual average concentration in all ditches (51 No. Samples) **	13	61
Actual average concentration in all ditches far from the road (12 No. Samples)***.	16	20
Actual average concentration in roadside ditches (39No. Samples)****	12	73
Existing road (2000)	130	670
Existing road high growth (2020)	130	670
Option 2 and 2A (2020)	400	1700
*Environment Agency EQS. **Actual average concentration recorded in all ditches of the water quality monitoring survey. ***Actual average concentration recorded in ditches of the control areas of the water quality monitoring survey. ****Actual average concentration recorded in roadside ditches of the water quality monitoring survey.		

Note: No allowance is made for attenuation or dilution on passage through the drainage system.

7.5.10 It is important to note that the predicted annual average pollutant road runoff rates used in this calculation are for the year as a whole and represent typical pollutant loads for roads in general. The predicted annual average pollutant runoff assessment outlined in the DMRB is a very conservative estimate of pollutant runoff. The assessment model used here makes the following assumptions;

- The pollutant build-up rates recommended are selected from old studies and are biased towards the higher values quoted in those studies.
- Pollutant build up rates do not always provide an accurate indication of likely discharge quality, with several studies indicating that only a poor correlation between traffic flow and discharge quality exists.
- The assumed runoff coefficient of 0.5 is low (a more realistic coefficient would be in excess of 0.7, hence the pollutants are assumed to be washed off in a low volume of rain, producing a higher discharge concentration.
- No allowance is made for attenuation or dilution on passage through the drainage system.
- In this model 40% of the total copper and all of the zinc deposited on the road surface is assumed to remain in the water.

7.5.11 The DMRB recommends that the assessment should be used in a tiered approach. Where the predicted concentration is less than the EQS then unattenuated discharge with respect to water quality is acceptable. Where

the calculated concentration in runoff is greater than the relevant EA EQS, more detailed evaluation will be required to determine whether additional pollution control measures are needed.

7.5.12 The site specific water quality monitoring carried out in this study indicates that at certain times of the year the water in the existing roadside ditches sporadically have copper, zinc and gasoline range organic concentrations greater than EA EQS and UK Drinking Water Standards. If these contaminants were sourced from road runoff then it would be expected that the increase in traffic flow predicted for Existing and Option 2 and 2A would result in a higher concentration of pollutants in roadside ditches at certain times of the year.

7.5.13 The actual average concentrations of the chemical analyses carried out during the water quality monitoring work in the ditches are also shown in Table 7.5.2 for comparison. The measured concentrations are close to or lower than the EA EQS for copper and zinc and lower than the predicted pollutant level of the runoff from the road. It is probable that copper and zinc in ditch water is largely attributable to high natural concentrations rather than road runoff. For example, recorded copper levels were higher in ditches sampled at a distance from the road than those close to it.

7.5.14 The increase in road surface area would create a higher volume of road runoff to roadside ditches than the existing road. This runoff water would have a low salinity being derived from rainfall. This increased volume would be expected to cause greater dilution in the salinity of roadside ditches than has been observed during the water monitoring survey of the existing road.

7.5.15 The water monitoring work indicates that relative effects of road gritting may not be that significant in comparison to the natural salinity seen in this environment which is close to the sea. However this is based on a limited amount of data.

7.5.16 Any additional road runoff pollution resulting from the proposals would be minimal and would predominately effect roadside ditches. There is little appreciable flow in the majority of dykes therefore transport of pollutants beyond the roadside ditch will take place slowly. The northern boundary of Damgate Marshes SSSI (component of Broads cSAC and Broadland Ramsar site) borders the road and includes the southerly roadside dyke (see figure 9.2). As a consequence of the above surface runoff pollution in Damgate Marshes is considered to be restricted to those ditches in the northern part of the site. Breydon Water SPA and Ramsar Site is not at risk from pollution resulting from surface runoff because as it is not directly linked with roadside ditches. In addition Decoy Carr and Halvergate Marshes SSSI (components of Broads cSAC and Broadland SPA and Ramsar Site) are not considered to be at risk from surface runoff related pollution due to their distance in excess of 400m and 600m respectively from the road.

7.5.17 Table 7.5.3 shows the predicted risk of accidental spillage for the existing road and options 2 and 2A. In this initial assessment the spillage risk is assessed for the entire length of road since all of the roadside ditches are considered to be at risk. This is a worse case. The spillage assessment for the existing road (year 2000) shows that the probability of having a pollution incident is at an acceptable level. This is because the return period for such an event is 1 in 145 years, whereas an unacceptable level of risk would be a return period of less than 100 years. A detailed description of the assessment methodology is given in Appendix 7.2.

7.5.18 The predicted increase in traffic flow in the design year (2020) with the do-minimum situation (if the scheme does not proceed), means that the probability of a pollution incident occurring increases to less than the acceptable 1 in 100 year return period. The increased traffic forecasts predicted by traffic modelling for Option 2 and 2A are greater than that predicted for the do-minimum scheme(App 7.1,ref. 19). The configuration of the scheme has also changed with the addition of a new roundabout at Halvergate junction which means the probability of a serious accidental spillage has increased. Therefore the pollution risk is further increased to 1 in 70 years.

Table 7.5.3: Probability that a spillage would cause a pollution incident.

Assessment	Risk that a spillage would cause a pollution incident/year
Acceptable risk of a pollution incident*	1 in 100 years
Existing road (2000)	1 in 145 years
Existing road high growth (2020)	1 in 83 years
Option 2 and 2A (2020)	1 in 70 years
*DMRB Volume 11 Section 3 Part 10.	

7.5.19 Both the Existing High Growth (2020) and Option 2 and 2A (2020) road present an unacceptable spillage risk if there is no mitigation. It is important to note that the spillage assessment only assess the spillage risk for the main carriageway and road junctions. The scheme option also involves the construction of access tracks alongside the main carriageway dramatically reducing the number of farm accesses which number over 80 with the current road. It is likely that the proposed access tracks would further reduce the spillage risk but this is not taken into account with the spillage risk methodology.

7.5.20 Risk of pollution through spillage is predominately to roadside ditches assuming that containment and clean up takes place within reasonable time after the incident. The northern boundary of Damgate Marshes SSSI (component of Broads cSAC and Broadland Ramsar site) borders the road and accordingly includes the southerly roadside dyke (see figure 9.2) which is currently at risk of being polluted as a result of an accidental spill on the road. Breydon Water SPA and Ramsar site is not at risk from pollution

resulting from accidental spill because as it is not directly linked with road side ditches. In addition Decoy Carr and Halvergate Marshes SSSI (components of Broads cSAC and Broadland SPA and Ramsar Site) are not considered to be at risk from surface runoff related pollution due to their distance in excess of 400m and 600m respectively from the road.

Insoluble pollutants and suspended solids

7.5.21 A significant proportion of the total polluting load arising from road runoff is associated with the solid fraction of a discharge, which may contain over 70% of the copper and 56% of the cadmium arising from a rural road. Insoluble and settleable materials may not cause a failure of water quality standards but could, under some circumstances, cause an unacceptable accumulation of solids on the bed of the receiving watercourse. Even if the solids are inert, fish, invertebrates and plants can be adversely affected by smothering. Currently there are no sediment quality or quantity standards to use as reference points. Some hydrocarbons and by products of incomplete fuel combustion are toxic, and the types of and quantities of fauna present can be changed if these by products are allowed to accumulate on the bed of the receiving water in large quantities.

7.5.22 During the detailed water quality monitoring work carried out in 2003 sediment samples were collected from selected ditches adjacent to the A47 and in control areas at some distance from the road. Chemical analysis was carried out to detect typical metal and organic contaminants associated with road runoff. The sediment analyses provide a means to determine if there is a long-term build-up of contaminants in the ditch.

7.5.23 In the absence of more suitable guideline values the sediment analyses have been compared with Environment Agency Soil Guideline Values and the withdrawn ICRCL Threshold levels[App 7.1,ref 20 to 23]. However it should be noted that these guideline values were developed largely for use in the redevelopment of contaminated land and may not be entirely appropriate for the case of sediment discharges from road drainage.

7.5.24 None of the samples analysed showed metal concentrations that were higher than EA Soil Guideline Values and ICRCL threshold levels. It is difficult to see any distinct trends in any of the analyses from each detailed study area. Metal concentrations measured in areas close to the road are not systematically higher than concentrations measured in the control areas away from the road. The sediment samples were also analysed for PAH, GRO and EPH compounds. Although detectable concentrations of these compounds were measured in the sediment samples, concentrations were low and it was difficult to attribute these samples to anything other than naturally occurring organic matter such as peat material.

7.5.25 However it should be noted that the existing A47 road surface is old and has already seen a lot of wear and weathering. It would be expected, at least initially that any new pavement surface would have a higher amount of insoluble pollutant runoff until the surface has worn in. Routine resurfacing work associated with the road would also create a higher amount of insoluble pollutant runoff.

Flow Patterns

7.5.26 The flow patterns local to the road would be disturbed by the proposed options. The larger scale quantities of flow to IDB main drains and pumps would not be changed as long as the existing culverts crossing under the road and the associated flow network is not altered. However there would be significant impacts to the water in ditches close to the road. These impacts are described in detail for option 2 and 2A below.

Flow Patterns Option 2

7.5.27 With Option 2 a new drainage ditch alongside the new embankment would drain the additional carriageway and the existing ditches would be retained. With carriageway crossfalls draining towards the ditches on the highway boundary the existing roadside ditch located within the central reservation would cease to receive any road runoff.

7.5.28 The change in ditch configuration would mean that there are changes in the hydrology of different ditches. The existing ditch that would continue to receive road runoff would now receive approximately twice the road runoff than at present because the carriageway draining to one ditch would increase from a width of approximately 3.4m to 9.3m. This would be an annual runoff volume increase of 110m^3/day for the entire length of road assuming an annual average rainfall of 600mm/yr. As a result larger variations in salinity would be created than are currently being experienced by the existing ditch. However over long time periods the ditch water would become less saline. The new roadside ditch would develop a water quality similar to the variations experienced in the existing roadside ditch that would continue to receive road runoff.

7.5.29 The existing ditch in the middle of the dual carriageway would no longer receive water from road runoff. Water in the ditch would be supplied from groundwater and flow from connecting ditches.. The flow from connecting ditches on both sides of the dual carriageway would remain unchanged as all dykes crossed by the new embankment would be culverted and all existing culverts/bridges under the existing embankment would be retained.

7.5.30 It is possible that the quality of the water in the central ditch would degrade as a result of being cut off from the road runoff and not receiving significant land drainage water from adjacent fields.

Table 7.5.4: Summary of water quantity and quality magnitude of impacts to ditches for Option 2			
	Number of ditches in typical cross-section	**Effect**	**Magnitude of Impact**
Existing ditch receiving no carriageway drainage	1	no road drainage less land drainage from fields	Moderate to Major Negative
Existing ditch receiving carriageway drainage	1	increased road drainage	Minor Positive
New roadside ditch	1	similar to existing retained ditch receiving road drainage	Minor Positive

Flow Patterns Option 2A

7.5.31 Option 2A would result in the loss of one roadside ditch and its replacement with a new drainage ditch receiving all runoff from one carriageway on the new embankment. One existing ditch would be retained and receive all runoff from the carriageway on the existing embankment.

7.5.32 The change in ditch configuration would mean that there are changes in the hydrology of different ditches. The existing ditch receiving road runoff would now receive approximately twice the road runoff than the existing scheme. The carriageway draining to one ditch would increase from a width of 3.4m to 9.3m. This would be an annual runoff volume increase of 110m^3/day along the entire length of road assuming an annual average rainfall of 600mm/yr. As a result larger variations in salinity would be created than are currently being experienced by the existing ditch. However over long time periods the ditch water would become less saline. The new roadside ditch would develop a water quality similar to the variations experienced in the existing retained roadside ditch.

7.5.33 One existing roadside ditch would be destroyed but the culvert linkages of dykes under the widened embankment would remain the same as with the existing road. The culverts would merely be extended in length. Therefore water flows between the dykes on each side of the road would remain unchanged.

Table 7.5.5: Summary of water quantity and quality magnitude of impacts to ditches for Option 2A			
	Number of ditches in typical cross-section	**Effect**	**Magnitude of Impact**

Existing ditch destroyed	1	Habitat Destruction	Major Negative
Existing ditches receiving carriageway drainage	1	Increased road drainage	Minor Positive
New roadside ditch	1	Similar to existing retained ditch receiving road drainage	Minor Positive

Culverts and Drains crossing the road

7.5.34 The existing road embankment crosses a large number of dykes, a proportion of which are connected under the embankment by culverts and also two bridge crossings. However some of the culverts have collapsed so that not all remain fully operational. IDB drainage infrastructure maps indicate that seven main drains cross the Acle Straight. In addition to this a number of culverts cross the road but some of these have collapsed or become disused. If collapsed culverts with little or no existing water connectivity are re-opened, new flow paths may be created between areas of marsh on either side of the road and affect the IDB management plans regime in each area. New bridges or culverts are proposed at all access tracks crossings of existing ditches so that water flows would not be affected at these locations.

Summary of Impacts on Ditches and the Flood Plain

7.5.35 Tables 7.5.6 and 7.5.7 summarise the impacts of Options 2 and 2A on the ditches and Floodplain. In general both Options would have negative impacts because some ditches would be destroyed or degraded. Creation of a new ditch would provide new drainage and habitat thus moderating the total impact. The waters of the River Bure and Breydon Water have the potential to be affected indirectly through the ditch network and pumps of the marsh. However whilst the road has localised impacts on the water quality, hydrology and biodiversity of adjacent small scale drainage ditches the effects on the much larger and more distant Bure and Breydon water would be negligible. However construction effects and increase in traffic during the operational phase would result in increased intrusion on birds using Breydon Water giving an adverse effect on the biodiversity attribute.

Table 7.5.6: Summary of Magnitude of Impacts for Option 2

Feature	Attribute	Magnitude of Impacts
River Bure	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Negligible
	Cultural heritage	Negligible
	Recreation	Minor negative

Table 7.5.6: Summary of Magnitude of Impacts for Option 2		
	Value to economy	Neutral
	Conveyance of flow and material	Neutral
Breydon Water (estuary)	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Moderate negative
	Cultural heritage	Negligible
	Recreation	Negligible
	Value to economy	Neutral
Ditches	Transport and dilution of waste products	Minor Negative
	Biodiversity	Major Negative
	Aesthetics	Minor Negative
	Conveyance of flow and material	Major Negative
Floodplain	Conveyance of flood flows.	Negligible
	Biodiversity	Negligible
	Aesthetics	Negligible

Table 7.5.7: Summary of Magnitude of Impacts for Option 2A		
Feature	**Attribute**	**Impact**
River Bure	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Negligible
	Cultural heritage	Negligible
	Recreation	Minor negative
	Value to economy	Neutral
	Conveyance of flow and material	Neutral
Breydon Water (estuary)	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Moderate negative
	Cultural heritage	Negligible
	Recreation	Negligible
	Value to economy	Neutral
Ditches	Transport and dilution of waste products	Minor Negative
	Biodiversity	Major Negative
	Aesthetics	Negligible
	Conveyance of flow and material	Major Negative
Floodplain	Conveyance of flood flows.	Negligible
	Biodiversity	Negligible
	Aesthetics	Negligible

Groundwater

7.5.36 The scheme options may also impact on the following groundwater attributes.

- Water supply
- Transport and dilution of waste products.
- Biodiversity
- Conveyance of flood flows

7.5.37 The amount of recharge available to groundwater would change little as a result of the proposed scheme options. Settlement of the new road embankment would cause a small amount of groundwater flow from beneath the embankment but this would only be a transient effect whilst groundwater pressures equalise.

7.5.38 There are no groundwater supply boreholes in the vicinity of the scheme and the scale of the groundwater resource would not be affected by the scheme. The projected increase in traffic flow for the area for the existing and proposed scheme means that there is an increased risk of pollution from spillage. Therefore, like surface water there is a negative impact from the scheme with respect to groundwater. Although runoff water quality is likely to deteriorate as a result of the increased traffic flow it is unlikely to have a significantly negative impact on groundwater quality.

Table 7.5.8: Summary of Impacts on Groundwater for Option 2 and 2A

Attribute	Magnitude of impact
Water supply	Negligible impact
Transport and dilution of waste products	Minor negative impact (due to increased spillage risk)
Biodiversity	Negligible impact
Conveyance of flows	Negligible impact

7.5.39 The significance of potential impacts using the criteria in Table 7.2.3 is shown in Table7.5.9 for Option 2 and Table 7.5.10 for Option 2A.

Table 7.5.9: Impact of the Proposed Scheme on the Water Environment for Option 2

Water Feature	Importance	Changes from Scheme	Magnitude of Impact	Significance
River Bure	Very High	Slight adverse impact on views for recreational users and heritage setting. Negligible effects on water quality.	Negligible	Low Significant Negative
Breydon Water	High	Negligible effects on water quality.	Moderate Negative	Significant

		Non water related effect on wintering and breeding birds (see Chapter 9)		
Ditches	Very High	Degradation of existing ditches. Construction of new ditches. Increased spillage risk.	Moderate to Major Negative	Highly Significant Negative
Floodplain	Very High	Change in flow patterns from reconnecting collapsed culverts	Negligible	Low Significant Negative
Groundwater	Low to Medium	Increased spillage risk	Minor Negative to Negligible	Insignificant

Table 7.5.10: Impact of the Proposed Scheme on the Water Environment for Option 2A

Water Feature	Importance	Changes from Scheme	Magnitude of Impact	Significance
River Bure	Very High	Slight adverse impact on views for recreational users and heritage setting. Negligible effects on water quality.	Negligible	Low Significant Negative
Breydon Water	High	Negligible effects on water quality. Non water related effect on wintering and breeding birds (see Chapter 9)	Moderate Negative	Significant
Ditches	Very High	Degradation of existing ditches. Construction of new ditches. Increased spillage risk.	Major Negative	Very Significant Negative
Floodplain	Very High	Slight change in flow patterns from reconnecting collapsed culverts	Negligible Negative	Low Significance
Groundwater	Low to Medium	Increased spillage risk	Minor Negative to	Insignificant

			Negligible	

7.6 Mitigation Measures

Road Runoff Treatment and Containment

7.6.1 The water quality and spillage assessments indicate that mitigation measures are required for two purposes.

- Containment of sediment running off the road.
- Containment of spillages.

7.6.2 Although the water quality prediction assessment indicates that soluble pollutant loads are above EA EQS the site specific monitoring survey indicates that dissolved concentrations of pollutants running off the proposed road are unlikely to be so high as to require mitigation in the form of a vegetative treatment system. However neither the DMRB water quality prediction nor the water quality survey assesses the short-term variation of water quality known as 'first flush'. It is thought that pollutant load from road runoff is worst during heavy rainfall after a long dry period, this is known as first flush. If feasible it may be prudent to incorporate a vegetative treatment system for attenuation of these first flush flows. This would also mitigate against the effects of any saline road runoff after a prolonged icy periods.

7.6.3 The IDB have requested measures be incorporated that prevent contamination of the field ditches and dykes by highway runoff particularly contaminated silt. The following pollution mitigation measures are proposed for inclusion in the drainage design. The outlets to all new or retained roadside ditches would incorporate a combination of high level outlets (weirs) to retain silt and lower level outlets (hanging walls or low slot weirs) to retain oils etc. The low weir arrangement would have provision to close the outlet using stop logs or penstocks and would provide containment in the local section of roadside ditch in the event of a major spillage. The outfall arrangements would be confined to the roadside ditch and not encroach into the field ditch. The minimal longitudinal gradient and the length of roadside ditch between perpendicular field ditches would generally result in the roadside ditch having outlets at each end or junction with other ditches.

7.6.4 A preliminary conceptual design has been developed for the new roadside ditches indicating that the road drainage would be made up of drainage runs, which would form a road drainage catchment not exceeding 400m in length. The catchments would drain to containment areas at the foot of the road embankment. Each containment area is likely to have a capacity of $25m^3$ and be lined with an impermeable material such as puddle clay. This

would prevent infiltration to the aquifer. At the exit of the containment area the hanging wall and weir arrangement would be installed within a metre of each other.

7.6.5 The containment area would outfall to a roadside ditch where a vegetative treatment system could be installed, which would attenuate dissolved organic and metal pollutants running off the road. Where feasible, without damaging the ecological interests of the roadside dykes and subject to consultation with English Nature, this conceptual design would also be applied to the existing roadside dykes. However there is likely to be some variation on the 400m length in order to avoid or minimise ecological impacts. Furthermore containment areas and vegetative treatment systems would only be provided in locations where the benefits arising from these measures would outweigh any adverse ecological effects.

7.6.6 Reducing the drainage runs to 400m and inclusion of the above mitigation measures would reduce the risk from spillage. Accordingly the spillage assessment can be recalculated with adjustment allowing for the containment measure which would reduce the individual risk by 65% as specified in DMRB[(App 7.1,ref. 1)]. The adjusted relative pollution probabilities are given in Table 7.6.1 below.

Table 7.6.1 Probability that a spillage would cause a pollution incident. Following mitigation

Assessment	Risk that a spillage will cause a pollution incident/year
Acceptable risk of a pollution incident*	1 in 100 years
Existing (2000)	1 in 145 years
Existing High Growth (2020)	1 in 83 years
Option 2 and 2A without mitigation measures (2020)	1 in 77 years
Option 2 and 2A with mitigation measures (2020)	1 in 108 years
*DMRB Volume 11 Section 3 Part 10.	

7.6.7 The proposed water pollution mitigation measures would provide spillage containment in roadside ditches. This would have a beneficial effect on the probability of a spillage causing a pollution event. This is reflected in the return period shown in Table 7.6.1 above which indicates that the spillage risk would be reduced to an acceptable level.

Provision of additional Dykes

7.6.8 Mitigation measures have been proposed as compensation for loss of ecological habitat in the dykes and include the provision of new habitat creation ditches alongside the access tracks, adjacent to the open fields (see chapter 9). If these were provided they would be likely to have a water

quality similar to that of the typical field boundary ditches in the area. However although these would provide a comparable range of habitat niches colonised with a range of flora and fauna over time, it is unlikely that a replication of the lost dyke flora and fauna could be achieved.

Maintenance of road runoff to the existing ditch in the central reservation

7.6.9 The current design with the crossfall drainage of the road surface falling towards the outer roadside ditches means that the existing ditch in the central reservation of Option 2 would no longer receive road runoff or runoff from adjacent fields and this is likely to degrade the water quality of the ditch. However if the crossfall on both carriageways is in the same direction then one carriageway would drain to the central reservation ditch mitigating against the loss of road runoff to this existing ditch.

7.6.10 The following drainage configurations are possible with Option 2;

1) All road drainage to existing central reservation ditch.
2) Existing and New outside ditches receive road drainage
3) Existing central reservation and New outside ditch receives road drainage
4) Existing central reservation and Existing outside ditch receives road drainage

7.6.11 These configurations are shown below in Table 7.6.2.

Table 7.6.2 Drainage Configurations for Option2

Ditch	Sources of ditch water for each configuration											
	Configuration 1			Configuration 2			Configuration 3			Configuration 4		
	Field Drainage	Road Drainage	Groundwater	Field Drainage	Road Drainage	Groundwater	Field Drainage	Road Drainage	Groundwater	Field Drainage	Road Drainage	Groundwater
Existing ditch in central reserve		x2	x			x		x	x		x	x
Existing outside ditch.	x		x	x	x	x	x		x	x	x	x
New outside ditch	x		x	x	x	x	x	x	x	x		x

7.6.12 The relative impacts these ditch configurations would have on existing and new ditches is not known. However it would seem logical that providing road runoff from at least one carriageway to the existing ditch in the central reserve would compensate for loss of field drainage and drainage from half of the existing road surface. This would therefore be desirable in order to help maintain the existing water quality in this ditch. Further research would be necessary to fully determine the relative merits of these ditch configurations and the specific impacts on the particular ecological interests of the ditch.

Water level management, ditches and culverts design

7.6.13 Design of new ditches and culverts should be carried out in consultation with the IDB. The IDB has a comprehensive water level management plan for the area and provision should be made to accommodate their plans. For example this may involve construction of a large culvert for the Stracey inlet and any other dykes that feed water to the marshes and cross the road.

7.6.14 Replacement of existing culverts (and construction of any new culverts) under the existing road embankment may affect the current flow regime on the marshes. For example, if collapsed culverts are replaced then this may affect the flow paths between marsh areas on adjacent sides of the road. Culvert replacement must be carried out in consultation with the IDB. The addition of any new culverts or replacement of dysfunctional culverts has the potential to have a beneficial effect on the management of the marshes and be supportive of the IDBs plans. However the design of culverts must be carried out in concert with the aspirations of the IDB. For example, this may include new culverts that have water control structures at one end in order to maintain different water levels on either side of the road. New culvert connections under the existing embankment could also significantly effect local wetland habitat conditions and should not be carried out without a detailed ecological assessment of the implications.

7.6.15 At the present time the Tunstall Boat Dyke is crossed with a low bridge. Option 2 would not alter the existing road embankment or culvert which in any case is not high enough to be navigable. A similar bridge would be provided with the new or widened embankments of Option 2 and 2A.

Flood Levels

7.6.16 The new embankment and new or replacement culverts should be designed so as not to significantly impede flood flows or increase flood risk elsewhere[App 7.1,ref. 17].

Summary of residual impacts

7.6.17 Tables 7.6.3 and 7.6.4 summarise the residual impact of the scheme on water resources once mitigation measures have been put in place. The spillage containment measures and measures to attenuate dissolved and insoluble pollutants (where feasible) have the effect of improving the quality of the discharge from road runoff. A combination of negative and positive impacts affect the biodiversity attributes of the ditches. The increase in road runoff would increase fluctuations in salinity in the ditches, which would be a negative impact. However, with a suitable drainage design it may be possible to attenuate these effects. The increased road runoff may even provide a higher quality (lower salinity) environment in ditches receiving road runoff.

7.6.18 Option 2 would result in isolation of an existing roadside ditch between two embankments thus loosing road and field runoff inflows and adversely affecting the water quality. The central reservation ditches may also become aesthetically degraded. Subject to further detailed studies to determine optimum drainage configuration it may be possible to mitigate against adverse effects on biodiversity caused by hydrological change for this central reservation ditch. However the effectiveness of design and management measures to fully compensate for the adverse effects on the ecology of this dyke is in doubt (see Chapter 9).

7.6.19 Option 2A would completely destroy an existing roadside ditch causing a major negative impact however this is somewhat mitigated by the creation of a replacement roadside ditch.

7.6.20 With both Options 2 and 2A effective mitigation of the effects on ditch habitat would require habitat creation with the provision of additional ditches. These could be located outside the access tracks and would compensate for loss of dykes and degradation of retained dykes. However with our present understanding of dyke species translocation it appears that these new ditches are unlikely to fully replace the lost habitat in existing ditches (see Chapter 9). Therefore, as the mitigation measures for biodiversity impacts are unproven there is little difference between the residual impact on the biodiversity of the dykes when compared with the impact before mitigation.

7.6.21 The provision of flow control structures to replacement culverts (and any new culverts) under the existing embankment, to control flows between adjacent areas of marsh across the road, would benefit the conveyance of flows and drainage flood management on the marshes.

Table 7.6.3 Summary of Residual Magnitude of Impacts for Option 2		
Feature	**Attribute**	**Magnitude of Impact**
River Bure	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Negligible
	Cultural heritage	Negligible
	Recreation	Minor negative
	Value to economy	Neutral
	Conveyance of flow and material	Neutral
Breydon Water (estuary)	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Minor Negative
	Cultural heritage	Negligible
	Recreation	Negligible
	Value to economy	Neutral
Ditches	Transport and dilution of waste products	Minor positive
	Biodiversity	Moderate negative
	Aesthetics	Minor Negative
	Conveyance of flood flows.	Minor Positive
Floodplain	Conveyance of flood flows.	Minor Positive
	Biodiversity	Negligible
	Aesthetics	Negligible

Table 7.6.4 Summary of Residual Magnitude of Impacts for Option 2A		
Feature	**Attribute**	**Magnitude of Impact**
River Bure	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Negligible
	Cultural heritage	Negligible
	Recreation	Minor negative
	Value to economy	Neutral
	Conveyance of flow and material	Neutral
Breydon Water (estuary)	Water supply	Neutral
	Transport and dilution of waste products	Neutral
	Biodiversity	Minor Negative
	Cultural heritage	Negligible
	Recreation	Negligible
	Value to economy	Neural
Ditches	Transport and dilution of waste products	Minor positive
	Biodiversity	Major negative
	Aesthetics	Negligible
	Conveyance of flood flows.	Minor Positive
Floodplain	Conveyance of flood flows.	Minor Positive
	Biodiversity	Negligible
	Aesthetics	Negligible

7.6.22 Table 7.6.5 summarises the residual impacts on groundwater. The effects of the scheme options on groundwater are generally neutral and the proposed mitigation measures would do little to change this. Unless a lined (impermeable) spillage containment area is incorporated in the drainage design, no additional protection of the aquifer would be provided.

Table 7.6.5 Summary of Residual Impacts on Groundwater for Option 2 and 2A	
Attribute	**Magnitude of impact**
Water supply	Negligible impact
Transport and dilution of waste products	Minor Negative impact (due to increased spillage risk)
Biodiversity	Negligible impact
Conveyance of flows	Negligible impact

7.6.23 The significance of potential impacts can be determined using Table 7.2.3. This is shown in Table7.6.6 for Option 2 and Table 7.6.7 for Option 2A.

Table 7.6.6 Residual Impact of the Proposed Scheme on the Water Environment for Option 2				
Water Feature	**Importance**	**Changes from Scheme**	**Magnitude of Impact**	**Significance**
River Bure	Very High	Slight adverse impact on views for recreational users and heritage setting.	Negligible Negative	Low Significant Negative
Breydon Water	High	Slight Negative effect on wintering and breeding birds	Minor Negative	Low Significant Negative
Ditches	Very High	Degradation of existing ditches. Construction of new ditches for habitat creation. Increased spillage risk but improved spillage containment.	Moderate Negative	Highly Significant Negative
Floodplain	Very High	Change in flow patterns. Improved conveyance of flows during flood events.	Negligible Positive	Low Significance Positive
Groundwater	Low to Medium	Increased spillage risk but improved spillage containment.	Negligible to Minor Negative	Insignificant

Table 7.6.7 Residual Impact of the Proposed Scheme on the Water Environment for Option 2A				
Water Feature	**Importance**	**Changes from Scheme**	**Magnitude of Impact**	**Significance**
River Bure	Very High	Slight adverse impact on views for recreational users and heritage setting.	Negligible Negative	Low Significant Negative
Breydon Water	High	Slight Negative effect on wintering and breeding birds	Minor Negative	Low Significant Negative
Ditches	Very High	Destruction of existing ditch. Construction of new ditches for habitat creation. Increased spillage risk but improved spillage containment.	Major Negative	Very Significant Negative
Floodplain	Very High	Change in flow patterns. Improved conveyance of flows during flood events.	Negligible Positive	Low Significant Positive

Table 7.6.7 Residual Impact of the Proposed Scheme on the Water Environment for Option 2A				
Groundwater	Low to Medium	Increased spillage risk but improved spillage containment.	Negligible to Minor Negative	Insignificant

Overall Assessment

7.6.24 Impacts are low or insignificant except for the effects on the ditches where a highly significant impact (Option 2) and very significant impact (Option 2A) would primarily result from short and long term effects on the flora and fauna in the roadside ditches. This particularly applies those ditches which would be lost as a result of the proposals or would suffer degradation as a result of being isolated from the existing dyke network (see Chapter 9). With current levels of knowledge mitigation in the form of provision of replacement dykes for habitat creation would not fully replicate this lost habitat although comparable habitats may be developed over time.

7.6.25 By relating the significance of impacts to the definitions for overall assessment of the effects of the scheme on the water environment given in Table 7.2.4, each scheme option can be assigned an overall assessment score. With mitigation Option 2 has on balance an overall score of 'Moderate Adverse Impact' as the proposals have a variety of impacts ranging from Low Significant Positive to Highly Significant Negative. Option 2A has on balance a 'Large Adverse Impact' with the proposals resulting in a range of impacts from Low Significant Positive to Very Significant Negative.

7.7 Summary of Impacts and Significance

7.7.1 Monitoring work carried out in summer 1997 and January to August 2003 indicates that general salinity in the ditches of the Acle Marshes has changed little. The detailed Electrical Conductivity monitoring carried out during the site works of January, April/May and August 2003 indicates that salinity in the ditches varies as a result of rainfall. Ditches that are isolated and have no large inflow and are surrounded by fields show no large variations in salinity. In contrast ditches that have high flow or drain large areas of hard standing receive a large volume of rainfall runoff and therefore have a higher variation in salinity. In general, for such ditches, higher rainfall means lower salinity. Ditches which receive road runoff are examples of variable salinity ditches.

7.7.2 Contaminant testing of sediment and water samples from a range of different ditch types indicates that the existing road is having little adverse effect on water quality with respect to typical road pollutants. However some elevated concentrations of zinc and gasoline range organics have been measured in some water samples from roadside ditches at certain

times of year. It is possible that individual rainfall events cause sporadic influxes of pollutants which have not been detected by the monitoring work. High copper concentrations were found in some samples tested but occurrences were found in locations both close to and far away from the road and therefore may represent high natural background levels.

7.7.3 A water quality prediction assessment for projected 2020 traffic levels carried out using the methodology outlined in the DMRB indicates that pollutant loads for the proposed scheme would be significant. However this model is very conservative and site specific monitoring indicates that it may predict overly pessimistic pollutant levels. It is likely that it is the variations in salinity caused by low salinity road runoff flowing into ditches of the proposed scheme that has a more significant impact on water quality and ditch ecology than pollutant load. Fluctuations in salinity may be more harmful to some ditch plants and animals than a consistently high salinity but it is not possible to be certain of this without more detailed ecological research. The Rivers Bure and Breydon Water are tidal and any salinity effects from the road on these water courses are insignificant in comparison.

7.7.4 Road de-icing salts may cause fluctuations in salinity in roadside ditches. However the monitoring work carried out in this study indicates that salinity due to de-icing may not be as great as the total variation in more naturally saline ditches.

7.7.5 Any additional road runoff pollution resulting from the proposals would be minimal and would predominately be limited to roadside ditches including the roadside ditches located in the northern periphery of Damgate Marshes SSSI (component of Broads cSAC and Broadland Ramsar site). All other designated sites of ecological interest are likely to remain unaffected by road surface runoff.

7.7.6 Spillage probability assessments indicate that the risk of serious accidental spillage would be unacceptable for the existing and proposed scheme 2020 traffic levels. The proposed mitigation measures of spillage containment, would mitigate against accidental spillage bringing the risk to within acceptable levels for both options. This therefore represents a beneficial effect compared with the do-minimum situation. The knock on benefits to the Bure and Breydon Water would be negligible.

7.7.7 With the provision of pollution containment measures the risk of pollution from accidental spillage would also be reduced for the roadside ditches in Damgate Marshes SSSI (component of Broads cSAC and Broadland Ramsar site). However the construction of such measures could cause some initial localised disruption to the ecological interests of the effected ditches. All other designated sites of ecological interest are likely to remain unaffected by accidental spillage.

7.7.8 Additional pollution mitigation measures are proposed such as high level hanging wall/low slot weir and vegetative treatment systems to attenuate dissolved and sediment borne pollutant runoff. These should be installed in all new ditches receiving road runoff and also, subject to ecological considerations, in those existing ditches which continue to receive road runoff.

7.7.9 Since the existing scheme has no pollutant prevention measures the proposed scheme with mitigation would have at least a slight positive impact on water quality in the ditch system with respect to road runoff pollutants. The knock on benefits to the Bure and Breydon Water would be negligible.

7.7.10 Design of new ditches and culverts should be carried out in consultation with the IDB. The IDB has a comprehensive water level management plan for the area and provision should be made to accommodate their plans. The addition of new culverts or replacement of dysfunctional culverts has the potential to have a beneficial effect on the management of the marshes and be supportive of the IDBs plans. For example water control structures could be positioned in culverts under the road to aid in management of the water levels in adjacent areas of marsh either side of the road. The design of culverts must be carried out in concert with the aspirations of the IDB and also with due regard to ecological requirements.

7.7.11 Option 2A would inevitably require the destruction of an existing roadside ditch with major adverse impacts on ditch biodiversity. With Option 2, subject to further detailed studies to determine optimum drainage configuration it may be possible to mitigate against adverse effects on biodiversity through hydrological change for the existing ditch in the central reservation. However the effectiveness of design and management measures to fully compensate for the adverse effects on the ecology of this dyke is in doubt (see Chapter 9). These biodiversity effects would be localised with Breydon Water and the River Bure being unaffected.

7.7.12 In order to provide habitat creation mitigation measures as compensation for loss of dykes and degradation of retained dykes, additional ditches outside the access tracks are proposed. However with our present understanding of dyke species translocation it appears that these new ditches are unlikely to fully replace the lost habitat in existing ditches (see Chapters 9 and 14).

7.7.13 An environmental barrier is proposed on the south side of the road (west of Vauxhall Roundabout) and this will mitigate against traffic and headlights disturbing wintering birds on Breydon Water, resulting in a reduction of impact in the operational phase, compared to the existing situation. There are likely, however, to be residual negative impacts resulting from the construction phase (see Chapter 9).

7.7.14 Tables 7.6.5 and 7.6.6 summarise the impacts of scheme options 2 and 2A on the river, estuary, ditches, flood plain and groundwater following incorporation of mitigation measures. Impacts range from Low Significant Positive effects on the Floodplain with both options to Highly Significant Negative for the ditches with Option 2 and Very Significant Negative for the ditches with Option 2A.

7.7.15 The main adverse impact resulting from Option 2 would be on biodiversity resulting from the degradation of the roadside dyke isolated in the central reservation, which with current levels of knowledge cannot be adequately mitigated (see Chapter 9).

7.7.16 The main adverse impact resulting from Option 2A would also be on biodiversity largely because the proposals require the destruction of an existing roadside ditch and its associated habitat. With current levels of knowledge mitigation in the form of provision of replacement dyke for habitat creation would not adequately replicate lost habitat.

7.7.17 The impacts of the scheme options on groundwater are generally negligible and the proposed mitigation measures would do little to change this. Unless a lined (impermeable) spillage containment area is incorporated in the drainage design, no additional protection of the aquifer would be provided.

7.7.18 With mitigation Option 2 has on balance an overall score of 'Moderate Adverse Impact' as the proposals have a variety of impacts on the different water features ranging from Low Significant Positive to Highly Significant Negative. Option 2A has on balance a 'Large Adverse Impact' with the proposals resulting in a range of impacts from Low Significant Positive to Very Significant Negative.

8 Landscape Effects

8.1 Introduction

8.1.1 The aim of this chapter is to provide an assessment of the landscape and visual effects of Options 2 and 2A described in Chapter 2. The impacts of the options upon the landscape can broadly be defined as physical changes to the character and quality of the landscape as a result of the development. The visual impact relates to changes in views of the landscape and the effects of those changes on people.

8.1.2 This chapter sets out the methodology used in carrying out this assessment followed by:

- the baseline data indicating existing landscape character, existing features and their level of importance and sensitivity within the landscape, covering the area that would be affected by the proposed options, and the visual effects of the existing road from sensitive properties and public rights of way;
- the effects of the proposals on landscape character and quality;
- an assessment of the effects of the proposals on views from sensitive properties and public rights of way by introducing the proposed options; and
- the various mitigation measures that could be undertaken to alleviate any of the identified effects and incorporates them as part of the assessment.

8.1.3 The text below provides an understanding of the existing landscape and the views within it. Following this, the effects arising from the proposed options are considered, so that an objective opinion can be achieved on the relative benefits/disadvantages of each option as they affect landscape and views.

8.1.4 The assessment work forms the basis of a Stage 3 assessment in accordance with the Design Manual for Roads and Bridges (DMRB)[25], Volume 11 as supplemented by guidance in Guidance On the Methodology for Multi-Modal Studies (GOMMMS)[26]. A Stage 2 assessment of landscape and views was undertaken between 1993 and 1996[27]. This Stage 3

[25] Design manual for Roads and Bridges Volume 11, Section 3, Part 5: Environmental Assessment. Highways Agency, incorporating 2001 updates.

[26] Guidance on the Methodology for Multi-Modal Studies, DETR 2001

[27] A47 Acle Straight Highway Improvements – Stage 2 Landscape Assessment, Landscape Design Associates

assessment work is guided by and follows the Environmental Scoping Report for the A47 Acle Straight Study[28].

8.1.5 This assessment reviews the work done under the Stage 2 assessment work, and:

- updates the existing baseline data;
- provides more detailed assessment and information and
- gives more detailed information on potential mitigation measures.

8.1.6 An assessment of the effects of the options on views for road users is indicated in Chapter 13 -Vehicle Travellers.

8.2 Methodology

8.2.1 The landscape and visual assessment has involved a combination of a desk study and field surveys using the guidance provided by DMRB and the guidelines issued by the Landscape Institute and the Institute of Environmental Assessment[29]. It identifies existing landscape designations and includes an assessment of the effects on landscape quality and character taking into account proposed mitigation measures. This results in an assessment on the overall significance of the effects of the proposals on the landscape. A visual impact assessment has also been carried out to identify the magnitude of effects (level of deterioration or improvement) on views from properties and areas of public access. This compares the quality of existing views to winter views for each option in the year of opening and summer views in the design year.

8.2.2 The fieldwork was undertaken in the field in the late summer of 2003. Where vegetation restricted or prevented views, an assessment of effects in winter was not directly possible and accordingly was based on professional judgement of the likely views available and any effects that may arise from the options.

Assessment of Visual Effects

8.2.3 Visual impacts and their magnitude have been identified using the visual impact methodology set out in DMRB Volume 11. This assessment was carried out by a landscape architect in September 2003 and focuses upon

[28] A47 Acle Straight study, Environmental Scoping Report, Hyder Consulting, October 2002.

[29] Guidelines for Landscape and Visual Impact Assessment, the Landscape Institute and the Institute of Environmental Assessment, 2002

the impacts and effects of the widened road and the mitigation and enhancement measures defined in Chapter2 and in Section 8.6 of this chapter. As there is already a major road present, it is the change resulting from implementation of the new proposals that was assessed and not the impact of the existing road.

8.2.4 In order to determine the extent of the visual influence of the proposed schemes, a Visual Envelope was defined, i.e. the boundary in which it would be possible to view the proposed road and its traffic. The DMRB indicates that adverse visual impacts in flat areas at more than 1,000m from the road are unlikely to be significant. However, due to the area's sensitivity recognised through its designation in the Norfolk and Suffolk Broads Act (1988), the visual envelope has been taken to 2km in open extensive areas (Figure 8.2).

8.2.5 An assessment of the effects of the proposals on views from the following sensitive properties or locations was then carried out:

- Dwellings,
- Commercial premises,
- Public buildings,
- Listed buildings and buildings/structures of heritage value,
- Pedestrian routes and public open spaces or other outdoor recreational places.

Impacts on industrial buildings, except where they comprise the above, have not been assessed. The assessment of views from buildings has not been confined to internal views but includes the immediate curtilage and garden.

8.2.6 Before carrying out the site assessment a desk study was carried out which included a review of the Stage 2 Assessment. The site assessment identified the existing nature of views, followed by the effects on them resulting from implementation of the proposals using two different scenarios:

- Impact on a winter day in the year the scheme would open to traffic – worst case scenario;
- Impact on a summer day in the fifteenth year after opening, taking account of all proposed planting except off-site planting – best case scenario.

8.2.7 The 15 years allows for planting to establish and achieve its intended function. The extent of growth within 15 years is dependent on number of factors, including:

- Species – some species grow much faster than other (e.g. willow is a fast growing species).

- Size of plants – older plants are bigger but take longer to readjust to new environments and thus establishment rates are slower than younger plants.
- Nature of planting conditions – soil quality nature and depth, fertility, water provision, aeration, adequate maintenance (particularly the removal of competition in the form of weeds).
- Other limiting factors – such as microclimate, weather conditions during the growth period, the presence of other competing woody vegetation, proximity to buildings, pollution, and vandalism.

8.2.8 In considering the extent of change to an existing view the following features were considered:

- the distance from the viewer to the road;
- the height and scale of the visible elements of the road relative to the receptor and their location; in particular traffic and lighting columns, but also signs, fences, safety barriers, as well as the carriageway itself;
- the relation of the scale of the road features to other features in the view;
- the proportion and angle of changes experienced within the view;
- the similarity of the introduced elements within the view to those that already exist;
- elements within the view which could further accentuate adverse or beneficial effects, by the introduction of similar elements within the view;
- the extent to which the introduced features can be assimilated into the view, and/or how acceptable they would be to the viewer;
- the frequency of use of the view by viewer, and the level of sensitivity to any changes; and
- the extent to which other views would be obstructed, by the presence of the introduced elements.

8.2.9 The DMRB guidance identifies the sensitivity of the viewer, e.g. sensitivity of users of public rights of way and from dwellings is high. This is combined with magnitude of impact when determining the level of impact based on the seven point scale indicated in Table 8.1.

Table 8.1 Definitions of Visual impact Scores

Score	Comment
Substantial Beneficial	• Major improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect,

	and where the viewer is regarded as being of higher sensitivity. • Major or overwhelming improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect in a small sector or as part of a noticeably oblique view, and where the viewer is regarded as being of higher sensitivity. • Major or overwhelming improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect, and where the viewer is regarded as being of lower sensitivity.
Moderate Beneficial	• Notable or clearly evident improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect, and where the viewer is regarded as being of higher sensitivity. • Appreciable improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect in a small sector or as part of a noticeably oblique view, and where the viewer is regarded as being of higher sensitivity. • Appreciable improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect, and where the viewer is regarded as being of lower sensitivity.
Slight Beneficial	• Perceptible improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect, and where the viewer is regarded as being of higher sensitivity. • Notable or clearly evident improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect in a small sector or as part of a noticeably oblique view, and where the viewer is regarded as being of higher sensitivity. • Notable or clearly evident improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect, and where the viewer is regarded as being of lower sensitivity. • Major improvement to the view, created by the introduction of feature(s) that enhance(s) the quality or interest of the view and or remove(s) existing feature(s) which currently have a negative effect in a small sector or as part of a noticeably oblique view, and where the viewer is regarded as being of lower sensitivity.
Neutral	• No change to view. • Where there is a change to the view, by the introduction of new features, but where the overall quality of the view does not deteriorate or improve.

	• Where the introduction of new features has a negligible or little perceptible effect on views.
Slight Adverse	• Perceptible introduced feature(s), which creates a deterioration in the view, and where the viewer is regarded as being of higher sensitivity. • Notable or clearly evident introduced feature(s) in a small sector or as part of a noticeably oblique view, which creates a deterioration in the view, and where the viewer is regarded as being of higher sensitivity. • Notable or clearly evident introduced feature(s), which creates a deterioration in the view, and where the viewer is regarded as being of lower sensitivity. • Dominant introduced feature(s) in a small sector or as part of a noticeably oblique view, which creates a deterioration in the view, and where the viewer is regarded as being of lower sensitivity.
Moderate Adverse	• Notable or clearly evident introduced feature(s), which creates a deterioration in the view, and where the viewer is regarded as being of higher sensitivity. • Prominent introduced feature(s) in a small sector or as part of a noticeably oblique view, which creates a deterioration in the view, and where the viewer is regarded as being of higher sensitivity. • Prominent introduced feature(s), which creates a deterioration in the view, and where the viewer is regarded as being of lower sensitivity.
Substantial Adverse	• Prominent or dominant introduced feature(s), which creates a deterioration in the view, and where the viewer is regarded as being of higher sensitivity. • Clearly dominant introduced feature(s) in a small sector or as part of a noticeably oblique view, which creates a deterioration in the view, and where the viewer is regarded as being of higher sensitivity. • Clearly dominant introduced feature(s), which creates a deterioration in the view, and where the viewer is regarded as being of lower sensitivity.

Assessment of Landscape Character and Effects

8.2.10 This assessment describes the existing character and quality of the landscape and identifies the effects of the proposals on it. This has been achieved by collecting data on the physical, biological, historical and cultural components which, contribute to its character and value. Information has also been collected relating to assessment already made including planning designations. The landscape has been evaluated to assess the importance or value of landscape components and features and the classification of the landscape into broadly homogeneous units of character and value. The classification is based on a hierarchy of different "Landscape Types" and "Landscape Character Areas". The former are landscapes where there are clear and recognisable sets of features which are commonly present and which often repeat themselves in different

locations. The latter is based on and is more usually derived from the generic Landscape Types and forms a unique geographic area.

8.2.11 Landscape character assessment is carried out at different scales. At a national scale, the Character Map of England[30], divides England into 159 Character Areas, and provides the broad framework for all other landscape character assessment work, including assessments at county and district scales. The Landscape Character Areas for the study area have been defined, through a combination of use of these documents, together with collating data on localised features and cultural heritage through desktop and field surveys. A 1:10,000 scale map was used to carry out the assessment work.

8.2.12 The methodology for assessing the impact of the proposals on landscape character and quality has been based on that described in GOMMMS. This has a qualitative environmental capital approach, which identifies elements of the landscape that matter (geographical scale, rarity, importance, substitutability, etc) and explains the reason for their importance. Each of the key features within the identified Landscape Character Areas was individually assessed, with an assessment of environmental capital. This resulted in a landscape value being applied to each character area.

8.2.13 This assessment of landscape value, was then combined with the Guidelines for Landscape and Visual Impact Assessment which sets out the principles that should be followed for establishing a sound methodology for assessing effects on landscape and views. The guidelines set out three principle criteria, which should be used in the assessment process:

- "sensitivity" (of landscape and viewer);
- "magnitude" of impact; and
- "significance" of effect (a combining of sensitivity and magnitude).

8.2.14 The assessment is often done through a scoring process, where sensitivity is multiplied by magnitude to give a scaled level of significance of impact. For this assessment it was considered appropriate to use a combination of these and the DMRB/GOMMMS guidelines. Therefore in determining the significance of effect, the magnitude of impact is measured against the value (or sensitivity) of a landscape character area.

8.2.15 The magnitude of effects have been measured using a seven point scale as follows:

30

- High negative or positive impact; where the scheme would cause a significant deterioration or improvement in the landscape. To be regarded as significant, the intrusive or beneficial feature would need to be a dominant element in the view from the location concerned.
- Medium negative or positive impact; where the scheme would cause a noticeable deterioration or improvement. Here the feature would be clearly apparent but would not be a dominant element.
- Low negative or positive impact; where the scheme would cause a barely perceptible deterioration or improvement in the existing view.
- No change; the scheme may be visible, but would result in no discernible deterioration or improvement in the existing view.

8.2.16 The magnitude of effects is then measured against landscape value to give the overall assessment score indicated in table 8.2 below.

Table 8.2: Estimating the Overall Assessment Category

Magnitude of impact	**Value of landscape Character Area**				
Value	Very High	High	Medium	Lower	Negligible
High Negative	Very Large Adverse	Very Large Adverse	Moderate Adverse	Slight Adverse	Neutral
Medium Negative	Large Adverse	Large Adverse	Moderate Adverse	Slight Adverse	Neutral
Low Negative	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse	Neutral
Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Low Positive	Slight Beneficial	Slight Beneficial	Slight Beneficial	Slight Beneficial	Neutral
Medium Positive	Large Beneficial	Large Beneficial	Moderate Beneficial	Slight Beneficial	Neutral
High Positive	Large Beneficial	Large Beneficial	Moderate Beneficial	Slight Beneficial	Neutral

8.2.17 The overall assessment category has also been matched against the GOMMMS overall assessment criteria indicated in table 8.3 below.

Table 8.3 Definitions of Overall Assessment Scores for Landscape	
Score	**Comment**
Large beneficial (positive) effect	The proposals provide an opportunity to enhance the landscape Very few investment proposals (including the Acle Straight) merit this score.
Moderate beneficial (positive) effect	The proposals provide an opportunity to enhance the landscape because: • they fit very well with the scale, landform and pattern of the landscape • there is potential, through mitigation, to enable the restoration of characteristic features, partially lost or diminished as the result of changes resulting from intensive farming or inappropriate development • they will enable a sense of place and scale to be restored through well designed planting and mitigation measures, that is, characteristic features are enhanced through the use of local materials and species used to fit the proposal into the landscape • they enable some sense of quality to be restored or enhanced through beneficial landscaping and sensitive design in a landscape which is not of any formally recognised quality • they further government objectives to regenerate degraded countryside.
Slight beneficial (positive) effect	The proposals: • fit well with the scale, landform and pattern of the landscape • incorporate measures for mitigation to ensure they will blend in well with surrounding landscape • will enable some sense of place and scale to be restored through well designed planting and mitigation measures • maintain or enhance existing landscape character in an area which is not a designated landscape, nor vulnerable to change • avoid conflict with government policy towards protection of the countryside.
Neutral effect	The proposals are well designed to: • complement the scale, landform and pattern of the landscape • incorporate measures for mitigation to ensure that the scheme will blend in well with surrounding landscape features and landscape elements • avoid being visually intrusive, nor have an adverse effect on the current level of tranquillity of the landscape through which the route passes • maintain existing landscape character in an area which is not a designated landscape, that is, neither national or local high quality, nor is it vulnerable to change

	• avoid conflict with government policy towards protection of the countryside.
Slight adverse (negative) effect	The proposals: • do not quite fit the landform and scale of the landscape • although not very visually intrusive, will impact on certain views into and across the area • cannot be completely mitigated for because of the nature of the proposal itself or the character of the landscape through which it passes • affect an area of recognised landscape quality • conflict with local authority policies for protecting the local character of the countryside
Moderate adverse (negative) effect	The proposals are: • out of scale with the landscape, or at odds with the local pattern and landform • are visually intrusive and will adversely impact on the landscape • not possible to fully mitigate for, that is, mitigation will not prevent the scheme from scarring the landscape in the longer term as some features of interest will be partly destroyed or their setting reduced or removed • will have an adverse impact on a landscape of recognised quality or on vulnerable and important characteristic features or elements • in conflict with local and national policies to protect open land and nationally recognised countryside as set out in PPG7 and PPG2.
Large adverse (negative) effect	The proposals are very damaging to the landscape in that they: • are at considerable variance with the landform, scale and pattern of the landscape • are visually intrusive and would disrupt fine and valued views of the area • are likely to degrade, diminish or even destroy, the integrity of a range of characteristic features and elements and their setting • will be substantially damaging to a high quality or highly vulnerable landscape, causing it to change and be considerably diminished in quality • cannot be adequately mitigated for • are in serious conflict with government policy for the protection of nationally recognised countryside as set out in PPG7.
Very large adverse (negative) effect	The proposals would result in exceptionally severe adverse impacts on the landscape because they: • are at complete variance with the landform, scale and pattern of the landscape • are highly visual and extremely intrusive, destroying fine and valued views both into and across the area • would irrevocably damage or degrade, badly diminish or even destroy, the integrity of characteristic features and elements and

	their setting • would cause a very high quality or highly vulnerable landscape to be irrevocably changed and its quality very considerably diminished • could not be mitigated for, that is, there are no measures that would protect or replace the loss of a nationally important landscape • cannot be reconciled with government policy for the protection of nationally recognised countryside as set out in PPG7.

8.3 Legislation

8.3.1 Relevant legislation is set out in Chapter 3: Planning and should be referred to for a detailed assessment of specific planning legislation and policies. This section identifies:

- the key legislation as it relates to landscape and views;
- additional important information within PPG7;
- the pertinent points within the development plan policies relating to landscape and views; and
- the key points that will form the basis for determining and concluding the assessment of effects.

Government Guidance

8.3.2 At the national level the most applicable guidance is set out in PPG7: The Countryside – Environmental Quality and Economic and Social Development. It identifies the following key aspects:

1 Sustainable development i.e. the need for development that respects and preferably enhances the environment in its location, scale and design. It specifically states that sustainable development will "maintain or enhance the character of the countryside and conserve its natural resources, including safeguarding the distinctiveness of its landscapes, its beauty, the diversity of its wildlife, the quality of rural towns and villages, its historical and archaeological interest, and best agricultural land.

2 Character of the countryside and the principle of protecting the countryside for its own sake with the objective of "enriching the quality of the whole of the countryside whilst accommodating appropriate development". PPG7 also highlights the Countryside Commission (now the Countryside Agency) and English Nature's analysis of the principal countryside features of England, which has led to the publication of the Character Map of England. This establishes distinct areas of common character at a national scale, without making judgements about their relative value. It also sets out the principle of this "character approach" in assisting to accommodate necessary change without sacrificing local character, and encourages local authorities to use the information when reviewing local countryside designations.

3 National Parks are given the highest status of protection with regard to landscape and scenic beauty. The PPG states the statutory responsibility of National Park as being "to conserve and enhance their natural beauty, wildlife and cultural heritage, and to promote opportunities for public understanding and enjoyment of their special qualities." Due to the great weight given to such designations, major developments should only take place in exceptional circumstances, and be subject to a rigorous

examination, including the assessment of any detrimental effects on landscape, and whether these can be moderated.

4 Local countryside designations which have less weight than national designations such as National Parks and this should be reflected in policies that are applied to them in development plans.

Regional and Local Guidance

8.3.3 There are several policies to protect, conserve and enhance the landscape character in the Norfolk County Structure Plan, Broads Authority Local Plan and the Great Yarmouth and Broadland District Local Plans. These are reviewed in Chapter 3 "Planning". Of particular importance are several policies in the Broads Authority Local Plan which essentially seek to protect the features that form the distinctive nature of the Broads. As such any developments that adversely affect these features will not be permitted. Such features include: fen and carr woodland, trees and woodland, drained marshland, listed buildings and their setting, and Conservation Areas. Developments are also required to provide appropriate landscape measures, which compliment and enhance the proposed development and their setting in the Broads landscape. Policy TC.1 specifically refers to road schemes within the Broads landscape, and the Authority will object where there is likely to be "a significant adverse effect on the landscape, wildlife, waterways or built environment of the Broads".

Landscape Designations

8.3.4 Relevant landscape statutory designations are indicated on Figure 8.1 and described below.

8.3.5 The proposed development falls almost entirely within the area administered by The Broads Authority which has similar status as a National Park

8.3.6 Local countryside designations have less weight than national designations. Designated areas identified within these plans which fall within the study area are as follows:

- Halvergate Marshes Conservation Area designated by the Broads Authority and covering most of the study area;
- Landscape Important to the Broadland Scene an area designated by Great Yarmouth Borough Council at the western end of the study area adjoining the boundary of the area administered by the Broads Authority;
- Broads ESA (2003) – designated by DEFRA to protect and enhance the traditional marshland grazing landscape, through offering incentives to landowners to undertaking appropriate management.
- Area of Important Landscape Quality (AILQ), designated by Norfolk County Council and covers much of the Norfolk countryside including

the Broads. It requires development to conserve and be sensitive to the appearance and character of this area. This is not illustrated on figure 8.1 but can be considered to fall within the Broads Authority administrative boundary.

8.4 Baseline Conditions

Existing Setting

8.4.1 The A47 Acle Straight provides almost a direct link between Acle to the west and Great Yarmouth to the east, crossing a large area of drained marshland, lying in the heart of the Broads. Much of this land is at or just below sea level and forms a large expanse of consistently flat land. The area is often referred to as the "Halvergate triangle", and is formed by reclaimed saltmarsh forming agricultural land, mainly grazing with some arable and drained by a mixture of linear and rectilinear dykes.

8.4.2 The Rivers Yare and Bure flow across this landscape and converge at the western edge of Great Yarmouth before entering the North Sea. Just before the River Yare meets with the River Bure it forms Breydon Water, a large expanse of open water or mud flats, (depending on tidal flows), which is an internationally important area for wading birds.

8.4.3 The Acle Straight is on an embankment approximately 1m high forming a strong visual feature across the marsh. The road is comprised of two straights taking an east-southeast direction from Acle to Halvergate Junction, before turning to take an exact east to west direction to Great Yarmouth (see figure 1.1). The route is mirrored approximately by the Acle branch of the Norwich – Great Yarmouth single track railway line approximately 160m to the south of the road and constructed in the late 19th century. The only other road within this vicinity that crosses the Broads is the Halvergate Branch road linking the B1140 and Halvergate to the Acle Straight at Halvergate Junction.

8.4.4 The grazing marsh forms a vast open landscape which is, very loosely, visually enclosed to the west by land that rises gradually to approximately 25m AOD to the south and west, and approximately 15m AOD to the north. To the east, Great Yarmouth is set on land between 3 to 5m AOD, and creates an area of relatively extensive urban development along the east coast. Whilst there are other notable settlements on the east coast, Great Yarmouth is most prominent in terms of character and size.

8.4.5 The small town of Acle is the most notable settlement towards the western end of the scheme. Other small villages and hamlets are scattered along the fringes of the Broads, lying on the slightly higher ground above the marsh.

8.4.6 There are few buildings on the marsh, these mostly comprise marsh farms and wind pumps. The windpumps are important characteristic features of Halvergate Marshes Conservation Area and as the only vertical elements within the main marsh area their presence provides a sequence of focal points across the landscape.

Existing Woody Vegetation

8.4.7 There is relatively little significant woody vegetation in conventional countryside terms, along the alignment of the A47 Acle Straight. The areas of existing vegetation within 160m of the road (to the south of the River Bure) are illustrated in Figure 8.5. The only notable areas of woody vegetation lie at either end of the road. At Acle there is carr woodland (predominantly Willow and Alder) to the south of the road and patchy, mainly, Willow and Hawthorn scrub to the north and to the south beyond the carr. There is also a small recent planted area of trees and shrubs to the north of Acle roundabout. At the Great Yarmouth end there are larger areas of intermittent scrub and trees, mainly Gorse and Hawthorn situated on land between the road and the railway line (which widens out in this area as sidings).

8.4.8 The carr woodland forms an important landscape feature at the west of the study area. It screens much of the settlement of Acle and acts as a backdrop in the more open, exposed and relatively featureless marsh.

8.4.9 Elsewhere along the Acle Straight there are sporadic individual trees, predominately White Willow, *Salix alba* and mainly to the south of the existing carriageway, with a number of them being pollarded. The exception is at The Pontiac Roadhouse (formerly Three Feathers PH or Stracey Arms) and Stracey Arms Mill, where more notable clumps of woody vegetation, mainly hawthorn and willow scrub, have been allowed to establish along the River Bure and around the building. Similar vegetation, together with some pollard willows, occurs on both sides of the Branch Road near to Halvergate Junction.

8.4.10 The general lack of woody vegetation along the road creates a very open and exposed experience for travellers, and consequently makes vehicles more prominent from locations within the surrounding landscape.

8.4.11 There is little woody vegetation to the south of the Acle Straight and the patchy areas of scrub and trees along the road and the railway form only minor features of little impact in the open landscape. These features could be considered to be out of character with the more traditional open marsh landscape. However, it should be noted that the existing remnant pollard Willow were once part of a continuous line of pollarded Willows along the Acle Straight and this is still evident along Halvergate Branch Road where White Willow is typically planted at 2 – 4m centres, and pollarded to a height of 1.8m.

Landscape Character

8.4.12 Understanding the character of a landscape provides an important baseline for assessing the capacity of the landscape to accommodate development. The assessment of landscape character within the area of the proposed schemes is based on existing character assessments by the Countryside Agency, local authorities and scheme based assessment, carried out as part of the Stage 2 environmental assessment. The Landscape Character Areas for the scheme-based assessment are shown on Figure 8.2. Extracts of the relevant existing character assessments are also provided for reference.

Landscape Character - National Landscape Character Assessment

8.4.13 The Countryside Character, Volume 6: East of England[31], identifies the area as Character Area 80: The Broads, which covers a similar area to that administered by the Broads Authority. The Broads covers a variety of low-lying wetland habitats characterised by open water, river channels, reed swamp, fen, carr woodland and drained grazed marsh. It indicates that wind pumps and isolated farmhouses are the most significant artefacts within the landscape.

8.4.14 The ends of the Acle Straight lie within Character Area 79: North East Norfolk and Flegg. This is a landscape of essentially low flat plateau that slopes gently from west to east comprising an extensively cultivated agricultural landscape.

Landscape Character - County-Scale Landscape Character Assessment

8.4.15 As part of the Norfolk Countryside Conservation Strategy, a landscape assessment was undertaken by Norfolk County Council within the Consultation Draft of March 1995. The assessment and strategy identifies The Broads as one of its nine Character Areas, but does not include a description.

8.4.16 The Strategy identifies the area surrounding The Broads (except to the south) as being North Walsham Plateau Character Area, which is further sub divided into the following smaller Landscape Types:

- To the west and north much of The Broads boundary is surrounded by the Landscape Type: Broads Transition which comprises flat fen and shallow wet valley floors of the upper reaches of the Broads' rivers. Land use is combination of arable with pasture on wetter land.
- To the east of the Broads, much of the landscape has no defined Landscape Type. The Character Area description corresponding well

[31] Countryside Character, Volume 6: East of England, Countryside Agency, 1999

with Character Area 79, North East Norfolk and Flegg in the above East of England study.

8.4.17 Within the North Walsham Plateau Character Area, the strategy identifies the need to create more enclosure inland, the planting of new hedgerows, hedgerow trees, and woodland, restoration of pasture, and maintenance of water levels and encouragement of reed growth along ditch margins.

Landscape Character - District-Scale Landscape Character Assessment: The Broads

8.4.18 A landscape assessment and strategy was produced in the 1980's by the Landscape Working Group of Broads Authority, entitled "Towards a Landscape Strategy for the Broads". The assessment and strategy predates the Countryside Character, Volume 6 and the Countryside Commission's current guidelines on landscape character assessment. The Broads Authority has requested that this document is not referred to as an assessment tool within this study, because it no longer follows current practice and guidance and may be misleading. A landscape character assessment is currently being undertaken for the Broads.

Landscape Character - District-Scale Landscape Character Assessment: Broadland District Landscape Assessment

8.4.19 In 2002 Broadland District Council produced the Broadland District Landscape Assessment[32] which included a "Landscape Assessment and Review of Areas of Important Landscape Quality". The assessment identified 13 Local Character Areas within which there were further sub-units. The landscape to the west and south of Acle falls within Local Character Area M. Character area M is described as a low rising, elevated plateau comprised of vast agricultural fields with few landscape features creating open views. This is assessed as a low quality landscape.

Landscape Character – Other Landscape Character Assessments

8.4.20 The Countryside Character, Volume 6: East of England, Character Area 80: The Broads and the Stage 2 Assessment for this scheme make reference to the "The Broads Environmentally Sensitive Area: Landscape Assessment", MAFF, 1995. However DEFRA have stated that they are unaware of its existence. Contact was also made with Great Yarmouth Borough Council, who indicated that a landscape character assessment may have been undertaken in the early 1990s, but it has not been made available.

[32] Broadland District Landscape Assessment – Supplementary Planning Guidance: Consultation Draft 2002,

8.4.21 The Stage 2 assessment identified four character zones, which are summarised below:

- Acle, Stokesby and Runham: a subtly undulating landscape, relatively wooded, enclosed and intimate, with a number of attractive small settlements – Very Attractive.
- Tunstall and Calthorpe Level Marshes: a flat landscape of mixed arable and grazing pasture/marsh land use, clearly bounded by gently rising ground. Views disrupted by the levees of the River Bure in the north – Highest Value.
- Halvergate, South Walsham and Acle Marshes (Including Breydon Water): an expansive, flat, open agricultural area, sparsely treed with mixed arable and grazing pasture/marsh land use – Highest Value.
- Yarmouth Edge: predominantly flat agricultural area, under the influence of the urban edge – Ordinary Landscape.

8.4.22 Whilst this Stage 3 assessment broadly agrees with the scheme based character assessment, it has been refined and parts redefined to:

- provide greater detail;
- provide a closer reflection of existing National, County and District landscape character assessments; and
- follow the GOMMMS methodology on landscape character assessment.

8.5 Baseline Data - Stage 3 Landscape Character Assessment

8.5.1 Seven Landscape Character Areas have been identified within 6 main LandscapeTypes:

- A – Open Grazing Marsh

  A1: Halvergate Triangle

- B – Semi-Enclosed Grazing Marsh

  B1: Calthorpe Level Marshes

- C –Transitional

  C1: Broads Transition

- D – Open Arable

  D1: Stokesby and Runham Open Arable

- E – Open Water

E1: Breydon Water

- F – Urban

F1: Great Yarmouth

F2: Acle

A1: Halvergate Triangle

8.5.2 This Character Area corresponds approximately with Halvergate, South Walsham and Acle Marshes area, identified within the Stage 2 assessment. The landscape is very wide and expansive, and in some locations can appear to extend to the horizon (see photograph 1, Figure 8.3). Low-lying, often at or below sea level and very flat, the underlying marine alluvial soils reflect its historic connections with the sea. Predominant land use is grazing marsh extensively grazed by cattle and horses. A well established system of dykes, criss-cross the land, defining subtle patterns, keeping the stock contained and ensuring the land is sufficiently drained to continue the established land use.

8.5.3 The landscape is defined by visual boundaries, with the rising land to the north and west and the built development of Great Yarmouth to the east. Each of the surrounding Character Areas: Broads Transition, Stokesby and Runham Open Arable, Calthorpe Level Marshes and Great Yarmouth, all form important backdrops and delineations.

8.5.4 The most distinctive features in influencing the visual character of the Halvergate Triangle are the rising landform, carr woodland and the expansive, spreading nature of built form on the eastern horizon of Great Yarmouth, particularly the South Denes Power Station. The hard built forms of the town intrude, strongly contrasting with the simple, elemental grazing marsh landscape.

8.5.5 The River Bure and River Yare are significant features, which meander through the marsh, contained and visually defined by flood banks, which rise approximately 2m. The River Bure lies to the north, flowing essentially west to east, whilst the River Yare flows south-west to north-east, lying closer to the southern and eastern margins.

8.5.6 While characteristic of the landscape, the intricate system of field dykes have little visual influence in the horizontal plane. Dykes fall into two identifiable categories: serpentine and rectilinear. The serpentine dykes seen in some parts of the marsh reflect the old, natural pattern of drainage, whereas the rectilinear dykes are more recent, created as part of the post-medieval planned enclosure. Halvergate Triangle is characterised by a greater presence of serpentine dykes than are found within the Calthorpe Level Marshes creating a subtle difference in character.

8.5.7 The landscape can often appear windswept and bleak and is heavily influenced by a wide skyscape. Brick towered windpumps are the most apparent vertical elements in landscape. Occasional willow trees, or slightly raised mounds, associated with marsh farms, clothed in trees and scrub and the occasional marshmans' house form other characteristic features. In this wide landscape even small elements such as field gates become notable features.

8.5.8 Many of the existing windpumps date from the eighteenth and nineteenth century, mainly standing beside the major, or former, watercourses, and set within this landscape context, provide the finest surviving example of a marsh landscape drained by wind. The windpumps are one of the strong elements contributing to the Conservation Area status.

8.5.9 Other human interventions on the landscape includethe Acle Straight road constructed in 1834 as a turnpike road, Branch Road, and two railways, the Norwich-Yarmouth Railway line (via Reedham), opened in 1844 and the Norwich-Yarmouth Railway Line (Via Acle) opened in 1883. Each of these form distinctly linear features crossing the landscape.

8.5.10 These features are recognised as part of the landscapes historic development, however, their character is at odds with the traditional marshland landscape. Whilst the roads and railway lines have little prominence and indeed are barely evident in many views, it is the passing of trains and vehicles that draws attention to their presence. Trains are infrequent, and consequently have much less of a prominent effect, in comparison to the continual movement of vehicles along the Acle Straight, drawing the eye to the movement, in a generally static landscape. Halvergate Branch Road has very few vehicles passing along it, and is also lined with closely planted pollarded willows. These were planted to retain the shoulders of roads when constructed and remain a distinctive feature of several roads within the Broads. The entire length of the Acle Straight was once lined by pollarded willows although most have been removed as a result of carriageway improvements and the laying of service ducts on the north side of the embankment.

8.5.11 An overhead power line running parallel to the Acle Straight between the road and the railway line, forms a notably intrusive feature in the open landscape. Other changes to the landscape character have resulted from lowering water levels to enable arable crops to be grown leading to a drying out of parts of the grazing marshes. The loss of visually obvious reeds and other dyke vegetation and permanent pasture of the grazing marsh is subtle but profound. This is most notable to the north of the River Bure, however ESA funding is to some extent causing a reverse of this trend.

8.5.12 Reeds within some of the roadside dykes provide some screening to traffic however these are not favoured on ecological grounds as they smother the important communities of dyke flora and fauna.

8.5.13 This landscape is heavily influenced and managed by man, however it retains a strong feeling of remoteness and tranquillity, that is hard to find elsewhere in eastern England. The landscape is of particular importance to visitors to the Broads many of whom would view it either from the Acle Straight itself, from the Weavers Way (see Chapter 5), or from the River Bure which is of importance for leisure boating. Other visitors include those interested in the wildlife of the area, particularly the bird life on Breydon Water which is adjacent to the area. The landscape forms a major part of the Halvergate Marshes Conservation designated due to its importance as a historic landscape. It is also part of the area administered by the Broads Authority and as this has equivalent status to a National Park the landscape can be regarded as being of national importance. It is therefore a landscape of Very High Value.

B1: Calthorpe Level Marshes

8.5.14 This Character Area corresponds approximately with Tunstall and Calthorpe Level Marshes, identified within the Stage 2 assessment. It forms a large expanse of flat land, but is notably less expansive, and has less of an intimate relationship with the sky and the horizontal plane, than the Halvergate Triangle. There is also a greater sense of man's management, enclosure and intimacy, with less remoteness. It is a simple, calm, essentially balanced landscape of stippled texture. Panoramic views are still possible, particularly from the River Bure flood banks and the Acle Straight (see Photographs 2 & 3).

Physical and Cultural Influences

8.5.15 The character of the Calthorpe Level Marshes reflects that of the Halvergate Triangle, in its form, makeup, composition, visual characteristics and historical influences. Consequently, reference should be made to Halvergate Triangle to avoid repetition. However, there are some notable differences between the Halvergate Triangle and Calthorpe Level Marshes:

- the expanses of flat, marsh are not so extensive as Halvergate Triangle, the area being more enclosed by the rising landform and tree cover of adjacent Character Areas.
- The character and nature of these different Character Areas also has a more prominent effect on the Calthorpe Level Marshes, with a diminishing sense of remoteness and tranquillity. The character of this landscape is strongly influenced by having more built and natural features, typically carr woodland, and the affect of a more cultivated landscape on its boundaries.
- there is a greater presence of woody vegetation, in particular hedges and scattered hawthorn, creating a slightly more intimate scale within the landscape and introducing vertical features. This gives the effect that the area is more intensely used by man and more inhabited;
- the dykes are predominantly rectilinear, indicating a more recent influence, as well as creating a more uniform and linear nature of dykes. These are more densely aligned;

- a comparatively higher proportion the land is currently cultivated for arable use than within Halvergate Triangle;
- The River Bure and its flood banks have a greater visual prominence within the landscape; and
- the traffic on the Acle Straight is often seen set against a backdrop of woodland or other more intensively managed landscapes and thus is less intrusive.

8.5.16 The landscape would be appreciated by the same visitors to the Broads as Halvergate Triangle and it is also visible from properties on the edge of Acle. Whilst not as unique as the Halvergate Triangle, the landscape is part of the area administered by the Broads Authority and part of the historic landscape covered by the Conservation Area. It is therefore a very important part of the Broadland scene and has a Very High Value.

C1: Broads Transition

8.5.17 This Character Area is contiguous with the Norfolk Countryside Conservation Strategy, Landscape Type: Broadland Transition, and corresponds with part of the Acle, Stokesby, and Runham area within the Stage 2 assessment.

8.5.18 The Character Area is distinguished by being set on low lying, flat (typically 0 to 5m AOD), or gently rising, undulating land on the western fringes of the Open Grazing Marsh and Semi-Enclosed Grazing Marsh Landscape Types. It acts as a transition zone between the open, flat marshes and the gently rolling arable landscapes further west. It is formed either by the narrow, damp and wet, enclosed river valleys of the small tributaries that feed into the River Bure and/or dyke system, or as gently rising land on the edge of the marshes. Soils are typically marshy alluvial and with occasional calcareous clayey soils.

8.5.19 The landcover is a mixture of arable and some grazed pasture fields, and on the fringes of the marsh, predominantly carr woodland, with some fen and areas of fen succession with scrub encroachment. Woodland species typically include; Goat Willow, White Willow, Crack Willow, Alder, with some Ash and the occasional Birch. Woodlands are fairly even aged, with relatively light canopies allowing a well established ground flora. Fens are typically areas of lightly grazed or ungrazed fen, with reed and sedge growth and scrubby Willow succession. The fields are medium to large in size with relatively few hedge boundaries.

8.5.20 Built features include small villages and occasional farms in the cultivated areas. In the lower lying area the land is unsuitable for settlement or cultivation as arable or grazed grassland and has been left to establish as flood plain grassland with invasive scrub or carr woodland. In amongst this, where there are more open tracts of flat land on the flood plain, where grazing marsh has been actively managed through land drainage, a system of dykes has developed with light grazing by cattle and sheep. This

essentially is an extension of land use associated with the Character Areas: Halvergate Triangle and Calthorpe Level Marshes, but is set within a clearly defined and enclosed setting.

8.5.21 This Character Area provides important enclosing landscape elements for the adjacent Character Areas, due to its intimate nature, and the high predominance of carr woodland, which is often absent from the adjacent open marshland Character Areas. This in turn provides a valuable backdrop and can also visually segregate the open grazing marshes from the open arable landscapes.

8.5.22 There are few notable views within the Character Area, and public access is limited to the area around Tunstall. Where public views do exist, they are mainly either within the carr woodland or over adjacent Character Areas. The area lies within the area administered by the Broads Authority but outside the Halvergate Marshes Conservation Area. It is therefore designated as a landscape of national value, its importance being that it is visible from the open marshland landscape which it contains and separates from the predominantly open, arable landscape further west. This is a landscape of High Value.

D1: Stokesby and Runham Open Arable

8.5.23 This Character Area reflects Local Character Area M, within Broadland District Landscape Assessment and corresponds approximately with Acle, Stokesby and Runham, identified within the Stage 2 assessment.

8.5.24 The landscape of this area is broad sweeping, often simple and relatively featureless. It is relatively uniform, with few features and intrusions. There is the occasional overhead powerline, but these are inconspicuous. Views are open and expansive and the relationship with the sky is important with the mood of the landscape influenced by weather conditions.

8.5.25 This Character Area is relatively large, lying to the north of, and predominantly enclosing the Halvergate Triangle. This lowland landscape has a landform that is gently undulating, underlain by glacial drift and till and loamy soils, which has provided excellent soils for a long, well established history of agriculture. Typically medium to large arable fields, with few boundaries, create an open and expansive landscape.

8.5.26 Historically, this landscape was less intensively farmed than today with a greater presence of hedges and hedgerows. Many hedges have now disappeared to accommodate modern agricultural practices, but in a number of situations individual trees have been left to form specimen trees along the extinguished boundaries. The resulting effect is to create a fairly distinctive landscape, if somewhat eroded, and relatively featureless. Hedges are infrequent but where they do occur are usually regularly cut hawthorn.

8.5.27 Settlements are small, few and scattered and the churces at Runham and Stokesby are important focal points on the edge of the Broadland landscape. There is also a great awareness of the isolated brick and flint farmhouses and barns from within the character area. Both settlements and farmsteads are distinguished by being set within or surrounded by tree clumps and hedges. Roads are typically small, meandering lanes, with open boundaries to adjacent fields.

8.5.28 The extreme southern edge of this area lies within the area administered by the Broads Authority and is important as it is visually contains the grazing marshland. It is also visible from the River Bure, which is important for leisure boating and therefor visible to visitors using the waterways of the Broads. The area lies outside the Halvergate Marshes Conservation Area. This landscape is of High Value.

E1: Breydon Water

8.5.29 This Character Area is included within Halvergate, South Waltham and Acle Marshes, identified within the Stage 2 assessment. This is a wide, open, expansive landscape, where the regular changing nature and character forms one of its most distinctive and fascinating qualities. The influx of a wide variety of birds creates its own visual attraction and interest. Distant views are always available across and within Breydon Water as boats travel along the River Yare. Otherwise the key aspect is the views over Breydon Water from its margins, in particular from Weaver's Way.

8.5.30 Breydon Water is a large expanse of tidal waters and low tidal mud flats, through which the River Yare flows. It is sufficiently large and distinctive in character, relative to the surrounding landscapes to be identified as a separate Landscape Type and Character Area. Its unique character distinguishes it from the surrounding open grazing marsh to the north, west and south, and from Great Yarmouth to the east.

8.5.31 Set within the flood plain of the River Yare, it is most notably influenced by the changing ebbs and flows of the tidal waters. At full tide, Breydon Water is a large, open expanse of water, reflecting the sky. As the tide retreats the mud flats become visible and start to dominate its character. With it comes the attraction of a large number of different wading birds, creating a distinctive and recognisable lively character which varies through the seasons.

8.5.32 The Character Area is a reflection of a historically much larger tidal estuary, which over time has diminished with the reclamation of the surrounding land and its continued drainage. The River Yare was historically an important navigable link between the North Sea and Norwich, and is listed as a linear feature in the National Monuments Record (See Chapter 9).

8.5.33 This important wildlife area is of value to visitors travelling to Great Yarmouth and to visitors to the Broads, particularly walkers using Weavers

Way and bird enthusiasts attracted by its international importance for wintering and breeding birds. Breydon Water lies within the area administered by the Broads Authority but outside the Halvergate Marshes Conservation Area. This is a landscape of Very High Value.

F1: Great Yarmouth

8.5.34 Great Yarmouth is a seaside resort, which can be contradictory in its character. Conflicting land uses lie in close proximity to each other. It is a distinctly linear settlement, defined and hemmed in by the sea, the marshes of the Broads, the River Bure and the River Yare. In more recent times development has expanded to the south and widened to form large residential areas such as Bradwell.

8.5.35 Only the western urban fringe of Great Yarmouth lies within the study area. This consists mainly of a number of large industrial and retails areas and some residential areas. Much of this area forms a direct visual conflict with the adjacent Broads landscape. The character of the townscape bordering the road is predominantly defined by an industrial estate, large retail warehouses, a railway and sidings and a caravan park and creates a poor visual gateway to the town. This combination creates a poorly defined layout, with little visual unity or interest, and generally poor appearance (see photograph 7).

8.5.36 This townscape would be experienced by a large proportion of visitors to Great Yarmouth and the visitors to Vauxhall Holiday park which is located immediately adjacent to the road. There are no landscape designations in this area although the area bordering the road has been identified as a Landscape Enhancement Area in the Great Yarmouth Local Plan (see Chapter 3). This area has a Low Value townscape quality.

F2: Acle

8.5.37 Acle is a small, nuclear town. Historic buildings surround an open market area creating visual character and heart to the town, where there are a number of shops and facilities that provide for the community (see photograph 9). From this centre, several roads radiate out and fairly non-descript residential areas of varied density form the majority of the land use. The A47, A1064, and carr woodland create a visually strong definition as well as a physical limitation to the extent of the town to the south and east.

8.5.38 Within the vicinity of the Acle Straight, the townscape is characterised by a petrol station, motel and amenities and high density starter homes, which create a mediocre appearance and character (see photograph 8).

8.5.39 The construction of a boatyard on the River Bure, and the increasing popularity of pleasure cruising, has drawn holiday makers to use the town in the summer. The landscape character of this small town is also appreciated by its residents. Acle lies outside the area administered by the Broads

Authority and outside Halvergate Conservation Area. However it has an attractive centre and well defined edge. This landscape has a Moderate Value.

8.6 Predicted Impacts and Mitigation - General

8.6.1 Throughout the design process, the engineering proposals have been designed to minimise the effects on the landscape and views. In particular the proposals involve retention of the existing road with the provision of a new carriageway alongside. The new carriageway would either be on a separate low level new embankment (Option 2) or on the existing low level embankment which would be widened to accommodate it (Option 2A). This section describes some of the impacts of the scheme and mitigation measures that have been adopted.

8.6.2 The design of landscape mitigation measures, has been based on the following objectives:

- to reflect the character, elements and features in the identified Landscape Character Areas;
- to minimise the adverse effects of the proposed options, in particular traffic, and where possible, improve the existing adverse effects of the Acle Straight and its traffic;
- to retain the open high quality views of the surrounding landscape;
- to replace vegetation and features that have a landscape and ecological value within the context of their surroundings;
- to avoid adverse effects on biodiversity features and incorporate ecological mitigation measures; and
- to ensure the best combination of measures, based on the often conflicting objectives stated above.

Lighting and Road Signs

8.6.3 The landscape through which the Acle Straight passes is almost devoid of any artificial light. Apart from light from the occasional property, the main source of artificial light comes from urban land uses on its periphery (particularly Great Yarmouth) and from the Acle Straight itself. Such absence of light adds to the sense of remoteness and its uniqueness.

8.6.4 The road lighting has been designed to minimise impacts on the landscape it is indicated on Figures 2.1 and 2.2 and incorporates the following:

- lighting would be restricted to existing locations at each end of the scheme and at Halvergate Junction;
- all proposed lighting columns would remain at the same height as the existing lighting columns and at approximately the same spacing;

- full cut off high pressure sodium lanterns would be used instead of existing low pressure lanterns thus significantly reducing the extent of light spillage outside the highway corridor and night time sky glow effects. This benefit would be most apparent at Halvergate Junction, within the vicinity of which where there is no other major lighting.

8.6.5 The beneficial effects of the replacement road lighting would be slightly offset by the increase in light from vehicle headlights as the flow of vehicles is predicted to increase slightly compared with the do-minimum situation.

8.6.6 Extent of intrusiveness depends on the angle at which traffic is viewed, being much less when viewed at 90°. Lights from vehicles, again draws attention due to the movement of lights across the landscape.

8.6.7 Vehicle headlights are most apparent on the Acle Straight itself, through the number of vehicles using the road and due to the open nature of the road. Extent of intrusiveness depends on the angle at which traffic is viewed, being much less when viewed at 90°. Lights from vehicles, again draws attention due to the movement of lights across the landscape.

8.6.8 There are numerous existing road signs along the Acle Straight which have been added to over the years in an ad hoc fashion to create an occasionally haphazard system. These would be replaced with a co-ordinated system of signs designed in accordance with current standards (see Figures 2.1 and 2.2). As a result a few of the larger directional signs would be slightly larger than at present. However in view of the sensitivity of the area dimensions (particularly heights) would be kept to the minimum. This adverse effect would be balanced by a beneficial effect of a reduction in the total number of signs resulting in a slightly less cluttered effect.

Woody Vegetation

8.6.9 The works would be restricted to the footprint of the proposed road, new dykes and access tracks (see Chapter 2). Therefore losses of trees and shrubs would be restricted to these areas and as there is very little woody vegetation along the route, losses would be small. Most losses would be to trees and shrubs growing on the existing road embankment.

8.6.10 Option 2 involves retention of the existing road on a separate embankment to the new carriageway and Option 2A with widening of the existing embankment would involve the complete loss of one of the existing vegetated embankment slopes. With the current proposals most of the existing embankment slopes (even where retained) would be regraded and therefore most existing roadside vegetation would be lost (see cross sections, Figures 2.3 and 2.4). However in order to retain downslope vegetation it is proposed to steepen the regraded slopes (see Chapter 9 and Figures 9.4 and 9.5). This combined with the use of protective fencing should enable some and retention of woody vegetation on the existing embankment slopes. Without a detailed survey and more detailed design it

is not possible to ascertain which trees could be retained, however a best guess is indicated on Figures 8.5 and 8.6.

8.6.11 Most of the trees to be lost are in good condition, with normal vigour and moderate life expectancy. A few are dead, dying or dangerous and possibly in need of removal on health and safety grounds. A number of others are identified as having a low retention value, due to their low visual value. Most are low, mulit-stemmed, White Willow and in the main at the western end near Acle.

8.6.12 Most of the group areas of woody vegetation lie outside the existing highway boundary towards the Acle end, at Halvergate Junction, and immediately adjacent to the Great Yarmouth end. However a few areas are within the highway boundary at the Acle end. The group woody vegetation lost, is typically Hawthorn and White Willow, with the more occasional tree species, such as Ash and Field Maple. At the Great Yarmouth end there are some areas of Gorse, much of which would be removed for the new carriageway. Other areas of lost woody vegetation are identified as being of good visual value and/or of high retention value, and are predominantly near to the Pontiac Road House and Scaregap Cottages.

8.6.13 The road was originally lined with closely spaced pollarded willows planted at the time the road was constructed. Most of these have been lost along the Acle Straight. Some have probably been lost incrementally due to e.g. accidents, other have probably been lost to construct lay-bys or due to carriageway widening and on the north side of the road most have been removed due to the provision of underground services in the road verge and adjacent area.

8.6.14 As the road was built in 1834 it is debatable whether these pollard willows constitute a traditional feature of the Broadland scene, or whether they spoil the naturally open, expansive landscape. Regularly spaced rows of trees are also not favoured on modern roads because of the mesmerising/strobe effect they can have when travelling at speed. Continuous rows of such trees along both carriageways may also be considered out of scale with the widened road. It has therefore been decided not to completely reinstate the rows of trees but to provide them in some locations and in patterns that would not be compromise the open character of the marshes.

8.6.15 Roadside planting along the existing embankment slope on the north side of the existing carriageway would generally not be feasible due to the presence of underground services beneath the verge and embankment slope. In particular a gas main will have an easement restricting tree planting in this area. However to the east of Halvergate Junction planting is feasible on the north side of the new embankment (Option 2) or widened embankment (Option 2A). Likewise to the west of Halvergate Junction planting would be feasible on the south side. With Option 2 planting is not proposed within the wide central reservation because it would prevent access for maintenance of the retained roadside dyke and it would also shade this dyke with resulting harmful effects to dyke flora and fauna.

8.6.16 To the east of Halvergate Junction there would be very little space to plant woody vegetation adjacent to the southern highway boundary due to the narrow spaces between the edge of carriageway and the retained roadside dyke. As a consequence there would only be space to plant a single row of trees/shrubs and even this would require a relaxation of DMRB guidelines. Except at specific locations for screening it is generally not proposed to acquire additional land for screen planting as such planting is considered inappropriate in the open marshland landscape. Furthermore, the shading caused by such dense screen planting would be harmful to the roadside dyke vegetation and fauna, much of which is of national or international importance. It would not therefore, generally be possible to create a sufficiently dense pattern of planting to screen the road. However where proposed, the planting would provide an element of separation between the road and surrounding landscape.

8.6.17 With the new embankment (Option 2) and the widened side of the existing embankment (Option 2A) a new dyke would be provided alongside the road. In these locations it would be feasible to acquire additional land and place this dyke further away from the new embankment slope thus providing space for screen planting which would not completely shade the dyke. However this measure has not been adopted because:

- dense planting in this area would be out of character with the open landscape;
- this would require additional land-take most of which would be grazing marsh which is an important wildlife habitat;
- the additional land-take could adversely affect some agricultural holdings and viability of some fields thus resulting in changes to land management practices with resulting adverse biodiversity and landscape effects.

8.6.18 The planting proposals are indicated on Figures 8.5 and 8.6. It would be similar for both dual carriageway options and incorporates the following aspects:

- planting of White Willow as a single row planted on both sides of the road from the Acle roundabout as far as Tunstall Dike, at Halvergate Junction, and for a short section at the Great Yarmouth end, where the railway line and the Acle Straight are at their closest and where birds on Breydon water would benefit from additional separation. These would be planted at distances of approximately 4m along the roadside embankments, between the carriageway and the existing or new dykes. They could be planted as unrooted whips and pollarded after 3-4 years to reflect the historic features that were once found along the entire length of the Acle Straight;
- planting of a small elongated copse at the Great Yarmouth end of Option 1 and 1A, within the larger inner verge created by the curving Acle Straight and Acle branch railway line, using White Willow, Goat Willow, Hawthorn and Ash; and

- small clustering of White Willow and Goat Willow, where some of the adjacent field dykes, meet the roadside dykes, to encourage Barn Owls and bats to rise above vehicles on the Acle Straight (see Chapter 9).
- Additional small areas of dense tree and shrub planting at Halveragte Junction and Scaregap to partially screen the buildings, and the River Bure with its associated bird habitat.

8.6.19 Character Area A1, the Halvergate Triangle is very open and planting in this area has been kept to a minimum in order to retain this character. However where the Acle Straight crosses through the Landscape Character Area, B1: Calthorpe Level Marshes, there are relatively subtle changes in landscape character mainly due to the increase in woody vegetation. Hence the opportunity has been taken of sympathetically introducing further woody vegetation along the Acle Straight, by reflecting the surrounding characteristics.

8.6.20 The woody planting incorporated at the Great Yarmouth end would be appropriate within the urban fringe setting, create improvements to the visual setting of the road (in line with local authority policy) and help screen the traffic from surrounding areas.

Other Screening Measures

8.6.21 A prominent vertical feature found within this landscape is that of the flood banks along the Rivers Bure and Yare. These are typically 2m high and visually divide the landscape. These historic features form an integral element that helps define the landscape's character. Consequently, the characteristics of these banks could be reflected in the creation of mounds or bunds along the Acle Straight, thereby having the benefit of visually screening vehicles and at all times of the year. They would also screen traffic generated noise thus benefiting the tranquility of the area. However provision of such features is not feasible due to:

- The numerous perpendicular dykes that meet the road necessitating each bund to stop at each dyke giving numerous gaps which would be unsightly and prevent provision of an adequate screen. Alternatively each of these dykes could be culverted but this would cause immense harm to the sensitive communities of dyke flora and fauna.
- Loss of or degradation effects on existing roadside dykes, which are important (and often protected) wildlife habitats.
- Loss of valuable grazing marshland which is an important habitat for birds and other flora and fauna.
- Visual intrusion caused by the bunds themselves, which would be straight and without substantial land-take could not mimic the levees of the Bure.

8.6.22 Apart from screen planting and mounding the provision of man made environmental barriers is another screening method commonly incorporated in highway schemes. These can be in the form of timber fences or walls

and provide effective visual and noise remediation. They also have the benefit of requiring relatively little space and would be feasible within the narrow confines of the Acle Straight.

8.6.23 However in the context of the open marshland landscape such features are not considered suitable as the barriers themselves would be highly visually intrusive. Two environmental barriers have been proposed at the less sensitive Great Yarmouth end of the scheme. These would be 2.5m high timber fences located on both sides of the road along an elevated section immediately to the south of Vauxhall Roundabout (see Figures 8.5 and 8.6).

8.6.24 The fence to the north of the road would be provided to screen Vauxhall Holiday Park from traffic generated noise (see Chapter 12). That to the south of the road would provide a noise and visual barrier to reduce disturbance to birds on Breydon Water. Both barriers would also coincidentally provide a landscape and visual screen and have been taken into account in the assessment of impacts below.

8.7 Visual Impact Assessment

Effect on Views from Properties

8.7.1 Figure 8.2 indicates the visual envelope for the existing road, which is defined as the extent of visibility to or from the scheme. The proposals are described in Chapter 2. The new (Option 2) or widened (Option 2A) embankment would remain the same height as existing and there is currently very little screening vegetation along the road. Accordingly the visual envelope for the proposals is the same as that for the existing road.

8.7.2 There is a Village Hall in Stokesby and the Little Chef next to Acle roundabout, have a lower sensitivity to change. There are also a number of farms, composed of barns and silos that lie on either side of the Acle Straight, which have views of the road and its traffic. Views from such non residential premises, would again be regarded as being of lower sensitivity to change. The remaining properties are residential or a combination of residential and commercial.

8.7.3 Traffic speeds for both options would increase to 70 mph and traffic flow would also increase by the same amount for both options. The central reservation with Option 2 would be 5.5m wider than that of Option 2A and consequently traffic on the new carriageway would be located 5.5m deeper into the existing open countryside. Given the large scale of this area this small distance is not considered significant in terms of visual impact except where properties or recreational features are located very close to the side of the road that would be widened. Except for three public footpaths there are no recreational facilities adjacent to the road and the scheme has been

developed to widen the road on the opposite side to the few properties which are adjacent to the road. Therefore visual impact during the operational phase has been assumed to be the same with both options.

8.7.4 The visual impact assessment was carried out as described in the methodology and the visual impact for both winter in year of opening and summer 15 years after opening is shown graphically on Figure 8.4. The detailed visual impacts of the dual carriageway proposals are indicated for each receptor in Appendix 8.1. This is summarised below starting north of the road at the Acle end of the scheme and moving in a clockwise direction to finish on the south side of the road, at the western end of the scheme.

8.7.5 Within Acle, houses on the eastern fringe have views of the road. There are a number of starter homes close to the end of the Acle Straight, some of which are immediately adjacent to the Acle Roundabout. Options 2 and 2A, do not affect the layout of this roundabout and night time impacts would be reduced due to reduced light spill from replacement road lighting. This beneficial effect would in the long term be offset by a slight increase in visually intrusive traffic compared to the do-minimum situation. Some roadside vegetation on the north side of the carriageway may be lost but this would have an insignificant effect on views. On balance the effect of the proposals would be Neutral in winter of the year of opening. After 15 years in summer most properties would experience a Slight Beneficial effect compared to the existing situation, however this would be due to the screening effect provided by a recently planted tree plantation on the eastern side of the A1064 Acle to Billockby Road and not the proposals.

8.7.6 There are numerous other houses to the north of Acle and along Acle Dike, with views over the grazing marsh towards the traffic on the Acle Straight. The proposals typically result in Moderate Adverse or Slight Adverse effects in winter of year 1 reducing to Neutral by summer of year 15. Again the reduction in effects would be mainly as a result of an improved screening effect from the tree plantation on the eastern side of the A1064. Properties further east such as The Willows and the Boat House would benefit less from this screening effect and despite a minor screening effect from the new roadside planting the effect would remain Moderate Adverse. Further north Mill House Farm, only has oblique views to the road and at some distance from the it is considered too far away to experience any perceptible change.

8.7.7 The grade 2 listed Commission Drainage Mill, Commission Drainage Mill House and a number of properties scattered throughout the village of Stokesby have attractive views to the south over the River Bure, and grazing marsh, but also include mid-distance views of the Acle Straight and its traffic. It is considered that the increase in traffic and traffic speed compared to the do-minimum situation would be perceptible from this distance and there would be a Slight Adverse effect on views in the year of opening. By summer of year 15 the line of willows planted along the northern embankment slope of the road would have matured and would provide some minimal screening. However this is considered insufficient to alter the category of visual effect would remain as Slight Adverse.

8.7.8 Other properties situated further north in Stokesby, are less affected by the road, particularly where they have oblique views, or have partially restricted views due to intervening buildings and vegetation.

8.7.9 There are several scattered properties along Runham Road, between the villages of Stokesby and Runham, which would be affected in a similar way to those properties most affected in Stokesby. This is mainly due to their open and expansive views over the marsh and direct views of the traffic on the Acle Straight.

8.7.10 Runham is a small village with a loose arrangement of houses, spread in an east-west direction. A number of these houses have views to the south over the grazing marsh that include distant views of the Acle Straight and its traffic. These views are typically less affected by the road than the properties within Stokesby and the area between the two villages, mainly because views to the south are either partial, broken, glimpsed or filtered, principally by boundary or intervening vegetation. The effects of the proposals would be Neutral in winter year 1 and summer of year 15.

8.7.11 There are a number of properties scattered along the River Bure (other than those at Stokesby), which include Six Mile House, Six Mile House Drainage Mill, Five Mile House and Drainage Mill, and the grade 2 listed Runham Drainage Mill, Runham Swim Drainage Mill and Ashtree Farm Drainage Mill. All have very attractive views over the River Bure and adjacent marsh. The traffic on the Acle Straight creates an intrusive effect on views, varying depending on proximity, angle and extent of intrusion into the view. For example southern views from Six Mile House area largely contained by boundary vegetation, but there are filtered views in winter. The extent of views at Five Mile House, are similar to Six Mile House except that views are open to the south and thus are affected throughout the year.

8.7.12 These properties do not have views of the road itself but the views would be affected by a perceptible increase in traffic flow and speed resulting in a Slight Adverse effect. Two exceptions are Old Hall Drainage Mill and a bungalow near to the pumping station at Tunstall Dyke which because of their closer proximity to the road would also experience a perceptible change in the view due to the new carriageway and access track. These properties would experience a Moderate Adverse effect on views in year 1 and year 15. Views from Bure Cottage near to Old Hall Drainage Mill area obscured by vegetation in summer but in winter there would be filtered views to the new road resulting in a Slight Adverse effect in year 1. The views from the grade 2 listed Mautby Mill are largely contained by the River Bure levees and the effects of the proposals have been assessed as Neutral.

8.7.13 There are a number of properties on the north-western edge of Great Yarmouth, which have views over the River Bure and marsh beyond. Within these views, the traffic on the Acle Straight is a perceptible feature, and consequently has an adverse effect on existing views. These properties do not have views of the road itself and because of the distance it is

considered that there would be no perceptible difference in views over the do minimum situation resulting in a Neutral effect.

8.7.14 The Vauxhall Holiday Park, is situated adjacent to the Acle Straight, at the eastern end of the proposals where the existing single carriageway merges into a dualled section of road at its approach to Vauxhall Roundabout. Vauxhall Holiday Park is composed of a number of 1 and 2 storey chalets, some caravans and other facility buildings. Additionally, there is a play area that forms part of the complex, lying immediately next to the Acle Straight. At the shared boundary with the A47 a close boarded timber fence provides screening at the eastern end of the site. However the western part of the site is more affected by the visual presence of the Acle Straight and its traffic although a thin band of vegetation along its boundary provides some screening.

8.7.15 Most chalets and caravans have the benefit of being screened, leaving only those on the edge exposed to view and even these are screened to the first floor level by a hedge on the boundary. The play area is exposed to views but single storey caravans are screened by the timber boundary fence. Some of the facility buildings do have occasional views of the Acle Straight but are less sensitive to change.

8.7.16 A proposed environmental barrier would be located to the east of the entrance to the holiday park and provide an effective noise and visual screen. However the play area and upper floors of the 2 storey chalets on the edge of the western part of the site would remain exposed to traffic. More effective screening could be provided by enhancement of the planting at the road boundary. However care would have to be taken to maintain a visibility splay at this entrance and it is also likely that the operators of the park would not want this commercial enterprise to be screened from view. No additional screening is therefore proposed in this area.

8.7.17 The road would be widened to the south in this area so that some traffic would be slightly further from the holiday units than at present. Nevertheless there would be a perceptible increase in visual intrusion for some chalets and the play area although this would be offset by a decrease in visual intrusion for many more units on the site. The site would also benefit at night time from decreased light spill resulting from the replacement road lighting. The site as a whole would experience a mixture of beneficial and adverse effects resulting in an overall Slight Adverse effect in both winter of year 1 and summer of year 15.

8.7.18 Moving west out of Great Yarmouth along the Acle Straight the road passes between two World War 1 pill boxes which are being considered for scheduling by English Heritage. The southerly one of these lies immediately adjacent to the south side of the carriageway and with both options would have to be removed to make way for the second carriageway (see Chapter 10). The pill box to the north is set further back from the road and although with widening to the south, some traffic would move further away from this structure visual intrusion would increase as a result of the

nearby access track, wider road and increased flow and speed of traffic. The effects have been assessed as Substantial Adverse.

8.7.19 Further west there are a number of properties to the south of the road and the Acle branch railway line. These are mainly isolated farms and drainage mills plus a number of houses in or near to the hamlet of Tunstall. The railway provides some sense of separation from the road and these properties are too far from the road to experience the physical changes to the road structure. However those nearer to the road would experience a perceptible increase in the flow of traffic. Consequently these properties have been assessed as experiencing either a Slight Adverse change in the view or a Neutral effect depending on distance from the road and in some cases any intervening feature which may screen the road. The effects would generally be the same for both year 1 and year 15.

8.7.20 There are three occupied properties located immediately adjacent to the Acle Straight, namely; the Pontiac Road House (formerly Stracey Arms), Mill House Farm (or Mill Shop), the Stracey Arms Drainage Mill and Scaregap Cottages. The existing carriageways and traffic on the Acle Straight already dominates all views to the south from these properties. The proposals would result in widening of the road, and the construction of a new roundabout at Halvergate Junction. Generally the works would be to the south of the existing road although the roundabout approach to the west of Halvergate Junction would require a small area of land-take to the north including a small corner from the car park of the Pontiac Roadhouse. There would also be increased visual intrusion resulting from construction of the access tracks and an access track junction at Scaregap which would require direct land-take from these properties.

8.7.21 The proposals would result in some localised losses of vegetation although new replacement planting is proposed. The adverse effects at Halvergate Junction would be partially offset by beneficial night –time effects due to reduced light spill and sky glow resulting from replacement of the existing road lighting.

8.7.22 The winter year 1 effects on views from these properties have been assessed as Substantial Adverse. Although new planting is proposed it would not be possible to fully mitigate these effects due to the lack of space for effective screen planting, therefore the effects would remain the same in summer of year 15.

Effects on Historic Setting

8.7.23 All identified listed buildings and historic built linear features have been assessed for the visual effect of the proposed options within their setting. A detailed assessment of effects, including effects on setting is described in Chapter 10: Cultural Heritage. Reference should also be made on the effects on Halvergate Marshes Conservation Area earlier in this chapter.

Effects on Views From Areas of Recreation and Linear Routes

8.7.24 Recreational areas include public footpaths and bridleways, waterways, recreation grounds, public open spaces and village greens. Users of these facilities are likely to be sensitive to change, particularly where views provide an important part of the enjoyment of the facility. Consequently, the group is referred to as having a higher sensitivity, even though in some cases it would include users focused on physical activity rather than views.

8.7.25 To the north of the Acle Straight, there is a village green at the heart of the village of Stokesby. It is situated adjacent to the River Bure and the Ferry Inn, and has its' own car park. This is an important area, not only for local residents, but also visitors, either arriving by car, bicycle or boat with the latter using the moorings next to the village green.

8.7.26 Part of the village green has no views of the Acle Straight but the western and southern parts have clear views over the River Bure, grazing marsh beyond and the traffic on the Acle Straight seen in the mid-distance. The carriageway is not visible in views, however traffic is clearly evident. As a result of the increase in traffic resulting from the proposals there would be a barely perceptible effect on views therefore the proposals would result in a Slight Adverse effect for both winter of year 1 and summer of year 15.

8.7.27 The only other area of public open space affected is a recreation ground on the north-west edge of Great Yarmouth, which incorporates physical activities such as a play area and pitch and putt, but also areas of open grass. This has an open boundary to the west allowing views over the River Bure, grazing marsh and the Acle Straight. The traffic on the Acle Straight is clearly visible in existing distant views however and the options would have a barely perceptible effect on this view resulting in a Slight Adverse effect for both year 1 and year 15.

8.7.28 There are a number of footpaths within the Visual Envelope to the north of the River Bure, which have no views of the Acle Straight, due to intervening features, most notably the floodbanks of the river Bure. There is a footpath to the Church of St Andrew in Stokesby that is slightly affected by views of the Acle Straight, but this would experience no perceptible increase in effects from the route options, over and above the do minimum.

8.7.29 A relatively small length of footpath along Paddys Loke, immediately to the west of Great Yarmouth loops to cross the Acle Straight and connect with the Weavers Way to the south of the road. Due to its close proximity to the Acle Straight, the existing road and its traffic already has a significant adverse effect on views. In the immediate vicinity of the road the proposals would further affect these views due to a perceptible increase in traffic and the adverse visual effects caused by the additional carriageway and access tracks. This would result in a Substantial Adverse effect reducing to Moderate Adverse further away from the road. This effect would be the same for winter in year 1 and summer in year 15.

8.7.30 The effects on a footpath linking the River Bure to the north side of the A47 via Scaregap farm would be very similar to the effect on Paddys Loke.

8.7.31 The other footpaths affected are notable footways within the Broads network. There are two footpaths, on the flood bank either side of the River Bure, which follow the meandering route of the river across the flood plain. The River Bure itself is an important recreational and tourist facility, with many pleasure boats leisurely travelling up and down its length. Whilst many of the boats are low, limiting views over the height of the adjacent floodbanks, boaters standing or sitting on the roofs of the boats do have views over the surrounding marshes. Hence the effect on boaters and walkers is often very similar. Due to its meandering nature the River Bure lies at varying distances from the road being within 70m at Scaregap and Stracey Arms to approximately 1.3km away elsewhere. There are subtle differences in the view to the road depending on which side of the river the viewer is located. But these are generally not sufficient to cause any perceptible difference in impacts from the proposals.

8.7.32 The entire length of the river within the Visual Envelope is affected by existing views of the Acle Straight and its traffic. Figure 8.4 shows the changing effects to southerly views along the length of the Bure resulting from the route options. The River Bure footpaths are at a higher level than the Acle Straight therefore users frequently have clear views of the road itself. Consequently at the locations in close proximity to the road there would be adverse effects on views resulting from both alterations to the road (particularly localised embankment widening) and perceptible effects on views resulting from the increase in traffic resulting from the proposals. Effects on views in the year of opening from much of the Bure and flanking paths would be Slight to Moderate Adverse but closer to the road at Scaregap and Halvergate Junction there would be Substantial Adverse effects. Some screen planting is proposed at Halvergate Junction and Scaregap but this would generally be insufficient to reduce the magnitude of impact in summer of year 15.

8.7.33 The Acle Dike forms a small offshoot of the River Bure, linking it to Acle and allowing mooring along its length. There is also a footpath on the north side of this dyke. Views of traffic on the Acle Straight can be experienced from some parts of this waterway and path and here users would experience a perceptible difference in the view as a result of the proposals. The effects would therefore be Slight to Moderate Adverse in year 1 and year 15.

8.7.34 Tunstall Dike lies to the east of Acle, connecting with the River Bure, and crossing the Acle Straight and railway line. There are two footpaths either side of the dyke extending over a relatively moderate length extending from the River Bure south to Tunstall. Woody vegetation encloses the very southern end of this dyke but most of it is open. Much of the dyke lies close to the Acle Straight and consequently in this area, the existing road and traffic have a significant effect on views which, progressively decrease towards Tunstall.

8.7.35 A short section of both footpaths, immediately to the south of the railway, have no views being screened by the railway embankment. As a result of the new carriageway, access tracks and increased traffic this, there would be a Substantial Adverse effect in the immediate vicinity of the road, progressively decreasing with distance from the Acle Straight. The effects would be slightly reduced in summer 15 years after completion due to maturing roadside planting but this would be insufficient to alter the magnitude of effects.

8.7.36 The River Yare is used by various boats, although seemingly less frequently than the River Bure. Much of the River Yare lies some distance from the Acle Straight, and as such is unaffected by it. It is only on approaching Great Yarmouth that it lies within the Visual Envelope, where the traffic on the Acle Straight becomes visible. The banks of Breydon Water help to partially screen views, but vehicles are still visible above it and would continue to be to the west with the proposed options. The increase in traffic resulting from the proposals would be just perceptible at this distance. However this area would benefit from the screening provided by an environmental barrier to be located along the south side of the elevated section of road immediately to the west of Vauxhall Roundabout (see Chapter 9). There would also be beneficial night time effects arising from new roadside lighting which would reduce light spill and night sky glow. Overall the beneficial effects would balance the adverse effects on the northern section of the River Yare giving a Neutral effect for both year 1 and year 15.

8.7.37 The Weaver's Way is a long distance footpath which in the north-west corner of the study area, follows the River Bure and Acle Dike before crossing the marsh immediately east of Acle. It crosses southwards over the Acle Straight and railway line, and follows the edge of the carr woodland before rising to pass through the villages of Tunstall and Halvergate. It then crosses the marshes, following the old marsh road, to finally follow the north-western edge of Breydon Water and enter Great Yarmouth just to the south of the Acle Straight.

8.7.38 Figure 8.4 shows the changing effects caused by the introduction of the options to views at various points along its length. Much of the Weaver's Way lies just outside or on the edge of the Visual Envelope and the effects would be Neutral as would effects from most locations within the visual envelope but at a distance from the road. Only where the route is close to or crosses the road at Acle would there be a Substantial Adverse effect. This effect would reduce with distance from the road. A section of the path along the northern edge of Breydon Water would experience a Slight Adverse effect, being partially screened from the road by a bund on the northern edge of the water. These would result from a barely perceptible increase in traffic and at the crossing point at Acle views of the widened carriageway. At the Acle end these adverse effects would be partially offset by beneficial night time effects resulting from replacement road lighting with reduced light spill and sky glow. The effects would be the same in winter of year 1 and summer of year 15.

8.7.39 There are two railways within the Visual Envelope, both of which provide a link between Great Yarmouth and Norwich, one to the south via Runham (Runham Line) and the second east – west via Acle (Acle Line). The two join close to Great Yarmouth, and for the purposes of this assessment this section of railway is referred to as the Acle Line.

8.7.40 Travellers on the train are less sensitive to change than pedestrians using footpaths who are moving at a much slower speed. Users of both lines have attractive views over the extensive marshes, and in the case of the Runham Line, over Breydon Water as well. The Acle Straight and its traffic only becomes visible from the Runham Line on approaching its junction with the Acle Line, where it is seen in views to the north. The effects of the proposals on these views would be perceptible and a Slight Adverse effect has been identified for Year 1 and year 15,

8.7.41 The Acle Line directly follows the alignment of the Acle Straight, just to its north. Views to the south of the railway are of attractive, expansive grazing marsh, but the Acle Straight and its traffic are prominent in views to the north. The new carriagway and new/widened embankment would be visible and the increase in traffic would probably just be perceptible. The effects of the proposed options have been assessed as Moderate Adverse for both year 1 and year 15.

8.8 Assessment of Effects On Landscape Character and Quality

8.8.1 The impacts of the proposals on landscape character and quality has been assessed for each of the character areas identified in Section 8.5 and shown on Figure 8.4. The assessment is described below and summarised in Table 8.4.

8.8.2 The Acle Straight and the proposed options for improvement, fall almost entirely within the Landscape Character Areas (LCAs) A1: Halvergate Triangle and B1: Calthorpe Level Marshes, with only Acle roundabout falling within F2: Acle and the extreme eastern end of the Acle Straight falling within F1: Great Yarmouth.

8.8.3 The remaining LCAs are C1: Broads Transition, D2: Stokesby and Runham Open Arable, and E1: Breydon Water. They are not directly affected by the proposed options, however, there is the potential for indirect effects on views and from increased traffic speeds and flows, which in particular affects tranquillity within the adjacent LCA's.

Halvergate Triangle Character Area

8.8.4 Halvergate Triangle is a unique and very important landscape, identified as having a Very High Value and sensitivity. Any change that occurs within the landscape that does not reflect its intrinsic character would have a damaging effect on its character. The open and flat nature of this landscape means that the addition of any new vertical features would be very evident and difficult to screen, this problem increasing proportionately to the scale of the feature and how alien it is in the context of local character.

8.8.5 It is a landscape which is highly valued for its remoteness and tranquillity, with few built features and little evidence of humans. Loss of any of these qualities would be highly detrimental to the landscape, more particularly so in locations where they are retained in the highest condition, i.e. typically within the centre.

8.8.6 This landscape is also culturally important and thus has a very high level of value, not just for landscape character, but also individually for each of its' constituent parts. Such is the sensitivity of this area to change that damage to any one of these parts (including a change to its management) would degrade the whole.

8.8.7 When the existing carriageway of the Acle Straight was constructed it introduced an alien feature into the landscape, bisecting, a large proportion of the grazing marsh. Unlike most pre 20th century roads that become a part of the landscape with time, this carriageway remains an alien feature as it appears superimposed on the landscape. However the road embankment is very low lying and the road itself is generally only visible at close quarters. It is the moving traffic, particularly HGVs, that forms the main intrusive feature in the landscape. Trains on the Acle Line are equally prominent in scale, but being infrequent are much less intrusive.

8.8.8 The aspects of Options 2 and 2A which would effect landscape character are as follows:

- A new low level carriageway would be built to the north between Acle and Halvegate Junction and to the south between Halvergate Junction and Great Yarmouth. It would be on a separate new embankment (Option 2) or the existing embankment would be widened (Option 2A), resulting in the loss and replacement of one existing roadside dyke (Option 2A) or the provision of an additional new dyke (Option 2).
- There would be additional localised dyke loss and replacement at lay-bys and Halvergate Junction and dykes perpendicular to the road would be bridges or culverted thereby retaining their physical and historical integrity but they would be visually "lost" as a landscape feature.
- Whilst there would be some loss of existing dykes and the removal of reeds (which provide a screening function), these would be recreated, in a similar relationship to the new road, and within a relatively short period of time the vegetation would re-establish, without any noticeable loss to the existing landscape character.

- Reeds would only be encouraged to grow in some new dykes specifically provided to improve water quality. All other dykes would be managed to maximise habitat quality for dyke vegetation and flora and this would discourage growth of reeds.
- There would be some (relatively minor) loss of existing woody vegetation and this would be proportionately greater with Option 2A due to the loss of one existing embankment slope.
- The number of lay-bys would be reduced from the existing eight to four slightly larger features.
- There would be a net reduction in the number of signs, although this would be offset by the need to increase the size of the advance direction signs and the need for a small increase in the number of larger signs.
- There would be no overall change in the height and spacing of lighting columns and there would be a reduction in the number and spread of lighting columns at the Great Yarmouth end of the scheme. At Halvergate Junction there would be the same number of columns (but covering a shorter length of road) and there would be two additional columns at the Acle end of the scheme.
- The lighting would incorporate cut off lanterns that would reduce light spill and sky glow.
- More or less continuous access tracks and 6 small junctions, (where the access tracks would join the carriageway) would be provided on both sides of the road . These would create an intrusive and largely uncharacteristic feature. However the tracks would be only be 4m wide, constructed at existing ground level and surfaced with a granular material. With time this would be encroached by grass and blend into the surrounding grassland.
- There would be an increase in traffic compared with the do-minimum situation (by 14.5% between Gt Yarmouth and Halvergate Junction and 19.4% Acle to Halvergate Junction in 2012). This is considered to be perceptible at locations close to and at medium range to the road.
- Speed limits would increase to 70 mph from the do-minimum situation of 50 mph (the existing speed limit is 60 mph).
- Acle Roundabout would have to be repositioned slightly further to the north-east to fit the new road alignment.

8.8.9 It is considered that there would be no significant difference between Options 2 & 2A in the type and extent of effect they both have on the landscape, with Option 2 being marginally better than 2A, by retaining most roadside dykes and creating a new dyke. Overall these changes would result in a significant perceptible difference to the landscape character and quality in locations close to the road. This would decrease with distance from the road and with the low embankment height and lack of high points from which to view the landscape the additional carriageway would generally not be visible from a distance. The main effect on the wider

landscape would result from the perceptible increase in volume and speed of traffic which would adversely affect the tranquility of the area.

8.8.10 Most mitigation measures normally used to screen highway schemes would be inappropriate in this area due to the open nature of the traditional landscape and the uniquely sensitive ecological habitats immediately adjacent to the road.

8.8.11 The magnitude of impacts on this character area resulting from the proposals has been assessed as Medium Negative. The Halvergate Triangle LCA lies entirely within the area administered by the Broads Authority and as such is considered a landscape of national importance. It also lies within the Halvergate Marshes Conservation Area which is a historic landscape of national importance, (see Chaper 10). The area therefore has a Very High Value and the overall assessment of effects would be Large Adverse.

8.8.12 In this area the proposals would be very damaging to the landscape because they:

- would be visually intrusive and would disrupt fine and valued views of the area;
- would be substantially damaging to a high quality or highly vulnerable landscape causing it to be diminished in quality;
- cannot be adequately mitigated for and
- are in serious conflict with government policy for the protection of nationally recognised countryside as set out I PPG7 (see Chapter 3).

Calthorpe Level Marshes Character Area

8.8.13 Calthorpe Level Marshes is similar to Halvergate Triangle, and the comments made above equally apply to this LCA. The proximity and influence of characteristics in adjacent LCAs are also more apparent, in particular the rising landform, carr woodland and built features. Consequentially, the effect of these is to make the Acle Straight and its traffic slightly less intrusive within this landscape and easier to incorporate vertical screening features as mitigation measures. The description of the effects of the proposed options, listed above for the Halvergate Triangle would be the same for Calthorpe Level Marshes LCA.

8.8.14 The overall impact of Options 1, 1A and 1B would be to create a Moderate Negative effect in magnitude. The character area has a Very High Value, establishing an overall assessment score of Large Adverse.

8.8.15 In this area the proposals would be very damaging to the landscape because they:

- would be visually intrusive and would disrupt fine and valued views of the area;

- would be substantially damaging to a high quality or highly vulnerable landscape causing it to be diminished in quality;
- cannot be adequately mitigated for and
- are in serious conflict with government policy for the protection of nationally recognised countryside as set out I PPG7 (see Chapter 3).

Broads Transition Character Area

8.8.16 There would be no direct effect on this Landscape Character Areas. However, depending on distance from the road there would be slight to moderate visual changes and changes to tranquillity caused by the proposals. The carr woodland immediately adjacent to the road would experience a perceptible increase in traffic noise and visual intrusion affecting tranquility. Other parts of this character area would experience slight visual changes or be too far away to experience any changes as a result of the proposals.

8.8.17 The magnitude of effects would be Medium Negative and this area has a High Value resulting in a High Adverse effect on this character area.

8.8.18 In this area the proposals are damaging to the landscape because they:

- would be visually intrusive and would disrupt fine and valued views of the area;
- would be damaging to a high quality and vulnerable landscape causing it to be diminished in quality;
- cannot be adequately mitigated for and
- are in conflict with government policy for the protection of nationally recognised countryside as set out I PPG7 (see Chapter 3).

Stokesby and Runham Open Arable Character Area

8.8.19 Only the southern fringes of this area are located within the visual envelope and much of the area is too far away to be affected by the changes resulting from the proposals to be perceptible. However the increase in traffic flow would be perceptible from southern edge of the area resulting in a Low Negative magnitude of effects. The landscape of this area has a High Value giving an overall assessment score of Slight Adverse.

8.8.20 In this area the proposals:

- would affect an area of recognised landscape quality;
- cannot be completely mitigated for because of the character of the landscape through which it passes and
- would conflict with local and national policies for protecting the character of the countryside (see Chapter 3).

Breydon Water Character Area

8.8.21 Most of this area is also too far away from the road for the changes resulting from the proposals to be perceptible and much of the area closer to the road is partially screened by an existing bund which fringes the water. The north-western part of the water would experience a perceptible increase in visual intrusion from the increase in traffic on the road. However this would be offset by the screening of traffic on the elevated section of road where it approaches Vauxhall Roundabout which would be provided by a new 2.5m high environmental barrier.

8.8.22 The beneficial effects of the proposals are considered to balance the adverse effects resulting overall in a Neutral magnitude of effects and overall assessment score

8.8.23 In this area the proposals;

- would avoid being visually intrusive or having an adverse effect on the current level of tranquility of the landscape;
- maintain existing landscape character; and
- avoid conflict with government policy towards protection of the countryside (see Chapter 3).

Acle Character Area

8.8.24 The proposals would have a small direct effect within this character area, due to alterations to Acle Roundabout and consequent loss of a small area of screening vegetation adjacent to a housing area. The western end of the new carriageway and its traffic would also be visible from the eastern residential edge of Acle. The small beneficial night time effect resulting from reduced light spill outside the road corridor would partially offset the adverse effects resulting in a Low Negative magnitude of effects. This is an area of Medium landscape Value and therefore the overall assessment score is Slight Adverse.

8.8.25 In this area the proposals:

- do not quite fit the landform and scale of the landscape;
- although not very visually intrusive would impact on certain views into the area;
- cannot be completely mitigated for because of the nature of the proposal itself;

Great Yarmouth Character Area

8.8.26 Again there would be adverse effects resulting from the new carriageway and the increase in traffic. Also the environmental barrier near to Vauxhall Roundabout would restrict the existing open views out of this area.

Beneficial effects include the provision of improved road lighting. Planting proposals would endeavour to replace that lost as a result of constructing the new carriageway. Overall the magnitude of effects would be Medium Negative. This area has a Lower Value and consequently the overall assessment score would be Slight Adverse.

8.8.27 In this area the proposals:

- do not quite fit the scale of the landscape;
- cannot be completely mitigated for because of the nature of the proposal itself;
- would conflict with local policies for enhancing the character of the area (see Chapter 3).

Effects During Construction

8.8.28 A description of the proposed construction methods and aims for reducing environmental effects are set out in Chapter 2. and a description of the disruption caused during construction is set out in Section 14.

Table 8.3: Landscape Assessment	
Landscape Character Area A1: Halvergate Triangle	
Description -Texture & diversity -Scenic quality -Unity or disharmony	A flat expansive landscape reclaimed by man over the centuries from salt marsh and mudflats, now characterised by marshland extensively grazed by cattle and horses. The grazing marsh is divided into fields by a complex pattern of dykes which have been developed over time to drain the area. A very unified landscape with a very strong local identity which is both remote and tranquil. A notable feature is River Bure which is above surrounding ground levels. Discordant features include the busy traffic on the Acle Straight and an overhead power-line which runs parallel to the road.
Scale it matters -To policy makers -To local stakeholders	Matters at a national scale with designation equivalent to a National Park and nationally important historic landscape designated as a Conservation Area.
Rarity -Commonplace to locality -Scarce	Very rare locally and nationally. The largest area of such grazing marshland in Eastern England with unique assemblages of wildlife habitat, parts of the area being designated as of international and national value for a variety of ecological habitats and protected species.
Importance/quality -How important -Level, national/regional/local -To whom	The whole of the area is very important to visitors who use the area, particularly the river Bure for boating holidays and visit Breydon Water for its internationally important bird life. Local people use the area (especially the Bure and paths for recreation, including shooting within the grazing marshes. The area administered by the Broads Authority has national significance as does the historic landscape of the Conservation Area. Individual Listed Buildings should be considered of regional importance given their heritage value. An area of Very High Quality/Value
Substitutability -Substitutable -Not substitutable	Conservation Area and equivalent National park status must be considered as not substitutable. Many of the buildings are listed or of heritage value and should also be regarded as non-substitutable. The roads and railway lines could be readily substituted.
Scope for change -Proposed for do minimum -Potential for enhancement	Part of an Environmentally Sensitive Area which provides a mechanism to grant aid landowners and encourage retention of or reversion to traditional grazing practices in order to conserve and enhance the traditional grazing marsh landscape. This would also enhance conditions for wildlife much of which is dependant on the permanent pasture and water habitat of the dykes which drain the area. A landscape very sensitive to change with very little scope to accept new development with a vertical form without adverse effects due to the open and flat nature of the landscape. Low level development such as low embankments are only visible over short distances, but vertical elements e.g. signs and traffic are visible over very great distances.
Magnitude of Impact	The proposals would entail provision of a new carriageway with widening of the existing road embankment (2A) or construction of a new one (2) with consequent land and dyke loss. The road itself would be only visible from relatively local areas but the proposals would generate increases in traffic compared to the do-minimum situation, which would be perceptible from greater distances. The proposals are not expected to affect management of surrounding farmland (see Chapter 4). The proposals would result in a High Negative effect on the landscape of this area which has a Very High Value.
Additional mitigation	All environmental measures have been considered in assessment. Most traditional landscape mitigation measures would be inappropriate in this open landscape and would harm the ecological interests of the area.
Overall assessment Score	The proposals would be visually intrusive and would disrupt valued views of the area; would be substantially damaging to a high quality or highly vulnerable landscape causing it to be diminished in quality; cannot be adequately mitigated for and are in serious conflict with government policy for the protection of nationally recognised countryside. Accordingly the dual carriageway options would have a **Large Adverse Effect**

Landscape Character Area B1: Calthorpe Level Marshes	
Description -Texture & diversity -Scenic quality -Unity or disharmony	A flat expansive landscape reclaimed by man over the centuries from salt marsh and mudflats, now characterised by marshland extensively grazed by cattle and horses. The grazing marsh is divided into fields by a complex pattern of dykes which have been developed over time to drain the area. A very unified landscape with a very strong local identity which is both remote and tranquil. A notable feature is the River Bure the waters of which are above surrounding ground levels. Discordant features include the busy traffic on the Acle Straight and an overhead power-line which runs parallel to the road.
Scale it matters -To policy makers -To local stakeholders	Matters at a national scale with designation equivalent to a National Park and nationally important historic landscape designated as a Conservation Area.
Rarity -Commonplace to locality -Scarce	Very rare locally and nationally. The largest area of such grazing marshland in Eastern England with unique assemblages of wildlife habitat, parts of the area being designated as of international and national value for a variety of ecological habitats and protected species.
Importance/quality -How important -Level, national/regional/local -To whom	The whole of the area is very important to visitors who use the area, particularly the river Bure for boating holidays and visit Breydon Water for its internationally important bird life. Local people use the area (especially the Bure and paths for recreation, including shooting within the grazing marshes. The area administered by the Broads Authority has national significance as does the historic landscape of the Conservation Area. Individual Listed Buildings should be considered of regional importance given their heritage value. An area of Very High Quality/Value
Substitutability -Substitutable -Not substitutable	Conservation Area and equivalent National park status must be considered as not substitutable. Many of the buildings are listed or of heritage value and should also be regarded as non-substitutable. The roads and railway lines could be readily substituted.
Scope for change -Proposed for do minimum -Potential for enhancement	The area forms part of an Environmentally Sensitive Area which provides a mechanism to grant aid landowners and encourage retention of or reversion to traditional grazing practices in order to conserve and enhance the traditional grazing marsh landscape. This would also to enhance conditions for wildlife much of which is dependant on the permanent pasture and water habitat of the dykes which drain the area. A landscape very sensitive to change with very little scope to accept new development with a vertical form without adverse effects due to the open and flat nature of the landscape. Low level development such as low embankments area only visible over short distances, however vertical elements such as signs and traffic are visible over very great distances.
Magnitude of Impact	The proposals would entail provision of a new carriageway with widening of the existing road embankment (2A) or construction of a new one (2) with consequent land and dyke loss. The road itself would be only visible from relatively local areas but the proposals would generate increases in traffic compared to the do-minimum situation, which would be perceptible from greater distances. The proposals are not expected to affect management of surrounding farmland (see Chapter 4). The proposals would result in a High Negative effect on the landscape of this area which has a Very High Value.
Additional mitigation	All environmental measures have been considered in assessment. Most traditional landscape mitigation measures would be inappropriate in this open landscape and would harm the ecological interests of the area.
Overall assessment Score	The proposals would be visually intrusive and would disrupt valued views of the area; would be substantially damaging to a high quality or highly vulnerable landscape causing it to be diminished in quality; cannot be adequately mitigated for and are in serious conflict with government policy for the protection of nationally recognised countryside. Accordingly the dual carriageway options would have a **Large Adverse Effect**

Landscape Character Area: C1 Broads Transition	
Description -Texture & diversity -Scenic quality -Unity or disharmony	Diverse landscape set on low lying or gently rising ground on the western fringes of the open grazing marsh. Mixed land uses with carr woodland and grazing in lower areas and increasing frequency of arable on higher ground. Narrow damp and wet valleys with woodland, slopes with mixed agricultural use plus small settlements. A harmonious landscape of High Quality
Scale it matters -To policy makers -To local stakeholders	Matters at a national scale within area of designation equivalent to a National Park but outside historic landscape designated as Conservation Area.
Rarity -Commonplace to locality -Scarce	Scarce landscape, its main value is that it visually contains the important marshland landscape and forms a backdrop to the marshes.
Importance/quality -How important -Level, national/regional/local -To whom	The area is important as a backdrop to the very important adjacent marshland. Important to local residents who live and farm in the area. Part of the area administered by the Broads Authority and therefore has national significance. An area of High Quality/Value
Substitutability -Substitutable -Not substitutable	Equivalent National park status must be considered as not substitutable.
Scope for change -Proposed for do minimum -Potential for enhancement	The area is outside the Environmentally Sensitive Area. Altough more enclosed and therefore less sensitive to change than the marshes the carr woodland is of ecological importance and the biodiversity interest is very sensitive to change. The more open areas are also sensitive to change due to the areas importance as a backdrop to the marshes On the upper slopes where arable predominates, traditional hedgerows have been removed through intensive farming practices therefore potential for enhancement by replacement of hedgerows.
Magnitude of Impact	The Acle Straight does not lie within this character area therefore there would be no direct impact. There would be a Medium Negative effect on views from area immediately adjacent to the Acle Straight in this area of High Quality.
Additional mitigation	All environmental measures have been considered in assessment. Most traditional landscape mitigation measures would be inappropriate in this open landscape and would harm the ecological interests of the area.
Overall assessment Score	The proposals would be damaging to the landscape because they would be visually intrusive and would disrupt valued views of the area; would be damaging to a high quality landscape causing it to be diminished in quality; cannot be adequately mitigated for and are in conflict with government policy for the protection of nationally recognised countryside. Accordingly both dual carriageway options would have a **Large Adverse Effect**

Landscape Character Area D1: Stokesby and Runham Open Arable	
Description -Texture & diversity -Scenic quality -Unity or disharmony	Broad sweeping, gently undulating area forming northern boundary to the marshes. Landscape now predominantly under arable use with occasional village and isolated farm. Formerly divided by a pattern of hedgerows many of these have now been removed to create a uniform often simple and relatively featureless landscape. A moderate quality landscape in its own right but its value is increased as it forms a boundary to the marshes.
Scale it matters -To policy makers -To local stakeholders	Matters at a national scale as the southern edge of this area is within the area administered by the Broads Authority and it is clearly visible from the open marshland. Outside the Conservation Area. Important to local residents and to visitors to the Broads as it forms a backdrop to views from the River Bure.
Rarity -Commonplace to locality -Scarce	Locally scarce .
Importance/quality -How important -Level, national/regional/local -To whom	The area is very important to visitors who pass through it to access the Broads and view it as a backdrop to the Broadland scene. The southern fringe of the area is administered by the Broads Authority which has national significance. Individual Listed Buildings should be considered of regional importance given their heritage value. An area of High Quality/Value
Substitutability -Substitutable -Not substitutable	Equivalent National park status must be considered as not substitutable. Many of the buildings are listed or of heritage value and should also be regarded as non-substitutable.
Scope for change -Proposed for do minimum -Potential for enhancement	Located outside the Environmentally Sensitive Area. An open landscape which is sensitive to change although less sensitive than the flat marshland. Little scope to accept new large scale development without adverse effects due to the open nature of the landscape. Traditional hedgerows have been removed through intensive farming practices in the recent past therefore potential for enhancement by replacement of hedgerows.
Magnitude of Impact	The dual carriageway proposals would be located some distance to the south. The physical changes to the road would not be visible from most of the area but the proposals would generate increases in traffic compared to the do-minimum situation which would be perceptible from this area. The magnitude of effects would be Low Negative.
Additional mitigation	All environmental measures have been considered in assessment. Most traditional landscape mitigation measures would be inappropriate in this open landscape and would harm the ecological interests of the area.
Overall assessment Score	In this area the proposals would affect an area of recognised landscape quality; cannot be completely mitigated for because of the character of the landscape through which it passes and would conflict with local and national policies for protecting the character of the countryside. Accordingly both dual carriageway options would have a **Slight Adverse Effect**

Landscape Character Area E1: Breydon Water	
Description -Texture & diversity -Scenic quality -Unity or disharmony	A wide, open, expansive landscape of water and low tidal mud flats during low tide. A unique, harmonious landscape/seascape of very high quality with diversity provided through changing tides and weather conditions which are reflected in the water..
Scale it matters -To policy makers -To local stakeholders	Matters at a national scale as part of the area administered by the Broads Authority. It is outside the Conservation Area. Important to local residents and to visitors to the Broads who come to view its internationally important bird life.
Rarity -Commonplace to locality -Scarce	Very Rare nationally and to locality.
Importance/quality -How important -Level, national/regional/local -To whom	The area is very important to visitors who travel specifically to view the bird life. The area is administered by the Broads Authority and has national significance. Individual Listed Buildings should be considered of regional importance given their heritage value. An area of High Quality/Value
Substitutability -Substitutable -Not substitutable	Unique and not substitutable..
Scope for change -Proposed for do minimum -Potential for enhancement	The most open are in the study area and the least able to manage change. A natural area and therefore any man made development is likely to have a significant adverse effect on the scene.
Magnitude of Impact	Most of the Water is too distant from the proposals to be affected. A very small area to the north-west may have slight adverse effects due to perceptible changes in the flow of traffic. However this would be balanced by the screening of traffic on the elevated section of road where it approaches Vauxhall Roundabout which would be provided by a new 2.5m high environmental barrier. Overall there would be a Neutral magnitude of effects on Breydon Water which is a landscape of Very High Value.
Additional mitigation	All environmental measures have been considered in assessment. Most traditional landscape mitigation measures would be inappropriate in this open landscape and would harm the ecological interests of the area.
Overall assessment Score	The proposals would avoid being visually intrusive or having an adverse effect on the current level of tranquility of the landscape; maintain existing landscape character; and avoid conflict with government policy towards protection of the countryside. Accordingly both dual carriageway options would have a **Neutral Effect**

Landscape Character Area F1: Great Yarmouth	
Description -Texture & diversity -Scenic quality -Unity or disharmony	Urban edge to seaside resort with mixed uses including industry, out of town retail, residential, leisure (holiday park)road and and railway sidings which combine to form an area lacking in unity. Little visual interest and poor scenic quality.
Scale it matters -To policy makers -To local stakeholders	Matters on a local scale to Great Yarmouth as one of the main approaches to the town.
Rarity -Commonplace to locality -Scarce	Common.
Importance/quality -How important -Level, national/regional/local -To whom	The area is of some importance to visitors and local people who pass through it to access or egress Great Yarmouth and stay at the holiday park. An area of Low Quality/Value
Substitutability -Substitutable -Not substitutable	The generally poor quality developments are substitutable.
Scope for change -Proposed for do minimum -Potential for enhancement	Area adjacent to the road is identified as a Landscape Enhancement Area in Great Yarmouth Local Plan reflecting local desire to enhance the appearance of this low quality gateway area into the town. Therefore much potential for enhancement with e.g. landscape planting of areas bordering the road. Do-minimum for road has proposals for enforcing reduced speed limit but no proposals for enhancement in this area.
Magnitude of Impact	The physical changes to the road would be significant involving construction of a second carriageway within a relatively constricted space. There would be insufficient space to fully reinstate lost vegetation adjacent to the railway. Other measures include environmental barriers on both sides of the road to the south of Vauxhall Roundabout, which would restrict existing open views. Beneficial night time effects resulting from new road lighting would reduce light spill outside the highway boundary and reduce sky glow. The magnitude of effects would be Medium Negative.
Additional mitigation	All environmental measures have been considered in assessment. Most traditional landscape mitigation measures would be inappropriate in this open landscape and would harm the ecological interests of the area.
Overall assessment Score	In this area the proposals do not quite fit the scale of the landscape; cannot be completely mitigated for because of the nature of the proposal itself; would conflict with local policies for enhancing the character of the area. Accordingly both dual carriageway options would have a **Slight Adverse Effect**

Landscape Character Area F2: Acle	
Description -Texture & diversity -Scenic quality -Unity or disharmony	A small town with a historic centre outside which are modern, uniform residential developments. Centre has a good scenic quality but the residential suburbs are ordinary.
Scale it matters -To policy makers -To local stakeholders	Matters at a local scale to residents. Protection of setting of centre matters to District Council.
Rarity -Commonplace to locality -Scarce	Locally scarce .
Importance/quality -How important -Level, national/regional/local -To whom	The centre and boating area on north-west side are important to visitors who stay for access to the Broads. Residential areas are important to local people. Individual Listed Buildings should be considered of regional importance given their heritage value. An area of Moderate Quality/Value
Substitutability -Substitutable -Not substitutable	Historic centre and Acle Dike area not substitutable, suburbs readily substitutable.
Scope for change -Proposed for do minimum -Potential for enhancement	Suburbs have some scope for enhancement with landscape planting and hard landscape improvements. Do-minimum proposals for road would not affect this area.
Magnitude of Impact	The proposals would have a direct effect on the eastern edge of the area due to realignment of Acle Roundabout resulting in a small loss of screening vegetation. The additional carriageway would also be visually intrusive. A beneficial effect would accrue from replacement road lighting which would reduce light spill and night time sky glow. Also increased traffic would be perceptible on the eastern fringe of the area. The magnitude of effects would be Low Negative.
Additional mitigation	All environmental measures have been considered in assessment. Most traditional landscape mitigation measures would be inappropriate in this open landscape and would harm the ecological interests of the area.
Overall assessment Score	The proposals do not quite fit the landform and scale of the landscape; although not very visually intrusive would impact on certain views into the area; cannot be completely mitigated for because of the nature of the proposal itself. Accordingly both dual carriageway options would have a **Slight Adverse Effect**

8.9 Summary

8.9.1 The existing Acle Straight crosses the Broads, one of the most sensitive landscapes in eastern England, valued for its unique landscape and cultural characteristics, and recognised by its status equivalent to a National Park. This part of the Broads lies within the Halvergate Marshes Conservation Area designated due to its unique historical landscape, and the Broads ESA, has been designated in order to encourage the continued management of this landscape and ecosystem.

8.9.2 The study area contains two core Landscape Character Areas, namely Halvergate Triangle and Calthorpe Level Marshes which cover much of the open grazing marsh within the vicinity of the Acle Straight. The majority of the route lies within these two Landscape Character Areas which are characterised as large scale landscapes of flat, grazing marsh dissected by a complex pattern of field dykes. There are few vertical features and consequently the existing Acle Straight and its traffic is often a notable or prominent feature within views.

8.9.3 The proposed options seek to minimise the disturbance, both physical and visual, through careful design that would reduce adverse affects, the loss of valued features, and diminish visual intrusion.

8.9.4 Options 2 and 2A, would incur relatively major changes to the existing road and generate additional, faster moving traffic. This would create an adverse effect on this very sensitive landscape and which has been assessed as a Large Adverse effect.

8.9.5 The remaining Landscape Character Areas are located on the periphery of the study area and would experience varying effects on landscape character ranging from Large Adverse to Neutral.

8.9.6 There are relatively few properties and outdoor recreational facilities within the vicinity of the Acle Straight. However views are very extensive due to the open flat nature of the landscape. Where the road is visible within views, these are mainly from properties on the eastern edge of Acle, the western edge of Great Yarmouth, a few houses within villages at some distance to the north and south, and some scattered farms, houses and drainage mills within the marshes.

8.9.7 The existing road already has an effect on views from most of these properties/facilities and the proposed physical changes to the road would generally be visible to properties within close proximity to the road. However it is the moving traffic on the road that causes most visual intrusion and this is visible from longer distances. The proposals have been predicted to generate an increase in traffic flows compared to the do-minimum situation. This increase is expected to be perceptible in views to

properties in close and medium range proximity to the road. Accordingly many properties or publicly accessible recreational areas within the visual envelope would experience some change in existing views.

8.9.8 Several properties and public paths close to the road would experience a substantial adverse effect on views. Other properties or recreational facilities further from the route would experience slight to moderate adverse effects.

8.9.9 The usual mitigation measures employed for screening trunk roads and their traffic are not generally appropriate for this scheme as they themselves would be visually intrusive in the surrounding open landscape. Also unique wildlife habitats of national and international importance are located immediately adjacent to the scheme and these would be harmed by the provision of screening mounds or dense planting belts.

8.9.10 The overall effect of the dual carriageway proposals on the landscape of the area is considered to be Large Adverse. There is little noticeable difference in the effects on views or landscape character between Option 2 and Option 2A.

9 Ecology and Nature Conservation

9.1 Introduction

9.1.1 This chapter assesses the potential effects from implementation of the scheme on the biodiversity within the study area. Biodiversity includes all species of plants and animals, their genetic variation and the complex ecosystems of which they are a part. It is not restricted to rare or threatened species but includes the whole of the natural world from the commonplace to the endangered (as defined in the UK Biodiversity Action Plan).

9.1.2 The overall objective of the study was to provide information for the Stage 3 assessment of the study area in accordance with Volume 11 of the Design Manual for Roads and Bridges (DMRB).

9.1.3 The Environmental Scoping Report (Hyder, 2002) identified the need for a number of specialist ecological surveys. The following surveys have been undertaken during the spring / summer 2003 as part of the study:

- Phase 1 Habitat Survey[33].
- Dyke Vegetation survey[34].
- Invertebrates survey, A47[35] .
- Winter Bird survey[36].
- Breeding Bird Survey[37].
- Survey of Otter and Water Vole populations[38].
- Bat survey[39].
- Badger survey[40].
- Reptiles and Amphibians survey[41].

9.1.4 This biodiversity assessment includes aquatic habitats. There is an obvious interaction between aquatic life and the chemical and physical aspects of

[33] Phase 1 Habitat Survey A47 Acle Straight, Hyder Consulting Ltd, 2003
[34] Survey and Assessment of Dyke Vegetation A47 Acle Straight. Norfolk Wildlife Services Ltd, 2003
[35] Survey and Assessment of Invertebrates, A47. Norfolk Wildlife Services Ltd, 2003
[36] Winter Bird Survey 2003 for the A47 Acle Straight Road Improvement Scheme Ecoscope, 2003
[37] Breeding Bird Survey Report for the A47 Acle Straight Road Improvement Scheme. Ecoscope, 2003
[38] Survey and Assessment of Otter and Water Vole Populations in A47 Acle Straight Norfolk Wildlife Services Ltd, 2003
[39] Survey and Assessment of Bats A47 Acle Straight, Norfolk Wildlife Services Ltd, 2003
[40] Badger Survey, A47, Acle Straight Road Improvement Scheme, Hyder Consulting, Ltd, 2003.
[41] Survey and Assessment of Reptiles and Amphibians on A47 Acle Straight Norfolk, Wildlife Services Ltd, 2003

the water environment. Where applicable, these interactions are discussed and cross-referenced to Chapter 7, Water Quality and Drainage. Construction impacts relating to Biodiversity are discussed in this Chapter but cross reference is also made to Chapter 14, Disruption due to Construction.

9.1.5 The study area for the Biodiversity topic is a corridor of overall width 1km, centred on the existing A47, Acle Straight, between Acle and Great Yarmouth (as shown on Figure 9.1). Within this general area appropriate specific study areas (sometimes of lesser extent than the overall study area) have been defined for each of the specialist surveys described below.

9.2 Methodology

9.2.1 In order to fully inform the baseline survey for the Stage 3 assessment, it was necessary to ensure that sufficient ecological survey was undertaken to determine this material consideration. The assessment process involves a description of the habitats and species present, an evaluation of their importance and an assessment of predicted impacts of the scheme, taking account of identified mitigation measures.

9.2.2 The methodologies used in this chapter are derived from the DMRB Volume 11[42],. Additionally, where relevant and necessary, this has been supplemented by the methodologies given in GOMMMS[43], which is based on advice from English Nature.

9.2.3 Significance criteria under this topic are based on the seven point scale set out in GOMMMS. Features are assessed against a number of ecological criteria including statutory and non statutory nature conservation designations, the presence of rare and protected species and their context within the range of habitats present in the study area. The effect of the proposed scheme is evaluated according to the ecological importance and sensitivity of the habitat effected and the predicted magnitude of the impact (see Tables 9.1, 9.2 and 9.3)

[42] Design Manual for Roads and Bridges Volume 11, Section 3, Part 4, Ecology and Nature Conservation
[43] The Guidance on the Methodology for Multi- Modal studies, Section 4.10, The Biodiversity Sub-objective

Table 9.1. Guidance on Describing the Nature Conservation Value of Features		
Value	**Criteria**	**Examples**
Very high	High importance and rarity, international scale and limited potential for substitution	Internationally designated sites
High	High importance and 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	Regionally important sites with potential for substitution and locally designated sites
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

Table 9.2. Criteria for Determining the Magnitude of the Impact	
Magnitude	**Criteria**
Major negative	The proposal 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 sites 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.

Table 9.3: Estimating the Overall Assessment 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

9.2.4 The assessment work includes recommendations on mitigation measures. Volume 10 of the DMRB 'Environmental Design' provides detailed guidance on environmental mitigation for road schemes and will be used as a reference for ecological mitigation. Consultations on the effects of the schemes and proposed mitigation measures appropriate to each specialism will be carried out with English Nature and other consultees, where appropriate.

9.2.5 The proposed methodologies for the specialist surveys were initially set out in a series of scoping notes. These were agreed in writing with English Nature prior to commencement of each of the surveys. The full methodologies, as adopted, are set out in detail in each of the specialist survey reports (listed above) and they each follow the most appropriate suite of techniques / best practice guidance for that specialist component of the study. For example, the field survey for reptiles followed the method laid down by Froglife (1999) and the initial walkover survey for great crested newts used the methodology based on Oldham et al. (2000), with subsequent detailed surveys using the methods given in English Nature (2001).

9.2.6 With respect to those specialist surveys that relate to the network of ditches in the study area, it was considered beneficial to use data collected over an extended time frame, in order to ensure adequate coverage of all stages of ditch management. For example, the current ditch flora survey was used to supplement the Botanical Ditch and Woody Vegetation Survey undertaken in 1995 by Green Environmental Consultants. This survey and report formed part of the Stage 2 Environmental Assessment for the A47 Acle Straight undertaken on behalf of the Highways Agency.

9.2.7 All current surveys were undertaken at the optimum time for the individual specialism, between November 2002 and September 2003. There were no seasonal constraints to the surveys. Whilst access was generally available, there were limited areas (ref. Access to Study Area map) for which access was not permitted by the landowner and other small 'landlocked' areas for which access was difficult. It should also be noted that there were some further limitations to survey due to Health and Safety considerations concerning livestock, hazardous access to ditches and also difficulties in surveying land within the curtilage of the highway. This applied in particular to the ditch flora and invertebrate surveys and the amphibian and reptile surveys.

9.2.8 Notwithstanding the above limitations, it is considered by the specialists that, coupled with existing records, coverage is representative of the study area and sufficient for the purposes of assessment.

9.2.9 The Stage 3 assessment also includes a desk study to review and update the data gathered for the previous ecological studies within the study area. A number of ecological studies have previously been carried out in the vicinity of the A47, Acle Straight. These are set out in table 9.4 below.

Table 9.4 The Source and Nature of Biodiversity Data		
Author & Date	**Report**	**Survey Data Included**
Faber-Maunsell, October, 2001	A47 Norwich to Great Yarmouth Road Based Study Report	Summaries only of the following data: Phase 1 habitat survey (Sept-Oct 2000) Phase 2 survey of semi-natural habitats (Aug - Sept 2000) Rare and scarce plant survey (Sept 2000) Mammal survey data (Sept 2000) Aquatic invertebrate (Sept 2000).
RSPB, ongoing database	RSPB Biodiversity species database 2000	Bird survey data
Ecoscope Applied Ecologists, 1998	Winter Ornithological Surveys of the Bure Loop 1997/98	Winter bird survey data
English Nature/Broads Authority /Environment Agency: Harris, Parmenter & Rundle, 1997	The Broads Grazing Marsh Dyke Survey	Ditch flora survey
Norfolk Wildlife Trust: Yaxley, 1997	Norfolk Water Vole survey	Water Vole survey data
RSPB: Babbs, Cook and Durdin, 1997	Broads ESA wintering waterfowl survey 1996/7	Bird survey data
Landscape Design Associates/ Green Environmental Consultants, 1996	A47 Acle Straight Ecological Surveys.	Aquatic Ditch flora survey data (submerged species only) (1995) Aquatic invertebrate survey data (May/ June 1995) Breeding wader survey data (April/ May 1995) Tree survey
RSPB: Weaver, 1995	Broads ESA Breeding Wader Survey	Bird survey data
Nature Conservancy Council: Doarks & Leach, 1990	England Field Unit Project No.76: A Classification of Grazing Marsh Dyke Vegetation in Broadland	Ditch flora data

9.2.10 A number of additional studies pertinent to the A47, Acle Straight were identified as part of the specialist assessment work. The full list of

references is included in each of the specialist reports but the most relevant of these include:

- A Flora of Norfolk Beckett[44],
- A Study of Marsh Dykes in Broadland[45] ,
- An Atlas of the Flora of Grazing Marsh Dykes in Broadland[46] ,
- Unpublished data from 1996 -1998 National Water Vole Survey[47].
- Otters and Vulnerable River Crossings Norfolk Wildlife Services (2003).
- Otters and Road Deaths Database held at Norfolk Wildlife Trust (2003).

9.2.11 The following statutory and non statutory wildlife and other relevant bodies were consulted as part of the study and / or the specialist component studies, as appropriate, to request any existing ecological data they may hold :

- English Nature
- Environment Agency (EA)
- Norfolk Wildlife Trust (NWT)
- Norfolk Biological Records Centre (NBRC)
- Broads Authority
- Norfolk County Council
- Great Yarmouth Borough Council
- Internal Drainage Board (IDB)
- Rural Development Service
- Royal Society for the Protection of Birds (RSPB)
- Department for Environment, Food and Rural Affairs (DEFRA)
- Norfolk and Norwich Naturalists Society
- Great Yarmouth Bird Club
- Local Wetland Bird Survey (WeBS) counter.

9.2.12 Data received from English Nature included Site of Special Scientific Interest (SSSI), Wetlands of International Importance (Ramsar sites), candidate Special Area of Conservation (cSAC) and Special Protection Area (SPA) citations and mapping and the cSAC conservation objectives and favourable condition tables for sites within the vicinity of the study area.

[44] A Flora of Norfolk Beckett, G and BullA (1999).
[45] A Study of Marsh Dykes in Broadland Doarks,C (1984)
[46] An Atlas of the Flora of Grazing Marsh Dykes in Broadland Doarks, C et al. (1990).
[47] Unpublished data from 1996 -1998 National Water Vole Survey relating to Norfolk Vincent Wildlife Trust (2000).

Information received from the EA, NWT and other consultees is referred to in the Baseline Situation section below. Biodiversity information held by NBRC was not made available during the consultation period.

9.2.13 English Nature as the leading stakeholder consultee for biodiversity issues, have also been involved in ongoing discussions with regard to the environmental design and other mitigation options for the scheme. Formal consultations will be undertaken post submission of the EAR.

9.3 Legislation

9.3.1 The principal legislation relating to biodiversity (species, habitats and sites) in the scheme study area is as follows:

- The Wildlife and Countryside Act, (1981) and subsequent amendments (UK protection);
- The Badgers Act (1992) (UK protection);
- The Conservation (Natural Habitats &c) Regulations (1994) (UK regulation implementing the EC Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora 92/43/EEC);
- The Countryside and Rights of Way Act (2000) (UK protection).

9.3.2 A number of sites of UK and / or European protected status occur within the study area. Their protected status is summarised as follows:

- Ramsar Sites, Wetlands of International Importance, designated under The Ramsar Convention 1971 (The Convention on Wetlands of International Importance Especially as Waterfowl Habitat)..
- candidate Special Areas of Conservation (cSAC) designated under the EC Council Directive on Natural Habitats and Wild Fauna and Flora 92/43/EEC.
- Special Protection Areas (SPA) designated under The birds Directive 1979 (EC Council Directive on the Conservation of Wild Birds 79/409/EEC).
- Site of Special Scientific Interest (SSSI) designated under the Wildlife and Countryside Act (1981).
- Local Nature Reserves (LNR), designated under The National Parks and Access to the Countryside Act 1949.

NB All cSACs, SPAs and Ramsar sites in the study area are superimposed on SSSI's.

9.3.3 A number of species of UK and / or European protected status also occur within the study area or were considered to have potential to occur. Their protected status is summarised as follows:

- Great crested newts are protected under Regulation 39 of the Conservation Regulations (1994) and Section 9 of the Wildlife and Countryside Act (1981);
- Otters are protected under The Conservation (Natural Habitats, &c) Regulations, Schedule 2, (1994) and Section 9 of the Wildlife and Countryside Act (1981). Otter is also listed in Appendix 2 of the Bern Convention, Article 6, which seeks to ensure special protection for such listed species;
- Bats are protected under Regulation 39 of the Conservation Regulations (1994) and Section 9 of the Wildlife and Countryside Act (1981);
- Badgers are protected under the Badgers Act (1992) and Schedule 6 of the Wildlife and Countryside Act (1981);
- Grass snakes, common lizards and slow worms are protected under Section 9 (1&5) of the Wildlife and Countryside Act (1981);
- Water voles are protected under Section 9 (4) (a &b) of the Wildlife and Countryside Act (1981);
- Norfolk Hawker *(Aeshna isosceles)* is protected under Section 9 (Schedule 5) of the Wildlife and Countryside Act (1981);
- Bewick's swan, marsh harrier, hen harrier, merlin, peregrine, avocet, ruff, black-tailed godwit, green sandpiper, barn owl, kingfisher, fieldfare, redwing, Cetti's warbler, bearded tit and Lapwing bunting are protected under Schedule 1 of the Wildlife and Countryside Act (1981);
- Little egret, Bewick's swan, white-fronted goose, marsh harrier, hen harrier, merlin, peregrine, avocet, golden plover, ruff, short-eared owl and kingfisher are listed under Annex 1 of the EU Birds Directive (79/409/EEC) which lists rare migratory and other species of birds, whose habitat is protected in SPA's.
- All wild birds and their nests are also protected under the Wildlife and Countryside Act and additionally under The EU Birds Directive.

9.3.4 The wider area in which the study area is located is designated as part of the Broads Authority, which has similar status to a National Park. Whilst this notification primarily recognises the national importance of the Broadland landscape, it also reflects the nature conservation interests of this area. The Broads Natural Area Profile (NAP) document sets out long term conservation objectives for the area and identifies changes needed to achieve targets set out in the UK and Norfolk Biodiversity Action Plans (see 9.3.7 below). The Broads Plan is the statutory document identifying the Broad Authority's management policies for the Broads.

9.3.5 The following working strategies for The Broads have been produced by the Broads Authority, with the RSPB, Norfolk Wildlife Trust and English Nature, based on the targets set out in the above documents:

- the Fen Management Strategy,

- the Drained Marsh Strategy and
- the Rivers and Broads Strategy.

The Broads Drained Marsh Strategy (2001) is most relevant to this study area provides objectives and targets, aimed at informing the co-ordination of management projects and the allocation of resources in the Broads area.

9.3.6 In addition to legislation there are also a number of relevant national, regional and local policy guidance documents. These are discussed and assessed with regards to scheme implementation in Chapter 3 Planning. Sites of local or county level importance for nature conservation are identified in the Norfolk Structure Plan.

9.3.7 Norfolk Wildlife Trust has produced a Local Biodiversity Action Plan (LBAP) for the county. Local BAPs identify Priority Habitats and Species, setting targets for their conservation and outlining the methods for achieving these targets. The UK Biodiversity Plan (UKBAP) identifies Priority Habitats and Species at the national level. The impact of scheme implementation on the achievement of the conservation targets of any local or national Priority Habitats and Species identified in the study has been included in this assessment.

9.3.8 Other notifications relevant to biodiversity in the study area include the Broads Environmentally Sensitive Area (ESA). ESA is a DEFRA designation introduced to offer incentives to encourage farmers to adopt traditional agricultural practises, to promote the conservation and enhancement of parts of the countryside with high wildlife, landscape or historic interest.

9.4 Baseline Situation

Statutorily Protected and Other Notified Sites of Nature Conservation Importance

9.4.1 The study area and wider vicinity of the scheme corridor includes habitat of significant nature conservation value. The existing A47Acle Straight passes through a system of grazing marshes and ditches which comprise part of the Norfolk Broads ESA. The national and inter-national importance of parts of the study area has been recognised through the designation of protected sites. These are listed below:

- The Broads cSAC
- Broadland Ramsar
- Broadland SPA
- Breydon Water Ramsar, SPA, SSSI and LNR

- Decoy Carr SSSI (which is a component of both the Broads cSAC and Broadland SPA and Ramsar)
- Damgate Marshes SSSI (which is a component of the Broads cSAC and Broadland Ramsar only)
- Halvergate Marshes SSSI (part of which is a component of the Broads cSAC and Broadland SPA and Ramsar and the remainder is part of Breydon Water SPA and Ramsar).

9.4.2 Other SSSI's outside the study area but within 3km of the study area are Great Yarmouth North Denes, Upton Broad and Marshes and Burgh Common and Muckfleet Marshes. The coastal part of North Denes SSSI is also designated as a SPA.

9.4.3 County Wildlife Sites (CWS) are non-statutory sites of local nature conservation importance. There are no CWS's within 2km of the study area, except Kitchener Road Cemetery, Great Yarmouth, which is in the middle of the built up area of Great Yarmouth. Correspondence with NWT[48] indicates that there may well be areas in the vicinity of the Acle Straight which, within a county context, are of CWS value but are not notified as such. In the past the Broads Authority (BA) considered that it was not useful to have designations below SSSI. It should be noted that there is now a change of policy and the Broads Authority and NWT are hoping to notify CWSs within the BA area in the future.

9.4.4 Part of Breydon Water (see above) is also a statutory Local Nature Reserve (LNR) and Acle Carr at the western end of the study area is owned by the Acle Trust and managed as a nature reserve.

9.4.5 The above statutorily designated and other notified sites of nature conservation importance are described by area below and identified in Figure 9.1.

The Broads cSAC

9.4.6 The northern periphery of this extensive site immediately adjoins the southern side of the existing A47, in the western part of the study area. It is considered to have a high diversity of habitats / species of European importance. Those parts of the wider cSAC which lie within the study area comprise Decoy Carr, Damgate Marshes and part of the Halvergate Marshes SSSI's. The European priority interests in the wider cSAC area include lake and dyke communities (natural eutrophic lakes), alder floodplain woodland, calcareous fen dominated by great fen sedge, alkaline springwater-fed fen, calcium rich nutrient-poor ponds, purple moor-grass

[48] John Hiskett NWT, personal communication.

grazing meadow, nutrient rich ponds dominated by pondweed and wet mires, as well as otter, fen orchid and Desmoulin's whorl snail.

Broadland Ramsar

9.4.7 This large area of low lying land in east Norfolk and northern Suffolk, includes the lower valley of the Waveney, Yare and Bure Rivers and their tributaries. Within the study area it has a boundary concurrent with the Broads cSAC boundary and includes the Decoy Carr, Damgate Marshes and part of the Halvergate Marshes SSSI's. It also immediately adjoins the southern side of the existing A47 at the western end of the study area. In addition to the medieval peat working lakes, which characterise the area, the succession of vegetation and various forms of traditional management have resulted in a large range of wetland habitats now present including carr woodland and wet grazing marsh.

9.4.8 The diversity of wetland habitats supports an outstanding assemblage of breeding and wintering wetland bird species, and regularly supports internationally important numbers of wintering Bewick's swans, wigeon, gadwall, and shoveler and nationally important numbers of breeding bittern, gadwall, garganey, shoveler, pochard, marsh harrier, Savi's warbler. Cetti's warbler and bearded tit, amongst other species. The area also supports large numbers of rare and vulnerable species of plants and invertebrates. The area is particularly notable for its dragonfly fauna including the Red Data Book Norfolk Hawker and is the only location in Britain where the endemic race of the swallowtail butterfly breeds successfully.

Broadland SPA

9.4.9 This area which includes Decoy Carr and part of Halvergate Marshes SSSI's but not the Damgate Marshes SSSI, does not immediately adjoin the existing A47. It qualifies as a SPA under Article 4.1 of the EC Birds Directive by regularly supporting nationally or internationally important numbers of the following Annex 1 species: breeding bittern, marsh harrier and wintering Bewick's swans, Whoopers swans and hen harriers. It also qualifies under Article 4.2 of the Directive by regularly supporting internationally important numbers of the following migratory species in winter : wigeon, gadwall and shoveler and nationally important numbers of wintering bean geese, European white-fronted geese and pink-fotted geese, teal, hen and marsh harrier, and pochard and breeding gadwall, garganey, pochard and Savi's warbler. It also supports an outstanding assemblage of wetland birds not listed above including water rail, avocet, snipe, redshank, common tern, kingfisher, Cetti's warbler and bearded tit, as well as wintering mute swan, bittern, short eared owl and Lapland bunting.

Breydon Water Ramsar, SPA and SSSI

9.4.10 Breydon Water Ramsar and SPA includes the Breydon Water SSSI and part of the Halvergate Marshes SSSI. Approximately 40% (453ha) of the site is also designated as a LNR. It is located at the eastern end of the study area, with the northern boundary of the site located within 100m of the southern side of the existing A47. It is an extensive inland tidal estuary at the mouth of the River Yare and at its confluence with the Rivers Bure and Waveney and contains the only intertidal flats on the east coast of Norfolk. The estuary is internationally important for wintering birds and nationally important for birds on passage. The area qualifies as a SPA under Article 4.1 of the EC Birds Directive by regularly supporting internationally important numbers of wintering Bewick's swan, nationally important numbers of avocet, lapwing, ruff, golden plover and breeding common tern. It also supports migrating European white-fronted goose, gadwall, shoveler and redshank, as well as important numbers of whimbrel.

9.4.11 There is also considerable botanical interest with small areas of salt marsh at the lower end of the estuary, brackish reedswamp at the upper end of the estuary, with extensive stands of common reed and brackish water communities in the surrounding borrow dykes (dykes created by the extraction of material for the creation of flood banks and other retaining structures). The mudflats are characterised by growth of green algae and two uncommon types of eel grass. The invertebrate fauna is rich and includes a scarce mollusc.

Decoy Carr SSSI

9.4.12 A large area of wet carr woodland and open fen occupying a side valley of the River Bure to the immediate south of Acle. The site, which is isolated from the main Broadland river system supports excellent examples of alder carr, reed bed, mixed fen and open water habitats. The SSSI is located at a distance of approximately 410 m from the existing Acle Straight. The majority of the woodland is sump alder carr on fen peats and supports a well developed ground flora, including lesser pond sedge, redcurrant and marsh fern. Small areas of acid valley alder woodland including oak and birch occur in areas where sandy soils underlie thin layers of peat.

9.4.13 A network of dykes containing clear spring water drain the wet areas of mixed fen vegetation. These contain a wide range of water plants including water violet, greater bladderwort, frogbit, shining pondweed and the locally uncommon water soldier.

Damgate Marshes SSSI

9.4.14 This forms part of the Broads cSAC and Broadland Ramsar, located at the western end of the study area to the immediate south of the existing A47. It is one of the richest areas of traditionally managed grazing marsh and dyke

systems now surviving in Broadland, recognised as a nationally important wetland site. The marshes lie on fen peats and alluvial clays and tend to be summer-grazed by cattle and cut for hay. Their nature conservation importance is concentrated principally on the aquatic flora and fauna of the dykes, which support a wide range of water plants, including several uncommon species in the relatively nutrient-poor waters.

9.4.15 Peaty ditches on the margins tend to be typified by broad leaved pondweed, fen pondweed, flat stalked pondweed, water violet and whorled water-milfoil. Away from the peaty margins, on the clay soils the ditches tend to be dominated by water soldier.

9.4.16 There is a great diversity of aquatic invertebrates including several species of dragonfly.

Halvergate Marshes SSSI

9.4.17 This forms part of the Broads cSAC and also part of both the Broadland Ramsar site and SPA and Breydon Water Ramsar and SPA. The northern part of this extensive SSSI lies within 600m of the southern side of the existing A47. Halvergate Marshes forms the largest expanse of traditionally managed grazing /grass marshes with their intersecting system of drainage ditches, within the Broads.

9.4.18 The ditches support an outstanding assemblage of plants and a rich invertebrate fauna and show a transition from fresh to brackish conditions, with a wide range of aquatic ditch community types for which the Broads are notable. These include acid and base-rich mesotrophic communities, meso-eutrophic communities, freshwater eutrophic types and truly brackish communities. The freshwater ditches rich in pondweeds are recognised in the Broads context as being of international importance. Nationally rare invertebrate species include the Norfolk hawker dragonfly, the great silver water-beetle and a large hoverfly of brackish dykes.

9.4.19 The area close to the Breydon Estuary possesses the best brackish ditch communities anywhere in the Broads, with a number of regionally important and nationally scarce species. The sea walls support the nationally scarce sea holly and marsh sow thistle, with marsh mallow and divided sedge on grazing marshes and ungrazed tracks along the Breydon Estuary.

9.4.20 The SSSI supports internationally important numbers of many of the species of wintering wildfowl and breeding birds noted in the descriptions of the Broadland and Breydon Water Ramsar and SPA sites above. The bird populations on Halvergate Marshes evolve in response to variations in grazing and other agricultural management and external influences including water level issues. Other notable bird species include oystercatcher, yellow wagtail, ringed plover, grey partridge, Brent goose and barn owl.

Site Context and Habitats in the Study Area

9.4.21 Whilst the nature conservation importance of strategic parts of the study area are recognised by national and international designations as set out above, the remainder of the study area is also of undoubted nature conservation importance. This is on account of the prevailing drained grazing marsh habitat, in the flood plain of the embanked River Bure. It has been indicated by English Nature (personal communication[49]) that all the grazing marsh habitat in the area is suitable for designation as a SSSI, mainly on account of the network of associated dykes, rather than the intrinsic quality of the grassland habitat. However at the time of SSSI designation only the best quality habitat was designated.

9.4.22 The land is currently under mixed agricultural use and forms part of the Broads Environmentally Sensitive Area (ESA). The marshes were originally subject to drainage works which commenced in the thirteenth century, at the same time as embanking the river. Some areas of land both to the north and south of the existing A47 are now under intensive arable cropping / set-aside in generally medium sized fields.

9.4.23 The major part of the study area on both sides of the A47, consists of species-poor, semi-improved neutral grassland grazed by cattle, sheep or horses, with some areas of improved grassland used for grazing or hay / silage production. There are localised remnant areas of semi-improved, marshy grazing grassland of higher intrinsic interest, which tend to be concentrated in the western part of the study area (partly within the Damgate Marsh SSSI). Whilst all the grassland has undoubtedly been improved to some extent, there is a variation in species composition between highly improved sown grassland used mainly for hay / silage production and the majority of the grassland in the study area which is used for sheep, cattle or horse grazing. These grazing areas tend to consist of a mixture of coarse tussocky grasses with over-sown productive cultivars of for example rye, timothy and clover, along with finer species of grass such as bents and fescues.

9.4.24 Field sizes are variable and there are a number of small irregular shaped remnant areas, resulting from road / railway construction. Some of these and other localised areas in the Acle Slough (towards the western end of the study area) are subject to seasonal waterlogging. The plant communities in these areas include common reed, greater pond sedge and other sedges, reed sweet grass and hard and soft rush, with localised ingress of invasive, weed species, including nettle, hogweed, marestail and some bramble.

9.4.25 The majority of the improved grassland contains a variable (generally low and species poor) component of broad-leaved species including dandelion,

[49] Meeting with English Nature August 2002

yarrow, creeping buttercup and common vetch. The exact nature of the plant communities present reflects current and past land management practise. Some fields which appear to have been 'improved' at some time by re-seeding / over-seeding with rye and other productive grasses, have more recently become re-colonised by species such as Yorkshire fog, bent grasses, knapweed and creeping thistle.

9.4.26 Land management and hence the ecological interests of the wider area,of grazing marsh habitat is influenced to some extent by national and regional policy and legislation. For example, during the mid–late twentieth century intensification and rationalisation of the marshes was promoted in the general area, including the installation of more effective mechanised pumped drainage, ploughing and re-seeding of grazing land and increased arable usage with associated deep drainage requirements, which resulted in lowering of the water table. This combined with raising of sea levels and deterioration of some river and estuarine floodbanks has led to increasing salinity in the ditch system of the lower river valleys and ditches in the middle and upper valley systems becoming more eutrophic, due to ingress of nutrient rich river water. These trends have resulted in overall reduction of ecological value in the study area and the wider Broads area, in particular relating to bird interest, plant and invertebrate communities.

9.4.27 The Broads ESA scheme has been instigated with a view to reversing the trend of agricultural intensification, by providing incentives for traditional grassland management, higher water levels and reduced fertiliser treatment. The Broads Drained Management Strategy (2001), indicates that at that time there had not yet been the wide scale improvement in wildlife hoped for and suggested that a continuing decline in ecological interests may be due to other factors, as discussed above, often from outside the catchment.

9.4.28 Notwithstanding the above, the drained marshes still represent an outstanding wildlife resource. The many ditches (including drainage ditches either side of the road) link together to form an important network of wetland habitat, of particular botanical and wildlife interest. The majority of the ditches are subject to regular management and the specific characteristics of any particular ditch are dependent largely on the stage in the management cycle. Water level management of the drained marshes is under the control of the Internal Drainage Boards (IDBs) and independent landowners and occupiers. Water Level Management Plans (WLMPs) are prepared on a whole IDB basis and monitored by DEFRA. The generally highly mechanised nature of modern ditch clearance has led in some cases to more systematic and intensive ditch management, which has caused some changes in plant and invertebrate communities and local extinction of some species. Conversely, neglect can also cause a decline in ditch interest.

9.4.29 The vegetative structure, species composition and habitat value of each individual ditch in the study area therefore varies according to past and

present management. It also depends on the stage in the management cycle at the precise time of survey. Ditch banks in un-grazed areas tend to be dominated by coarse grasses, tall ruderal vegetation and marginal aquatic species, as well as bramble and occasional growth of shrubby willow, elder and hawthorn, to a height of 4-8m. Some sections of ditch are silted, stagnant and congested with reed growth but the majority appear to be managed on a regular basis and function effectively as drainage channels. Reference should also be made to water quality and hydrological issues discussed in terms of management, road drainage and water quality, in the Water Environment Topic (see section 7.4). The majority of the ditches are devoid of woody vegetation although there is some scattered scrub on the ditch banks.

9.4.30 There are few hedgerows or other woody vegetation in the study area, although there is intermittent growth of pollard and other willows, elder, bramble and other scrub along the existing A 47, along the railway line and around buildings. At the eastern and western ends of the route there is generally more woody vegetation on the road verges, including lines of mature poplars associated with the Vauxhall Holiday Park on the edge of Great Yarmouth and short lengths of road side tree / scrub belt.

9.4.31 The eastern end of the study area contains relatively extensive areas of carr woodland, including Damgate woodland and other adjoining areas of alder carr, disjointed by the railway and the A47 Acle bypass, to the south of the existing A47. Elsewhere there is little mature woodland or scrub, although there is an area of recent broad leaved woodland planting, known as Roman Wood, to the north of the road near Acle and occasional, mature / semi-mature, small woodland blocks further east.

9.4.32 Similarly, there are few small ponds within the study area, although important areas of brackish reed bed / lagoon associated with Breydon Water, occur at the eastern end of the study area. Further brackish reed beds adjoin the margins of the wide meandering course of the River Bure, to the north of the road. The river itself is used as a thoroughfare for pleasure boats and for other low key recreational use.

9.4.33 The verges and embankment slopes along the existing A 47 tend to be narrow and are enclosed on their outer edges by drainage ditches. These areas support an irregular distribution of willow scrub and in the western part individual pollarded willows (recently re-pollarded). There are also a number of low elder, hawthorn, elm, apple and other scrubby species including occasional growth of gorse. The verge ground flora is typically disturbed by the proximity to the road and high traffic levels and dominated by coarse grasses with localised areas of low bramble thicket and a variably dominant tall ruderal component. There is also some localised spread of common reed and reed sweet grass from ditch banks into the road verges.

9.4.34 The individual habitats present within the study area are described in the Phase 1 survey report, in a series of Target Notes.

9.4.35 The specialist botanical, herpetological, invertebrate, water vole and otter survey, as well as breeding and wintering bird surveys provide detailed information relating to the nature conservation interests of the ditches and drained marsh habitat in the study area. Records and locations of notable and rare species are illustrated in Figure 9.2.

Dyke Vegetation

9.4.36 The data collected in 2003 relating to dyke vegetation supplements the data gathered in a previous survey (Green, 1996). The data was computer analysed using the Twinspan programme to identify discrete communities (or endgroups) of aquatic and emergent Broadland Dyke flora , using the key given in Doarks and Leach (1990). Twinspan provides a dichotomous key using indicator species. Twinspan Endgroups are therefore defined as typical assemblages of dyke flora, 12 different endgroups were recorded during the current survey.

9.4.37 Of the Twinspan Aquatic endgroups A1 to A7, groups A1 and A2 were not represented in the study area. Endgroups A3a, A3b and A5a are considered to be of international importance (one of the features for which the Broads SAC has been designated). These tend to be typical of waters of low conductivity and occur at the western end of the study area. A3b has the nationally scarce water soldier as a constant species (main host plant of the protected Norfolk Hawker dragonfly). Further east the ditches generally become more eutrophic (nutrient rich) and moderately saline and in this area endgroups A4 and A5b are relatively frequent, these are considered to be of national importance, with other endgroups of regional importance.

9.4.38 In terms of emergent endgroups, E1 is most frequent at the western end of the study area and is most clearly associated with important aquatic communities. E2 is swamp vegetation typical of nutrient rich water margins and is scattered throughout the study area. E3 is found more occasionally along grazed ditch margins, and with E4 which is dominated by common reed, is most widespread throughout the study area. E5, which includes salt marsh species, is associated with brackish conditions at the eastern end of the study area.

9.4.39 The following rare and scarce aquatic and emergent species were recorded during the current survey. The location of these records are shown in Figure 9.2:

- Nationally Scarce: water soldier, marsh sowthistle, dittander and marshmallow.
- Regionally Scarce: slender spike rush.

- Formerly Nationally Scarce and now considered to be notable: brackish water crowfoot, flat-stalked pondweed.
- In addition the Nationally Scarce hair-like pondweed and Regionally Scarce floating liverwort were recorded in the 1996 survey but not in 2003.

Invertebrates

9.4.40 Due to the expected correlation between aquatic invertebrate communities and the environmental quality of the ditch habitat, the following environmental features of the ditches were recorded as part of the invertebrate survey:

- Conductivity – which generally increased towards the eastern end of the study area. There were few consistent differences between the north and south sides of the road or between field and roadside drains, with two exceptions: several ditches of particularly high conductivity north of the road and west of the Pontiac Roadhouse (Stracey Arms) and ditches of low conductivity about 3km to the east of the Pontiac Roadhouse (Stracey Arms) on both sides of the road.
- Clarity – turbidity was very variable in the study area with no systematic pattern.
- Habitat Quality – this was assessed using a four point scale (Category 1 = high quality and Category 4 = low quality). Ditches of low quality occurred over much of the length of the study area with high quality ditches occurring only in the western part of the study area. No sites of high conductivity were judged to have a high habitat quality score.

Aquatic Invertebrate Assemblages

9.4.41 The species richness of aquatic invertebrate assemblages, decreased as habitat quality decreased, conductivity increased and generally as turbidity increased.

9.4.42 There are no readily identifiable categories of aquatic assemblages; many of the component species are widely distributed and the richness of the assemblages varies continuously. However, the specialist invertebrate study proposed a classification of the assemblages and provided an indication of their distribution, as summarised below:

- Aquatic species rich freshwater invertebrates– most of the ditches between Acle and the Pontiac Roadhouse (Stracey Arms), both north and south of the road and a few ditches to the immediate east.
- Aquatic moderately species rich with brackish influence – most of the ditches between the Pontiac Roadhouse (Stracey Arms) and Great Yarmouth.

- Aquatic species poor – ditches scattered along the length of the study area.

Flying Invertebrates and Assemblages of Marginal Vegetation

9.4.43 The species richness of this assemblage increased with increased habitat quality. The most diverse fauna including wetland hoverflies and soldier flies, is widely distributed in the study area. Ditches supporting a species poor fauna, with the hoverfly component dominated by transients, are found scattered less frequently throughout the study area.

Terrestrial Invertebrates

9.4.44 Three broad types of terrestrial habitat were sampled during the study. An interesting assemblage of species was found in these habitats including a few nationally notable species:

- Fen – Fen sedge (*Cladium mariscus*) dominated fen in the area south of the road near Acle, supporting a diverse assemblage of invertebrates, including a number of notable snails and spiders.
- Reed Bed – tall stands of common reed (*Phragmites communis*) monoculture, supporting a relatively species-poor assemblage dominated by ground dwelling species, occurring in small scattered patches bordering ditches and field corners.
- Grazing marsh and ditch edges – a distinctive assemblage including a number of ground beetles, occurring throughout the study area.

Rare and Scarce Invertebrate Species

9.4.45 The 2003 survey recorded a total of 12 rare and scarce invertebrates, these include Red Data Book (RDB) species which are of highest priority and are considered to be 'endangered', 'vulnerable' or 'rare' and only occur 15 or fewer, 10km squares of the national grid in the UK. Nationally scarce species area also rare and are estimated to occur within the range of 16-100 10km grid squares in the UK. 3 RDB species were recorded from the aquatic sampling, 2 of which are also UKBAP species and 4 nationally scarce species. 2 nationally scarce soldier flies and 2 other nationally scarce species were recorded from the terrestrial searches. In terms of flying invertebrates, the RDB Norfolk Hawker dragonfly (*Aeshna isosceles*) were also recorded and this species and its breeding habitat is also protected under Schedule 5 of the Wildlife and Countryside Act (1981).

9.4.46 Rare or scarce species were recorded from 23 of the 65 ditch samples. These were located along much of the length of the road, to both the north and south. However, the area between Tunstall Dyke and Acle, especially south of the road within the Damgate Marshes, contains a particularly important invertebrate fauna, including RDB species not found elsewhere.

This is thought to be due to a combination of factors including the particular peaty conditions in the dykes in this area. The Invertebrate Site Register (ISR) system was used to allocate points to sites with rare species (Nationally Notable A and Red Data Book). Most ditch samples with an ISR score occurred on sites with low conductivity, high clarity and high habitat quality scores. However, the maximum scores for Category 1 (high quality) ditches were greater than for Category 2 ditches of lower habitat quality.

9.4.47 It should be noted that the previous invertebrate survey (Green, 1996) recorded 20 scarce species not recorded in 2003 and an additional 2 RDB species. The results of the 2003 survey indicate that there may have been some losses of species typical of brackish conditions in the intervening period due to an eastward extension in predominance of freshwater communities.

Winter Birds

9.4.48 The full results of the winter bird survey are scheduled in the stand-alone report. 69 of the 109 bird species recorded during the current survey have some designation or conservation status:

- 16 species protected under Schedule 1 of the Wildlife and Countryside Act (1981, amended 1985): Bewick's swan, marsh harrier, hen harrier, merlin, peregrine falcon, avocet, ruff, black-tailed godwit, green sandpiper, barn owl, kingfisher, fieldfare, redwing, Cetti's warbler, bearded tit and Lapwing bunting.
- 4 additional species protected under Annex 1 of the EU Birds Directive (79/409/EEC): little egret, white-fronted goose, golden plover and short-eared owl. These are rare migratory and other species of bird whose habitat is protected in SPA's.
- 14 species listed on the Birds of Conservation Concern (BoCC) Red List[50]: hen harrier, grey partridge, black-tailed godwit, lesser spotted woodpecker, skylark, song thrush, marsh tit, starling, house sparrow, linnet, twite, bullfinch, yellowhammer and reed bunting. These are species whose breeding or wintering population has decreased and / or whose breeding or wintering range has declined by 50% or more in the preceding 25 years.
- 47 additional species recognised on the BoCC Amber List[51] . These are species whose breeding or wintering population has decreased and / or whose breeding or wintering range has declined by 25% - 49% in the preceding 25 years.

[50] The Population Status of birds of the UK and Isle of Mann: an Analysis of Conservation Concern, Gregory et al, 2002

[51] The Population Status of birds of the UK and Isle of Mann: an Analysis of Conservation Concern, Gregory et al, 2002

- 6 species listed as UK Biodiversity Action Plan (BAP) Priority Species including grey partridge, skylark and song thrush, which are specifically listed on the Norfolk Biodiversity Action Plan.
- The survey indicated that six of the above species are present in the study area in sufficient numbers (exceeding the 1% national wintering population threshold) to be, or to be on the verge of being, nationally important (Bewick's swan, white-fronted goose, wigeon, avocet, golden plover, ruff). Also pink footed goose is present in internationally important numbers, with internationally important numbers of pintail recorded on one occasion.

NOTE: Whilst some birds were not found in sufficient numbers within the A47 study area to meet the 1% population criteria, they still contribute to the wintering bird assemlages of national and international importance within the Broadland and Breydon Water SPA / Ramsar sites.

9.4.49 Distribution maps of these significant species are included in the winter bird report and the distribution pattern determined by the 2003 survey is summarised below:

- Bewick's swan was only found in large flocks in discrete areas including fields either side of Halvergate Road to the south of the A47 and fields to the north of the River Bure and Scaregap. Few birds were noted close to the A47.
- Pink-footed goose was found in internationally important numbers in locations east of Halvergate Road, particularly south of the railway and also to the north of the A47 (often within 100m of the road), immediately west of Scaregap footpath.
- White-fronted goose were found in nationally important numbers amongst flocks of pink-footed goose, to the east of Halvergate Road and south of the railway.
- Wigeon were found in nationally important numbers at Breydon Water, with smaller numbers using grazing marsh to the west of Breydon Junction.
- Pintail were limited to Breydon Water only, generally at high tide in the eastern part of the estuary.
- Avocet were limited to the eastern end of Breydon Water at high tide.
- Golden plover are distributed in varying numbers in the A47 study area, often with moderately large numbers of lapwing. Peak numbers were found south of the A47 and railway to the east of Halvergate Road, the Scaregap area on both sides of the road and in fields to the immediate north of the road near Breydon Water.
- Ruff frequented the grazing marsh on both sides of the A47, in nationally important numbers, amongst flocks of golden plover and lapwing.

9.4.50 Other notable species included marsh and hen harriers, which were noted hunting throughout the study area. Merlin and peregrine were less frequent and tended to frequent the Breydon Water area. Barn owl was noted on 8 occasions during the winter bird survey, mainly in the Damgate Marshes area to the south of the A47. Observations of barn owl hunting close to the A47 were also made in the Halvergate Road and Kerrison's Level area and a road casualty barn owl was found to the west of Tunstall Dyke.

9.4.51 Sightings of Cetti's warbler were concentrated in 3 locations at the River Bure east of Acle Dyke; either side of the A47 in the Weavers Way area at Acle Carr and the River Bure to the east of the Pontiac Roadhouse (Stracey Arms). Bearded tit was found in small numbers along the River Bure wherever reedbeds occurred.

9.4.52 The existing road influence the location of wintering birds and few were noted within the 50m of the road. There were generally low numbers recorded in the corridor between the road and the railway.

Breeding Birds

9.4.53 Of an overall total of 92 species recorded within the study area during the breeding bird survey, 53 were confirmed to be breeding or holding territory and this equates to a breeding bird assemblage of regional importance. The following 26 of these breeding species are either statutorily protected or of conservation importance:

- 4 species protected under Schedule 1 of the Wildlife and Countryside Act (1981 amended 1985): hobby, barn owl, Cetti's warbler and bearded tit.
- 1 additional species protected under Annex 1 of the EU Birds Directive (Directive 79/409/EEC): common tern. These are rare migratory and other species of bird whose habitat is protected in SPA's.
- 7 species listed on the Birds of Conservation Concern (BoCC) Red List[52] grey partridge, skylark, song thrush, linnet, reed bunting (all also UK BAP species), grass hopper warbler and house sparrow. These are species whose breeding or wintering population has decreased and / or whose breeding or wintering range has declined by 50% or more in the preceding 25 years.
- 14 additional species listed on the BoCC Amber List[53]: mute swan, shelduck, kestrel, oystercatcher, lapwing, redshank, swallow, meadow pipit, yellow wagtail, dunnock, blackbird, mistle thrush, willow warbler and goldfinch. These are species whose breeding or wintering

[52] The Population Status of birds of the UK and Isle of Mann: an Analysis of Conservation Concern, Gregory et al, 2002

[53] The Population Status of birds of the UK and Isle of Mann: an Analysis of Conservation Concern, Gregory et al, 2002

population has decreased and / or whose breeding or wintering range has declined by 25% - 49% in the preceding 25 years.

9.4.54 The breeding population of Cetti's warbler and common tern in the study area, are considered to be of national importance, with populations of hobby, barn owl, bearded tit and grasshopper warbler considered to be of County importance. Breeding populations of grey partridge, skylark, linnet and reed bunting are considered to be of district importance , with those of song thrush and house sparrow of only parish level importance.

9.4.55 The remaining 39 non-breeding species included those that may be breeding close to the study area, birds on passage and those that were simply flying over the study area. The following 26 of these are either statutorily protected or of conservation importance:

- 5 species protected under Schedule 1 of the Wildlife and Countryside Act (1981 amended 1985): marsh harrier, hen harrier, avocet, whimbrel and kingfisher.
- 5 additional species protected under Annex 1 of the EU Birds Directive (Directive 79/409/EEC): little egret, golden plover, green sandpiper, short-eared owl and lesser grey shrike.
- 5 species listed on the BoCC Red List: turtle dove, bullfinch (both also UK BAP species), ring ouzel, starling and yellowhammer.

9.4.56 Whilst the importance of the study area is well established, it is also considered that If some of the above species found on site were verified as breeding in subsequent years, the study area may qualify as a site of national importance for its Lowland Damp Grassland breeding bird assemblage.

Otters and Water Voles

9.4.57 The survey has revealed no definite otter holts within the study area although an otter holt within 500m of the existing road (unknown location) has been reported to English Nature by a confidential source. The survey indicated current use of the study area by otters and identified two spraint (defecation) sites directly associated with the A47. Available records for the area include evidence of otters on the lower stretches of the River Bure and two recent road deaths on the Acle Straight. A recent east of England study on otters[54] identified the Acle Straight as one of two trunk roads in the region which is causing significant severance to otter populations.

9.4.58 The Broads river systems are considered to be a stronghold for otters. It is therefore considered reasonable to assume that use of the study area by otters is likely to continue in the future.

[54] East of England otter study, Norfolk Wildlife Services, 2003

9.4.59 Water voles were identified on 63% (131 out of a total of 207) of the ditch sections within the study area. A total of 148 water vole burrows, 651 territorial latrines and 1,256 feeding stations were recorded within 50m of the existing road. Standard calculations give a provisional population of 450 water voles within this area[55]. Particular concentrations of water voles were noted on the southern side of the A47 in the area to the east of Pontiac Roadhouse (Stracey Arms) and around Scaregap (mainly to the north of the road). It should be noted that many of the higher concentrations of water voles were found in relatively botanically poor ditches, including some brackish water courses. This is contrary to usual water vole habitat requirements.

9.4.60 The Broads grazing marshes are considered to provide a current stronghold for water voles in Norfolk (Henson 2003)[56], and the extensive nature of the habitat combined with the high density of watercourse renders the area of particularly high potential for water voles. Water vole populations in the study area should probably be viewed as part of a larger population inhabiting the Halvergate Levels Yaxley, R 1997)[57].

Bats

9.4.61 The study area has a general lack of suitable bat roosting sites, as the landscape lacks significant tree cover and there are few suitable buildings. Only one veteran willow, two railway bridges and 2 small groups of buildings in the study area were regarded as having medium potential for bats, with no likely nursery roosts and only two suitable sites for winter roosts, due to the exposure to winds within the study area. The potential for significant roosts is therefore believed to be minor in areas likely to be directly affected by the road, although there may be minor undetected roosts.

9.4.62 Emergence surveys undertaken around the above structures indicated the presence of Whiskered/Brandts, Natterers, Daubentons, Serotine and Pipistrelle 45 Kilo-hertz (kHz) type and Pipistrelle 55 kHz type bats feeding around the structures. It was considered that these bats were foraging in the general area rather than emerging from the structures themselves.

9.4.63 Transect survey also revealed general bat activity within the study area, similar to other grazing march bat communities, as follows :

- Whiskered / Brandt's: the two species occurred relatively frequently in areas where trees or scrub occur close to water.

[55] (Preliminary Report on the Changes in the Water Vole population of Britain as shown by the National Survey of 1989 – 1990 and 1996 – 1998. Strachan, C et al, 1000)

[56] Henson, S (2003) Water vole and otter status and distribution in Norfolk (unpublished material for the Norfolk Wildlife Trust)

[57] Report of the Norfolk water Vole Survey, Environment Agency Eastern Area. Norfolk Wildlife Trust,

- Natterer's: sporadic occurrence with a large number of registrations on a single night foraging amongst trees along the River Bure at the Pontiac Road House.
- Daubenton's: widespread along dykes especially in connection with the River Bure and the ponds at Breydon.
- Serotine: sparce occurrence in a number of habitats.
- Noctule: extremely rarely found in the study area with only a single record close to Scaregap Farm, in open farmland.
- Pipistrelle: both 45 kHz type and 55 kHz type Pipistrelles are relatively frequent and widespread, although the 55 kHz type outnumbered the 45 kHz type on all transects. The 55 kHz type Pipistrelles were generally associated with dykes, lanes, ponds, shelter belts, hedgerows and buildings. There was a particularly high concentration of 129 55 kHz type Pipistelles along the dykes adjacent to the Pontiac Road House on one occasion. Nathusius' Pipistrelle was not recorded.
- Barbastrelle: no records within the study area.
- Brown long eared: no records but due to the difficulty of recording this inaudible species it may be present foraging in small numbers within some of the woodland areas.

Badgers

9.4.64 The badger survey indicated no active or disused badger setts in the study area. There were no other signs of badger activity such as latrines, foraging marks, prints or hairs. It should be noted that whilst no available records relating to badger activity were made available to us, informal consultation with NBRC indicated a badger mortality at the Acle end of the road in recent years. No further information or verification is available but it is likely that this road mortality related to a single male badger exploring for expansion territory or foraging out of area in the alder carr woodland. This is not thought to be significant.

9.4.65 The habitats within the study area are not generally speaking, suitable for badgers. The major areas of woodland are wet carr woods, which are unsuited to sett establishment. The River Bure forms an effective barrier to badger movement and the network of substantial ditches throughout the study area and the railway running parallel to the southern side of the road (which is fenced both sides), both form partial barriers.

Other Mammals

9.4.66 There are small rabbit and fox populations, mainly associated with scattered areas of woodland, scrub and hedgerow in the study area. Low population levels of brown hare (UK BAP species) were noted throughout the study area, mainly utilising the extensive areas of grazed pasture and ditch bank vegetation.

Reptiles and Amphibians

9.4.67 Very few ponds are present in the study area and the majority of these are heavily saline. No records of the legally protected great crested newt occurred in the study area during the survey and NWT indicate that there are no known existing records of great crested newts in the study area. These appear to be almost entirely absent from Broads Natural Area (one of a series of 120 Natural Areas into which the country has been subdivided by English Nature)[58]. No response to requests for great crested newt records was received from Norfolk Biological Services.

9.4.68 The survey indicated that grass snake populations are present at low densities within the study area, mainly within the areas around Damgate Marshes and Tunstall Dyke. Low densities of common lizard also occur within the study area, in linear areas of habitat alongside farm tracks, along railway lines and within wide road verges. A brownfield site at the eastern end of the study area near Great Yarmouth, consisting of derelict railway sidings, flood banks and bounded by a railway line and wide verges of the existing A47, appears to hold a significant area of lizard habitat. Slow worms were not recorded during the survey and no response to requests for great crested newt records was received from Norfolk Biological Services.

Overall Evaluation of Nature Conservation Value.

9.4.69 Table 9.5 below summarises the nature conservation value for each of the biodiversity features described above. These have been developed in accordance with the measures indicated in Table 9.1.

Table 9.5 Nature Conservation Value of Features

Feature	Value
Broads cSAC (incorporating Damgate Marshes SSSI	Very High
Broadland Ramsar (incorporating Damgate Marshes SSSI)	Very High
Broadland SPA	Very High
Breydon Water SPA and SSSI	Very High
Breydon Water Ramsar and SSSI	Very High
Halvergate Marshes and Decoy Carr SSSI	High
River Bure	Lower
General Grazing Marsh	Lower
Other Habitats	Lower
Breeding birds	High
Wintering birds	Very High
Dyke Vegetation	Very High
Invertebrates	High

[58] Natural Areas Programme, English Nature 1998

Otters	Very High
Water voles	Medium
Bats	Lower – (no roosts)
Badgers	Lower
Reptiles	Lower

9.5 Predicted General Impact and Mitigation

9.5.1 In this section the potential effects of the proposed Option 2 and 2A dual lane improvement schemes are discussed in general terms. Sections 9.6 and 9.7 give a more detailed impact assessment and recommendations for mitigation measures on a site and species specific basis. Sections 9.6 and 9.7 also include a final assessment of residual impacts based on the incorporation of mitigation measures, using standard environmental assessment procedures.

9.5.2 When considering the effects of construction and also the ongoing operation of the improved scheme it is important to note that the existing A47 currently influences the movement patterns and habitat distribution of all the communities of plants and animals and individual species in its vicinity.

9.5.3 Whilst it is acknowledged that there are particular problems associated with the existing A47, including habitat fragmentation, severance and mortality of some mobile species, some biodiversity interests in the area, for example birds, reptiles and water voles, have also over time, adapted themselves to accommodate the impact of the existing road. For example, the road verges are used by reptiles and water voles and birds have to some extent become used to the visual and other operational impacts of the existing road. In addition the relatively recent construction of the existing road (in the 19th century) was directly responsible for the creation of over 14km of roadside dykes, now supporting flora and fauna of international, national and regional ecological importance (see Figures 9.2 and 9.3 Ecology and Nature Conservation Constraints Plans).

9.5.4 The aim of the current study is to identify where and to what extent the proposed improvement schemes would exert further adverse impact or potential beneficial effects on the ecological interests of the study area. The schemes have been designed to incorporate a number of specific measures to mitigate against potential ecological impacts and in some cases to reduce the extent of existing adverse impact. Further means of mitigating potential, identified impacts are set out below, together with proposals for providing compensatory habitat of potential long term ecological benefit.

9.5.5 Sources of additional impact may result from :

- Direct land take;
- Construction phase effects – noise, lighting, material pollution and timing; of operations;
- Operational severance (habitat fragmentation) and mortality of fauna;
- Other post construction effects - habitat degradation, operational noise, lighting, pollution and ensuing effects on water quality, drainage and land management.

General Impacts - Direct Land Take

9.5.6 Chapter 2 contains a detailed description of Options 2 and 2A. The implementation of the dual-lane options involve retention of the existing road as one carriageway and provision of a new carriageway constructed on a separate embankment with Option 2 and on a widened embankment with Option 2A (see Figure 2.2). The central reservation in Option 2 would be 8m wide and contain the existing, retained roadside dyke. This dyke would be lost with Option 2A, which would have a narrow 2.5m wide central reservation. A replacement roadside dyke would be constructed on the new highway boundary with Option 2A and a similar new ditch would provide an additional third roadside dyke with Option 2. With both options the new carriageway would be provided on the north side of the existing road to the west of Halvergate Junction and on the south side to the east of Halvergate Junction. With Option 2 most existing embankment slopes would be regraded resulting in loss of existing grass and woody vegetation. The exception to this would be the southern slope to the west of Halvergate Junction. With Option 2A the retained embankment slope would be regraded to the east of Halvergate Junction but would remain intact between Halvergate Junction and Acle.

9.5.7 Access tracks along both sides of the major part of the route would be provided in order to consolidate field and propertyaccess. These would be simply constructed with minimal earthworks and they would have a granular unsealed surface.

9.5.8 Direct land take is greater for Option 2 than Option 2Abecause the overall width of the road corridor is greater. The major part of the land loss for both options consists of grazing marsh under pastoral use (some 32 ha for Option 2 and 23 ha for Option 2A) but also includes land under arable production, improved grassland under hay/sileage production and non agricultural land. Whilst the losses are cumulative along the route, there would not be significant adverse effects in any particular locations. There would be localised land take within the Broads cSAC and Ramsar site.

9.5.9 Localised additional widening would occur at lay by points, at a proposed roundabout at Halvergate Junction and at 6 access track junctions.

9.5.10 Loss of dyke is considerably more extensive with Option 2A than Option 2 because one of the roadside dykes would be lost along the entire route lengthresulting in a total loss of approximately 11000m of dyke. In Option 2 would result in localised loss and replacement of roadside dykes associated with the junctions and other specific additional widening points and culverting of perpendicular dykes crossed by the new embankment. It is estimated that in total some 4000m of roadside dyke would be lost. In both options a new dyke would be provided along the entire length of the route. In Option 2 some 12000m of new dyke would be provided as part of the scheme resulting in a net gain of 8000m and in Option 2A, some 10500m of new dyke would be provided resulting in a net loss of 500m.

9.5.11 With both dual options the dyke on the southern side of the road between Acle and Halvergate Junction has been retained. This is the most ecologically sensitive section of roadside dyke in the study area and includes the major part of the scarce water soldier population and the highest concentration of other important rare and scarce species of flora and invertebrate fauna.

9.5.12 Neither of the dual options would require use of the access tracks for diversion routes during the construction period. It is currently proposed that the northern access track is used as concessionary routes for non-motorised users post-construction with additional path links proposed to connect the tracks with Acle Roundabout and Vauxhall Roundabout.

9.5.13 During the construction phase any site or storage compounds would be located outside the ecologically sensitive area administered by the Broads Authority. Their precise location cannot be determined at this stage and if the project proceeds further they would be the subject of a separate planning application, therefore they have not been considered further in this chapter..

General Impacts – Construction Phase

9.5.14 The most significant construction phase effect is the risk of polluting the retained ditches adjacent to the scheme. Even with very stringent procedures to avoid water contamination the risk must be considered high due to the close proximity of retained water-courses and the confined working area. Slight increased effects on the water quality of roadside dykes, is unlikely to significantly effect more robust aquatic species such as water voles, otters and grass snakes and those less specialist species of flora and invertebrate fauna of wide tolerance range. However, even slight fluctuations in salinity, sediment, or other aspects of water quality may affect those rare and scarce species of aquatic and emergent dyke flora and aquatic invertebrate fauna, thought to be particularly sensitive to environmental change. Such species may be existing on the limit of their range in this part of the UK. It appears that there is currently insufficient species specific knowledge to ascertain the full impact of scheme proposals on the rare and scarce species of flora and invertebrates. As it is uncertain

whether any potential impacts can be fully mitigated against, it is necessary to assume the 'worst case scenario' with respect to these species.

9.5.15 Direct effects on roadside and perpendicular dykes would result from bridge/culvert construction, removal of existing dykes and connecting new dykes. At these locations there would be enhanced potential for abnormal levels of silt and the influx of other accidental contaminants to damage habitats, through smothering, limited oxygen supply and disruption of the existing nutrient / chemical balance.

9.5.16 Noise, light, visual and possible aerial and runoff pollution disturbance during construction is intrinsically greater in Option 2 than Option 2A, due to the greater extent of construction works and longer construction period (22 months for Option 2A and 28 months for Option 2). However, neither of the dual options would necessitate night time working.

9.5.17 Effects on biodiversity during construction are described further in chapter 14 of the report.

General Impacts – Operational Severance and Mortality

9.5.18 Both the dual options have the potential to exert considerably higher levels of mortality and other operational severance including prevention of cross road transfer, because of the increased width of carriageway. A number of measures have been built into scheme proposals in order to negate some of the existing and potential adverse impacts at the design stage. These include re-establishing a number of collapsed culverts under the existing A47 where water connectivity remains between the dykes on each side of the existing road embankment. Elsewhere otter underpasses would be provided at a minimum spacing of 500m to re-establish linkages for animals which were severed when the road was built in the 19th century.

9.5.19 The decision was taken not to increase the overall number of dyke connections under the existing embankment but to provide 'dry' otter underpasses (subject to detailed design). Any additional culvert links would have generally provided some benefit to otters, water voles and grass snakes However the effects of significantly increasing the connectivity of the existing network of dykes over the existing situation, are unknown in terms of impact on water quality and water flow with potential adverse effects on the sensitive dyke flora and invertebrate fauna.

9.5.20 Post-construction, the operational speed limit on both Options 2 and 2A would be 70mph (compared to 60mph existing and 50mph do-minimum). This increased speed limit would potentially increase mortality of fauna and severance effects compared to the 'do-nothing' situation.

General Impacts – Other post-construction effects

9.5.21 The dual carriageway proposals would result in a moderate increase in traffic flows compared to the do-minimum situation and traffic speeds would increase to 70mph. This would not result in a corresponding increase in air pollution, most local receptors would experience the same levels of pollutants or very slightly more compared with the do-minimum situation and at all receptors levels would be lower than the existing situation (see Chapter 11). Options 2 and 2A would result in small increases in noise compared with the do-minimum situation (see Chapter 12). However these small increases would be gradual and initially the use of a low noise surface would reduce noise levels. The new carriageway would extend noise levels further into relatively undisturbed habitat, for example traffic would be closer to Breydon Water which is an important area for wintering and breeding birds.

9.5.22 Water quality and drainage issues are important considerations with respect to biodiversity in this area of grazing marsh as many of the ecological interests depend on wetland or aquatic habitats. However pollutants from road runoff are not considered to be a significant problem with the existing road. For both dual options, the carriageways would have crossfall drainage, with all runoff from each respective carriageway draining to just one adjacent dyke on the outside boundary. Potential runoff pollution would thus be split between the two external roadside dykes. Whilst increased traffic flow would result in corresponding increases in vehicular derived pollutants, in the dual options the additional extent of carriageway surface would result in increased dilution of the runoff. Generally, therefore, increased pollutant would be countered by increased dilution and this would have the effect at most times of the year, of relatively clean runoff entering the roadside dykes and local reductions in intrinsic dyke salinity.

9.5.23 In the context of dyke habitat the main water pollution issues would be localised and would relate to Gasoline Range Organics (GRO's) and de-icing salts. The former may be a problem during cold weather conditions when they do not evaporate and can enter and remain on the ditch water thus harming susceptible aquatic plants and invertebrates. De-icing salts used on the road could lead to greater fluctuations between saline and freshwater conditions, which could also adversely affect some sensitive invertebrate or aquatic plant species. The increased traffic would result in a small overall increase of GRO's within the system, although they would be locally more dilute. The increased area of carriageway would result in increased total quantities of salt being applied during cold weather but this would be insignificant in the context of the maritime location and dilution levels in runoff would remain constant. Overall the proposals would result in similar fluctuations in salinity to the existing road but the effects would extend over a greater area than at present due to increased land take.

9.5.24 There is an increased potential risk of pollution from spillage which could affect both surface and ground water, due to slight increases in volume of

road runoff and predicted increases in traffic flow. This would be addressed through the provision of sluices or stop logs to enable isolation of any length of ditch contaminated by accidental spills and represents an improvement over the existing situation.

9.5.25 Slight increased adverse effect on the water quality of roadside dykes as a result of implementation of the scheme, is unlikely to significantly impact on more robust aquatic species such as water voles, otters and grass snakes and those less specialist species of flora and invertebrate fauna of wide tolerance range. However, even slight fluctuations in salinity fluctuation, sediment, GRO levels or other aspects of water quality (which may occur following high rainfall events, prolonged dry periods or following freezing weather conditions), may affect those rare and scarce species of aquatic and emergent dyke flora and aquatic invertebrate fauna, which are thought to be particularly sensitive to environmental change and may be existing on the limit of their range in this part of the UK. It appears that there is currently insufficient species specific knowledge to ascertain the full impact of scheme proposals on the rare and scarce species of flora and invertebrates. As it is uncertain whether any potential impacts can be fully mitigated against, it is necessary to assume the 'worst case scenario' with respect to these species, until such time as it may be proved that these worst case effects may be unfounded.

9.5.26 Hydrological issues are complex in the study area and dictated to a large degree by the pumping regime and agricultural management of the surrounding land (see Chapter 7). There is currently a complicated water management system of infra-structure on the marshes. This is generally considered by informed parties to be inadequate to maintain high water levels in the marshland, due to water supply being out-stripped by evapo-transpiration and exacerbated by leakage to arable areas where water levels are lower. This matter is currently being independently investigated by the IDBs and as discussed in chapter 7, proposals have been set out to address the problems. In this context, it is not predicted that any effects of Options 2 or 2A would exert any significant impact on the overall hydrology of the grazed marshes. It is expected however that there would be localised changes in flow patterns and increases in runoff resulting from the scheme which would generally be dealt with by additional pumping capacity to maintain water within the dykes at existing levels. This would be discussed and agreed with the relevant consultees.

9.5.27 The proposed crossfall drainage scheme would result in the dyke retained within the central reservation in Option 2 not receiving any road runoff and it would effectively be starved of water. This represents a potentially major localised hydrological change.. In Option 2A one of the existing roadside dykes would be lost and a new replacement dyke would be created along the entire length of the route. This would initially represent a major change, but once re-established, the overall hydrological situation would be similar to the existing situation, although there may be small localised changes to flow patterns and hydrology.

9.5.28 The effects on land management are described in Chapter 4. There is potential for the road improvements to result in changes in the management of some areas of land adjoining the road due to reduction in field / holding size, severance, increased distance / travelling time for access or in some cases, facilitated access. This could potentially lead to abandonment or amalgamation of fields / land holdings, loss of dykes, and / or changes in management from arable to grazing or grazing to hay / sileage production. Any changes in land management may have the potential for corresponding changes to the ecology of the drained marshland area.

9.5.29 The possibility of the proposals leading to some change in land management was identified particularly in the area to the east of Halvergate Junction on the north side of the road. This results from problems of access to holdings arising from both the dual carriageway proposals. However this problem could be resolved by relatively minor changes to the design of the access tracks to the east of Halvergate Junction (see Chapter 4).

General Mitigation - Measures incorporated in Scheme Design

9.5.30 The scheme description in Chapter 2 includes a number of important measures already adopted as part of the scheme, to mitigate against potential effects on biodiversity. These measures aim in general terms to minimise disturbance to the overall integrity of the grazing marsh system and its valuable ecological components.

9.5.31 The provision of a full time, on-site Environmental Manager (EM), supported by an environmental clerk of works and other environmental specialists, for the duration of the construction period, is considered to be a necessity for a construction project within a site of high ecological sensitivity, such as this. The EM would be responsible for producing an Environmental Management Plan (EMP) in advance of the works, which would include all standard and additional mitigation, monitoring and management operations required to ensure that any identified adverse effects on biodiversity features are minimised. This would set out a complete plan of management for all dykes under Highways Agency control and would detail the standard 'Best Practise' procedures to minimise impacts of road construction. The EM would be responsible for liaison with English Nature and the other stakeholder consultees and for the briefing and supervision of all contractors in relation to the ecological interests of the area and the extreme importance of pollution control.

9.5.32 Other specific measures already incorporated in the scheme design include the deliberate exclusion of the site compounds, including all material and equipment storage areas from the area administered by the Broads Authority.

9.5.33 All replacement dykes would be created before the existing dykes are isturbed, to facilitate habitat creation by translocating aquatic communities from the sections of dyke to be lost. The timing of dyke creation is discussed in additional measures below.

9.5.34 Those sections of dyke running perpendicular to the road which are to be crossed by the access tracks, would be bridged to allow free flow of water and growth of vegetation below the bridge, rather than culverted. This is particularly important in the Damgate Marshes area and other sections of dyke identified as supporting national or internationally important communities of aquatic flora or invertebrates.

9.5.35 Long term maintenance of the roadside ditches, verges and other Highways Estate, would be the responsibility of the Highways Agency. This provides the opportunity to ensure that conservation management regimes (including sympathetic de-silting, cutting of riparian vegetation and litter clearance etc), are implemented to help improve the biodiversity value of these important habitats. This ability to manipulate the management regime would aim to indirectly off-set any potentially adverse effects resulting from changes in road runoff characteristics. A complete plan of management of all dykes remaining under the final Highways Agency control would be drawn up in consultation with the relevant IDBs, English Nature and land owners. It would include flow regimes, maintenance by dredging, water level control and bankside management and would be completed before any construction commences and

9.5.36 Mitigation measures to deal with water quality are described in Chapter 2 and further measures are indicated in Chapter 7. The outlets to all existing and replacement lengths of roadside dykes which would receive runoff from the improved road, would incorporate a combination of high level outlets (weirs) to retain silt and lower level outlets (hanging wall or low slot weirs) to retain oils etc. The low weir arrangement would have provision to close the outlet using stop logs or penstocks and would provide containment in the local section of roadside ditch in the event of a major spillage. This would prevent spread of polluted receiving waters along the length of the roadside dyke and into the wider dyke network and is an improvement over the existing situation. Such measures to contain liquids following an accident involving a major petrol, diesel or chemical spillage into the dykes are described fully in section 7.6. and would be particularly critical where the dykes are located in or feed into areas designated for their national and international importance such as Damgate Marshes.

9.5.37 The use of vegetative filter beds to attenuate dissolved and sediment borne pollutant runoff (particularly useful for treatment of first flush pollutants after heavy rainfall events) has also been identified as a mitigation measure in Chapter 7. These would be provided to all new lengths of roadside dyke and to any existing ditches where provision could be made without harming existing ecological habitat. However such linear vegetative 'filter beds' would, significantly affect the potential botanical value of roadside ditches

and such proposals would preclude any possibility of maintaining or establishing nationally or internationally important aquatic communities, due to their intrinsically overgrown nature. These filter beds would therefore have to be provided in addition to ditches for nature conservation habitat. In Option 2, if the potential problems of retaining the existing ecological interests in the central reservation dyke (as discussed above) prove to be difficult to resolve, a possible alternative option is to convert the retained central dyke into a linear reed bed. This would require changes to the current crossfall drainage proposals.

9.5.38 Any increased runoff resulting from the scheme would be dealt with by additional pumping capacity, to maintain water levels in the dykes at existing levels.

9.5.39 Inert construction materials would be used for new embankment and widening of the existing embankment as well as construction of the access tracks. This would reduce any potential impact resulting from possible leachates entering the dykes. Agreement with respect to acceptable levels of leachates would be achieved with the Environment Agency.

9.5.40 The road lighting has been designed to minimise impact on biodiversity features within the study area. In Options 2 and 2A, lighting does not extend beyond the existing linear extent of highway lighting although there would be an increase in the number of light standards due to the increased area of carriageway to be lit. Full cut off lamps would be installed to reduce sky glow and the level of light spillage to areas of habitat adjoining the road and overall there would be an improvement over the existing situation.

9.5.41 Collapsed culverts with existing water connectivity would be reinstated and elsewhere, otter underpasses would be provided at a minimum spacing of 500m to re-establish linkages for animals that were severed when the road was originally built. The existing and reinstated culverts would be extended to accommodate widened embankment where necessary. This is an improvement over the existing situation. It should be noted, however, that whilst the underpasses would be designed and constructed in accordance with current guidelines as far as possible, due to the low embankment height restrictions, there is currently some doubt whether it would be possible to achieve dry underpasses that fully complied with the recommended height (600mm) .

9.5.42 In Option 2A, single lengths of culvert would be used to cross the entire carriageway system (approx 30m). In order to encourage use by otters the underpasses should be as straight and large as possible.

General Mitigation – Background to Identifying Additional Measures for Operational Phase

9.5.43 It is recognised that the ecological interests of the study area are complex and involve a variety of different sites, communities, rare and scarce and other species of international, national and regional importance. These varied interests, whilst currently co-existing in the study area, have diverse and sometimes conflicting habitat requirements. It should also be noted that the existing A47, already exerts significant impact on the ecological interests of the area, to which there has been a general degree of adaptation over the years.

9.5.44 It is therefore important that additional mitigation measures aimed at enhancing ecological interests, do not inadvertently disturb the current status-quo. In general terms, the maintenance of the ecological integrity of the existing dykes is considered of paramount importance. It is also necessary, given the variation in importance of the different components of the ecosystem, that priority is given to those features which are considered to be of greatest importance. Therefore priority should be given to those features for which this particular part of the Broads grazing marsh environment is considered unique i.e. the dyke flora and invertebrate fauna. The habitat requirements of breeding and wintering birds are also of primary importance, followed by otters and to a lesser extent bats, water voles and reptiles.

9.5.45 Therefore, for example, if a potential mitigation measure aimed at enhancing habitat for reptiles or water voles, such as increased dyke connectivity, compromises the favourable status of dyke vegetation or invertebrates, that particular mitigation measures should not be adopted.

9.5.46 Additional site or species specific mitigation measures are discussed fully in the relevant specialist reports and summarised in the subsequent sections of the chapter. There follows a number of more general habitat protection / creation measures that relate to the study area. It should be noted that some measures recommended in the specialist reports include recessing the carriageway, permanent bunding and other large-scale screening along the carriageway have been given careful consideration but have not been taken forward. This is because of other environmental constraints (for example, screening bunds would compromise the ecological value of roadside dykes and other screening methods would have adverse visual impacts with the Broads are of landscape value). Engineering and drainage constraints would also prevent recessing the carriageway. The omission of these particular mitigation measures is not considered to lead to a significant reduction in the overall benefits of the proposed mitigation because the mitigation measures proposed in this chapter deal with the key adverse impacts.

9.5.47 With Option 2 there would be localised losses of roadside dyke (and associated valuable habitat) and complete loss of one roadside dyke with Option 2A. The scheme allows for replacement roadside drainage ditches and mitigation would allow for further dyke provision for habitat creation. This habitat creation would be agreed with English Nature and would concentrate on specific habitat and feeding requirements and also tolerance ranges of particular indicator species that occur in the dykes.

9.5.48 In order to fully inform the design process with respect to dyke retention and the complexities of road drainage, it is recommended that more research is undertaken to identify particular stretches of roadside dyke that are so important that every effort should be made to ensure that the status quo is conserved and managed.

9.5.49 It is recommended that in areas of international importance (in terms of sites or features), there should be a ratio of dyke replacement of 1:3. Elsewhere all other dykes are still of significant existing or potential ecological value and a replacement ratio of 1:2 is recommended. This sort of ratio is considered necessary to provide a margin of safety, as there is a degree of uncertainty regarding the success of new habitat provision, in particular as some new dykes may not become suitable habitat in a short time frame. On this basis it is estimated that for Option 2A approximately 600m of dyke of international importance would be lost and should therefore be replaced by some 1800m of new dyke. In addition, approximately 10000m of other dykes would be lost and these should be replaced by 20000m of compensation dyke.

9.5.50 The scheme design allows for provision of 10500m of new dyke and therefore a further 11500m of new dyke for habitat creation is recommended for Option 2A.

9.5.51 For Option 2 there would be no loss of dyke of international importance (provided that the hydrological issues with respect to the retained central reservation dyke can be resolved) but the remaining 4000m of dyke to be lost should be replaced by 8000m of new dyke. The scheme design allows for provision of 12500m of new dyke, this is excess to the recommended compensation dyke provision, but given the uncertainty over the future value of the central reservation dyke, it is considered appropriate that new dyke provision is generous.

9.5.52 The location of additional habitat creation dykes would need to be agreed with English Nature, the IDB and other interested parties. One possibility is to create new dykes parallel to the existing roadside dykes, on the external edges of the new access tracks (see cross section, Figure 9.3 / 9.4). In order to optimise the potential value of any new compensation dykes, it is recommended that they are located or bridged in such a way to allow

ongoing grazing of the external margins of the roadside dykes and also to allow grazing of both sides of the new dykes.

9.5.53 Due to the complexitiy of the dyke invertebrates plant communities new replacement dykes should be created at least 3 years in advance of loss of existing dykes. This is in order to maximise the opportunity for the new dykes to develop mid and late successional stage communities of flora and fauna, as quickly as possible after removal of the existing seciotns of dyke. There is current uncertainty concerning the likely success of translocation operations, for many rare and scarce species of dyke flora and invertebrates (see dyke vegetation and invertebrates below). It is therefore recommended that in the event of a dual carriageway option being adopted, further research is undertaken on the feasibility of translocating the species that would be affected and to determine whether the 3 year time scale is feasible to achieve satisfactory habitat reinstatement.

9.5.54 Mitigation for the minor losses of lowland grazing marsh should include reconsideration of the access track design. This should aim to reduce lengths of track by stopping tracks at the boundary of the furthest land ownership parcel from its junction with the road rather than at the furthest individual field.

9.5.55 It is also recommended that compensation for the losses of lowland grazing marsh associated with Options 2 and 2A, should include conversion of existing retained arable or improved grassland adjoining the A47. This should preferably be managed to a standard equivalent to tier 3 of the ESA so as to optimise the potential ecological gain. The rate of compensation for loss of grazing marsh should be 1:3 in areas of international importance (i.e. Damgate Marshes) where there is a higher risk of failure in re-creating habitat of similar favourable condition characteristics to that lost. A replacement ratio of 1:1 for loss of other areas of grazing marsh lost to the proposals. These are mostly relatively easily substitutable, species poor, semi-improved grassland but of importance for their relationship to the associated dyke habitat and for supporting wintering and breeding birds. It is estimated that for Option 2 a total of approximately 32ha of grazing marsh would be lost and of this, some 0.5 ha is within Damgate Marshes. This totals some 64.5 ha of compensation grazing marsh habitat requirement for Option 2. For Option 2A, a total of approximately 23ha of grazing marsh would be lost and of this some 0.5ha is within Damgate Marshes. This totals some 46.5ha of compensation grazing marsh habitat requirement for Option 2A.

9.5.56 These areas of grazing marsh compensation are considerably larger than or the single lane options and in this respect if the measures were to be fully implemented there is therefore greater long term potential for beneficial effects. The location of suitable areas of arable / improved grassland conversion should be located in areas adjoining existing grazing marsh, in order to ensure that the ground water / drainage regime is suitable.

9.5.57 The longer term management of retained habitats, would require careful consideration and agreement with English Nature. There is potential for conflict of interest between different species and their diverging habitat requirements, when considering developing specific regimes to optimise micro-habitat conditions for particular species.. In general terms it is necessary for the needs of dyke flora and invertebrate fauna to take precedence over the needs of other species or groups. This is due to the unique and particularly sensitive nature of the dyke habitat in this area. For example, in areas where grazing is not possible, (e.g. the internal banks of roadside dykes), suitable measures may include a specific cutting regime involving specific small scale, rotational items of management could be developed. This would be experimental, by nature and would aim to mimic the effects of grazing by creating open patches of disturbed ground and a variable matrix of vegetation cropping. This would be of potential benefit to dyke flora and invertebrate fauna and could also have incidental benefit on species such as barn owl, by discouraging hunting in the roadside zone. There would, however, be corresponding disadvantages to species currently using the rough roadside vegetation, such as reptiles, bats and water voles. A detailed strategy would be developed to ensure that where possible, all key species under consideration would be able to thrive in appropriate parts of the route corridor.

9.5.58 With respect to Option 2, there are significant potential problems associated with retaining flow in the central retained dyke. The current proposals are for all road runoff to be directed to the external roadside dykes, leaving the internal dyke without a source of water except via reinstated culverts and rainfall. This is unlikely to be sufficient to perpetuate the existing valuable dyke flora and fauna. It is therefore proposed that the crossfall is altered to allow road runoff from at least one carriageway to enter the central dyke. The design of access tracks should ensure that drainage from field continues to feed retained or new external roadside dykes to ensure that water levels and flow are adequate. This is a complex matter and requires further consideration and hydrological study to achieve the optimum solution.

General Mitigation –Additional Measures for Construction

9.5.59 Measures to prevent pollution during the construction period are set out in Chapter 14of this report. Any potential for contamination of ecologically sensitive roadside dykes, could be reduced by the use of containment ditches / plastic liners and settlement lagoons.

9.5.60 It is important to reduce potential impacts on roadside dykes during the construction phase, particularly with regards to the vulnerable roadside dykes retained within the central reservation with Option 2. It is therefore recommended that temporary screens are erected on the sides of all dykes bordering the works, to reduce spray contamination and aerial pollution

9.5.61 Mitigation with both options should include arrangements to ensure adequate access to all agricultural land is maintained at all times so as to enable current land management regimes to continue.

General Residual Impacts - Potential Benefits

9.5.62 On the basis that the mitigation measures already incorporated into the scheme are adopted, with Options 2 and 2A there would be a number of potential benefits over the 'do-minimum' situation. These are:

- reinstatement of some culverts and provision of otter underpasses, with the potential to enhance connectivity and reduce existing levels of severance;
- provision of cut-off lighting to reduce light spillage;
- road improvements resulting in lower accident rate and less risk of noise and other 'trauma' disturbance and physical disturbance to the soft highway estate;
- containment measures to prevent pollution of the surrounding dyke system from accidental spills
- potential for long term conservation management of roadside dykes and other 'soft' road estate.

General Residual Impacts - Potential Adverse Effects

9.5.63 Notwithstanding the above benefits, there are significant general impacts on ecological considerations that would not necessarily be negated by implementation of either the incorporated or the recommended additional mitigation measures. These 'worst case scenario' residual impacts for Options 2 and 2A are:

- Losses of valuable dyke communities of flora and fauna on the assumption that translocation/habitat creation would not succeed and/or hydrological change would significantly affect the existing habitat conditions. This primarily results from direct land take and also in Option 2 the adverse hydrological changes to retained (central reservation) dyke habitat.
- Possible changes to water quality/drainage characteristics of dykes as a result of changes to road runoff characteristics and resulting impacts on dyke flora and fauna.
- Localised losses of land within the Broads cSAC and Ramsar site;
- Significant losses of grazing marsh habitat.
- Possible land management changes (although some potential benefits of abandonment of small parcels of land for reptiles, water voles, otters and birds).

- Noise and light disturbance and water pollution during construction. Whilst these impacts would be temporary in duration, water pollution may have permanent effects on sensitive dyke communities.
- The significantly increased width of road corridor and speed limit would result in potential increases in mortality of fauna, other severance and disturbance effects.

9.6 Site Specific Assessment of Impact and Mitigation Measures

9.6.1 In this section the potential effects of Options 2, and 2A are discussed in detail for each of the designated areas and other habitats of biodiversity significance. The schemes have been designed to incorporate a number of specific measures to mitigate against potential ecological impacts and in some cases to reduce the extent of existing adverse impact. Further means of mitigating identified impacts are set out below, together with proposals for providing compensatory habitat of potential long term ecological benefit. A final assessment of residual impacts is then based on the incorporation of mitigation measures, using standard environmental assessment procedures

The Broads cSAC and Broadland Ramsar (Incorporating Damgate Marshes SSSI) - Impact

9.6.2 The access track junction has been deliberately located to the east of the eastern boundary of the designated site. However the construction of access tracks to the south of the existing A47 carriageway would necessitate approximately 4500m^2 in Option 2 of land take from the northern extremity of the Damgate Marshes SSSI, which forms part of the extensive Broads cSAC and Broadland Ramsar. This would be 5000 m2 in Option 2A due to an access track passing place in the eastern part of the SSSI. This land take relates generally to a narrow (4m wide) strip of semi-improved pasture land under grazing management, with one field at the extreme western end consisting of marshy fen grassland. It is not expected that once implemented, the access track would exert significant impact in terms of severance or disturbance. The track would be simply constructed and would only be used by occasional agricultural traffic. The presence of the track would not prevent grazing of the roadside dyke.

9.6.3 Unlike the single lane options in which 90m of roadside dykes, in the extreme eastern part of the SSSI, cSAC and Ramsar, would be lost to accommodate the access track, there would be no such loss of dyke in the dual options. There would, however, be localised losses to 8 dykes running perpendicular to the road alignment for both options, which would need to be bridged (4m width) at each access track crossing point.

9.6.4 Neither of the dual carriageway options would extend any further on the southern side than the existing road and therefore in the operational phase any additional impacts relating to noise, spray contamination, runoff and aerial pollution, would relate purely to any increases in quantity of traffic over time. In both options, the increased speed limit would exert some additional disturbance.

9.6.5 As described in the general Impacts section above, during the operational phase water quality changes in the dyke system surrounding the road, including those in the SSSI, cSAC and Ramsar may be slightly different to the existing situation but the effects would be both subtle and localised. Similarly Options 2 or 2A would not exert any significant impact on the hydrology of the designated site other than to the roadside dyke which would receive a larger volume of surface runoff. This additional runoff would result in a greater amount of freshwater entering the ditch and thus greater dilution of traffic generated pollutants but potentially slightly greater fluctuations in salinity. This ordinarily would not be of concern but in this context very subtle changes could have some effect on the sensitive dyke plant and invertebrate communities.

9.6.6 Probably the main risk to the habitats of local ditches would arise from the construction phase with the potential for contamination particularly from sediments. Such contamination could have long term impacts on the dyke plant and invertebrate communities.

9.6.7 The European priority interests of the cSAC include otter, lake and dyke communities (natural eutrophic lakes), alder floodplain woodland, calcareous fen and nutrient poor ponds. The predicted effects on otters and the floristic and invertebrate interests of the dykes are set out in the relevant sections below). The priority interests of the Ramsar site also include an outstanding assemblage of breeding and wintering wetland bird species and large numbers of rare and vulnerable species of plants and invertebrates. The potential effects on these individual species and assemblages of species would be addressed separately below.

9.6.8 The impacts of the road would be restricted to the northernmost part of the designated sites and although the impacts would be significant they would not affect their overall integrity. The pre-mitigation magnitude of impact of the dual lane options on the designated sites and their European priority features is considered to be Intermediate Negative. This feature has a Very High Value therefore the overall assessment category would be Large Adverse. This is as a primary result of land take and increased disturbance both during and post construction, although in the dual options there would be no loss of dyke within the designated site. This is an advantage over the single lane options. This assessment takes account of the intrinsic effects of the scheme on the priority features using the site, in particular, breeding and wintering birds.

The Broads cSAC and Broadland Ramsar (Incorporating Damgate Marshes SSSI) -Additional Mitigation

9.6.9 Land take within the SSSI, cSAC / Ramsar could be reduced by terminating the proposed access track at the eastern boundary of the land holding located at the eastern extreme of the designated site. This would reduce potential land take and future disturbance but need to be discussed in detail with the landowner before any obligations could be made.It is also recommended that public access is not permitted to the access track within the designated site. This would reduce any potential disturbance by non motorised users.

9.6.10 To reduce temporary disturbance effects during construction the southern side of the road should be screened in the vicinity of the designated site, to reduce potential temporary disturbance effects. This is particularly important during the bird breeding season.

9.6.11 Other mitigation measures relating to individual species / assemblages of species are included in the relevant sections below. The ongoing role of the Highways Agency in dyke management would allow for monitoring of communities of flora and fauna in the roadside dykes within the designated site. This would ensure that conditions in the retained dyke are favourable and where possible optimised, for the rare and scarce species of fauna and flora currently found in the roadside dykes.

9.6.12 Losses of grazing marsh and dyke within the designated sites, should be replaced with new compensation habitat on a 1:3 basis, as described in the general mitigation section.

The Broads cSAC and Broadland Ramsar (Incorporating Damgate Marshes SSSI) -Residual Impact

9.6.13 The negative impact on the designated sites would be reduced, if all the above mitigation measures were to be fully implemented. However the risk of localised contamination during construction and uncertainty of effects on the roadside dyke from increased road runoff water would remain. This would result in reduction of the magnitude of impact to Minor Negative. This feature has a Very High Value therefore the overall assessment category would be Slight Adverse.

9.6.14 Due to the European status of these sites, English Nature would make a decision regarding the need to undertake an appropriate assessment of impact on priority features. As there will be some degree of impact on this site, it is considered likely that there will be a need for Appropriate Assessment.

Broadland SPA – Impact and Mitigation

9.6.15 There would be no direct land take from any components of the Broadland SPA, the northernmost boundary of which lies some 400m to the south of the existing road.

9.6.16 Changes in water quality and flow in the dyke system adjoining the road would be small and localised and would not effect the dyke system within the SPA.

9.6.17 In terms of European priority features, due to the relative distance of the designated site from the road and the intervening railway embankment, which provides a partial screen it is considered that the magnitude of impact of the proposals and overall assessment category would be Neutral. Therefore no additional mitigation would be required.

9.6.18 It is not considered that any additional mitigation is required.

9.6.19 Due to the European status of this site, English Nature would make a decision regarding the need to undertake an Appropriate Assessment of impact on priority features. Due to the lack of a significant adverse impact, it is not considered likely that there will be a need for an Appropriate Assessment.

Breydon Water Ramsar, SPA and SSSI – Impact

9.6.20 There would be no direct land take from Breydon Water and the scheme is physically separated from Breydon water by the Norfolk railway line. However the new southern carriageway would be constructed to the south of the existing road and traffic would therefore be slightly closer to the designated site.

9.6.21 The effects on water quality in Breydon Water would be negligible (see Chapter 7.

9.6.22 The road and low vehicles are mostly screened from Breydon Water by scrub growth on intervening railway land and a linear mound, which borders the Water. However an elevated section of the road at the approach to Vauxhall Roundabout is visible from the Water. The proposals for both dual carriageway options would result in moderate increases in traffic compared to the do-minimum situation. There is therefore potential for increased disturbance from noise, moving traffic and vehicle lights to nationally and internationally important populations of wintering and breeding birds during the operational phase and also during construction. The visual severance effect of the widened road corridor may also be off putting to birds coming into roost on Breydon Water.

9.6.23 The proposals include the provision of full cut off lamps to street lighting, which would reduce sky glow and light spill outside the road corridor and therefore benefit the ornithological European features in this site.

9.6.24 As the ornithological interests are the major European priority feature of this site, it is necessary for the assessment of impact on this site to include impact on breeding and wintering birds. The impacts of the road would be restricted to the northernmost part of the designated site and although the impacts would be significant they would not affect its overall integrity. The pre-mitigation magnitude of impact is considered to be Intermediate Negative. This feature has a Very High Value therefore the overall assessment category would be Large Adverse.

Breydon Water Ramsar, SPA and SSSI – Additional Mitigation

9.6.25 Additional mitigation recommendations to reduce potential impacts on the ecological interests of Breydon Water, relate primarily to breeding and wintering birds. In order to reduce potentially adverse effects of vehicle headlights, noise and other disturbance on Breydon Water and its bird interests, a 2.5m high environmental barrier is proposed along the southern side of the highway, at the eastern end of the scheme (see Figures 8.4 and 8.5). This would extend westwards from Vauxhall Roundabout. It would provide noise attenuation and screen all low vehicles and the headlights of all high sided vehicles on the existing elevated section of the road thus representing an improvement over the existing situation in this area

9.6.26 To mitigate against impacts during the construction phase this environmental barrier should be erected in advance of the works and temporary screens should be provided elsewhere on the south side of the road in the vicinity of Breydon Water during any works in this area. This would provide an additional temporarily screen to road traffic as well as construction works during the construction period. These measures are described in further detail in the sections on breeding and wintering birds below and should off set most adverse effects of the dual carriageway options.

Breydon Water Ramsar, SPA and SSSI – Residual Impact

9.6.27 Residual magnitude of impacts and overall assessment category are considered to be Minor Negative during construction and Neutral during operation. The overall assessment category is therefore Slight Adverse.

9.6.28 Due to the European status of this site, English Nature would make a decision regarding the need to undertake an appropriate assessment of impact on priority features. This is not considered to be a straight forward decision and should be discussed with English Nature at the consultation stage.

Decoy Carr SSSI and Halvergate Marshes SSSI – Impact and Mitigation

9.6.29 There would be no direct land take from any components of the Decoy Carr SSSI, or Halvergate Marshes SSSI. The northernmost boundary of the former lies some 400m to the south of the existing road and the northernmost boundary of the latter is approximately 600m to the south of the road.

9.6.30 Changes in water quality and flow in the dyke system adjoining the road would be minimal and localised and would not effect the dyke system within these SSSI's.

9.6.31 In terms of priority features, due to the relative distance of the designated sites from the road and the intervening railway embankment, which provides a partial screen, it is considered that the magnitude of impact of the proposals and overall assessment category would be Neutral. Therefore no additional mitigation would be required.

River Bure - Impact

9.6.32 There would be no direct land take from the River Bure or its immediate riparian corridor, including areas of fen vegetation.

9.6.33 The study on water quality and drainage indicates that despite predicted increases in traffic using the road after dualling, changes in water quality and flow in the receiving waters of the River Bure would be negligible (see Chapter 7).

9.6.34 There is potential for noise and visual disturbance to nationally and internationally important populations of wintering and breeding birds, within the vicinity of those parts of the River Bure near the road, both during construction and the ongoing operation of the improved road. This is more significant in the dual options than the single carriageway improvements due to the increased proximity of the widened road corridor to parts of the River Bure (particularly in the Halvergate Junction and scare Gap areas) and the proposed construction of a roundabout at Halvergate Junction. The proposals incorporate the use of cut off lighting in the vicinity of the Halvergate Junction. It is expected that this measure would help offset the additional disturbance associated with the dual carriageway proposals and provide some level of benefit to the ornithological features associated with the River Bure.

9.6.35 Although the effects on the river itself are considered to be Neutral, there will be an Intermediate Negative impact during the construction and operational phases on bird life (see species sub-sections below). This feature has a Lower Value, therefore the overall assessment category would be Slight Adverse.

River Bure - Additional Mitigation

9.6.36 Additional mitigation recommendations to reduce potential impacts relate primarily to breeding and wintering birds. These measures are described in the sections on breeding and wintering birds below.

9.6.37 In both of the dual carriageway options, the northern carriageway is aligned close to the River Bure in the area to the immediate west of the Halvergate junction and in the vicinity of Scaregap. In order to reduce adverse effects on bird interests in the vicinity of the river, it has been recommended that sections of permanent screening (environmental barrier and/or planting) should be provided on the northern road boundary and that this should be implemented prior to onset of construction. However a permanent environmental barrier would be inappropriate in these areas of open marshland landscape and there is insufficient space to plant a dense screen within the highway boundary. A single row of pollard trees has been indicated on the northern embankment slopes in these areas supplemented with additional tree and shrub planting. This would provide some separation but it was considered inappropriate to provide a dense planting belt.

9.6.38 This planting would not be provided in advance of the works although temporary screens would be provided during the construction period. These would be located along the northern side of the road where the River Bure is within 100m of the road and would reduce temporary visual and noise effects.

River Bure - Residual Impact

9.6.39 If the additional mitigation measures are adopted it is considered that the residual Magnitude of Impact would be Minor Negative and the overall assessment category would be Slight Adverse.

General Grazing Marsh - Impact

9.6.40 The majority of land use is in the study area is agricultural with most land used as grazing marsh. Land take from this area in Options 2 and 2A would be approximately 32ha and 23ha respectively, some of it lost to access track construction. The areas of grazing marsh are closely associated with the intersecting network of drainage dykes. These are not considered in this section as the impact on dykes is covered in detail in the dyke vegetation and invertebrate sections in 9.7.

9.6.41 The magnitude of impacts is assessed as Intermediate Negative. This feature has a Lower Value and therefore the overall assessment category would be Slight Adverse. This is primarily a result of land take and does not take into account effects on breeding and wintering birds, which are

discussed below but includes effects on other wildlife including the BAP species brown hare.

General Grazing Marsh - Mitigation

9.6.41 It is recommended that mitigation for the direct losses of grazing marsh would be addressed by provision of compensation grazing marsh habitat, as described in the general mitigation section above.

General Grazing Marsh - Residual Impact

9.6.42 If the compensation dyke and grazing marsh proposals were to be fully implemented there would be a Minor Positive magnitude of impacts resulting in a Slight Beneficial residual effect.

Other Habitats – Impacts and Mitigation

9.6.43 There would be no losses of habitat in the Acle carr area of scrub, wet woodland and marshy / fen grassland at the western end of the scheme. In terms of other woody vegetation along the route, the landscape is generally open and there is little tree or scrub growth along the route that would be affected by the scheme proposals. The exceptions to this are occasional immature trees and mature roadside pollard willows, mainly located in the western part of the study area and sporadic growth of hawthorn, elder, dog rose and willow scrub on dyke margins. All vegetation on one embankment slope would be lost to the scheme with Option 2A. With Option 2 both existing embankment slopes would be retained with variable vegetation losses along the route.

9.6.44 In the eastern part near the railway sidings is an area of generally low scrub and rough grass, part of which would be lost to construction of the proposed new southern carriageway, in the dual options. This loss is only considered significant in terms of reptilian use (see Section 9.7 below).

9.6.45 The overall magnitude of impacts on other habitats in the study area are considered to be Minor Negative for Option 2 and Intermediate Negative for Option 2A. This feature has a Lower Value, therefore the overall assessment category would be Slight Adverse for both options.

9.6.46 Mitigation would include the provision of replacement tree and shrub planting (see Chapter 8 and Figures 8.5 and 8.6) and the provision of compensation areas of rough grass / scrub lost from the eastern part of the study area.

9.6.47 Residual magnitude of impacts and overall assessment categories are considered to be Neutral for both Options on other habitats in the study area.

Table 9.6 Summary of Site Specific Impacts							
Feature	**Value**	**Magnitude of Impacts Before Mitigation Option 2**	**Magnitude of Impacts With Mitigation Option 2**	**Magnitude of Impacts Before Mitigation Option 2A**	**Magnitude of Impacts With Mitigation Option 2A**	**Overall Assessment Category Before/With Mitigation Options 2**	**Overall Assessment Category Before/With Mitigation Option 2A**
Broads cSAC (incorp. Damgate Marshes SSSI)	Very High	Intermediate Negative	Minor Negative	Intermediate Negative	Minor Negative	Large Adverse/ Slight Adverse	Large Adverse/ Slight Adverse
Broadland Ramsar (incorp Damgate Marshes SSSI)	Very High	Intermediate Negative	Minor Negative	Intermediate Negative	Minor Negative	Large Adverse/ Slight Adverse	Large Adverse/ Slight Adverse
Broadland SPA	Very High	Neutral	Neutral	Neutral	Neutral	Neutral/ Neutral	Neutral/ Neutral
Breydon Water SPA and SSSI	Very High	Intermediate Negative	Minor Negative	Intermediate Negative	Minor Negative	Large Adverse/ Slight Adverse	Large Adverse/ Slight Adverse
Breydon Water Ramsar and SSSI	Very High	Intermediate Negative	Minor Negative	Intermediate Negative	Minor Negative	Large Adverse/ Slight Adverse	Large Adverse/ Slight Adverse
Halvergate Marshes and Decoy Carr SSSI	High	Neutral	Neutral	Neutral	Neutral	Neutral/ Neutral	Neutral/ Neutral
River Bure	Lower	Intermediate Negative	Minor Negative	Intermediate Negative	Minor Negative	Slight Adverse/ Slight Adverse	Slight Adverse/ Slight Adverse
General Grazing Marsh	Lower	Intermediate Negative	Minor Positive	Intermediate Negative	Minor Positive	Slight Adverse/ Slight Beneficial	Slight Adverse/ Slight beneficial
Other Habitats	Lower	Minor Negative	Neutral	Intermediate Negative	Neutral	Slight Adverse/ Neutral	Slight Adverse/ Neutral

9.7 Species Specific Impact Assessment and Mitigation Measures

9.7.1 In this section the potential effects of Options 2, and 2A are discussed in detail for each species or assemblage of species identified for consideration. The schemes have been designed to incorporate a number of specific measures to mitigate against ecological impacts and in some cases to reduce the extent of existing adverse impact. Further means of mitigating identified impacts are set out below, together with proposals for providing compensatory habitat of long term ecological benefit. A final assessment of residual impacts is then based on the incorporation of mitigation measures, using standard environmental assessment procedures

Dyke Vegetation - Impact

9.7.2 Direct land take would be significant for both dual options. There would be losses of approximately 4000m of roadside dyke in Option 2 and 11,000m in Option 2A and further disturbance resulting from bridging of short sections of dyke running perpendicular to the road, for access road construction. This is of most significance in the vicinity of Damgate Marshes where, together with other strategic locations along the route there would be losses of roadside dyke supporting internationally and nationally important dyke flora (see Figures 9.2 and 9.3). Such direct losses would be high with Option 2A (approximately 1800m of such dyke in the vicinity of Damgate Marshes) where roadside dyke is lost along the whole length of the scheme. This effect would be much lower with Option 2 (350m of roadside dyke of national importance only in the vicinity of Damgate Marshes), as there is a much lower rate of dyke loss and losses would only be localised.

9.7.3 There is also potential for longer term habitat degradation of dyke habitats resulting from hydrological changes and changes in land management, to adversely affect regionally, nationally and internationally important communities of aquatic flora. Again this is of particular significance to the retained roadside dyke within the central reservation with Option 2. However these changes may also effect dykes on the highway boundary due mainly to access problems. This has been identified as a pre mitigation risk, particularly east of Halvergate Junction on the northern side of the road (see Chapter 4).

9.7.4 Land management changes from grazing to arable or hay / silage cropping, could have significant effects on the dyke flora. Any cessation of grazing is likely to result in adverse impacts on rare and scarce species and sensitive assemblages of flora. The provision of access tracks would not materially affect the condition of adjoining roadside dykes, as they would not be fenced and stock would still be able to graze the external dyke banks.

9.7.5 General aspects relating to water quality and hydrology are described in Chapter 7. The particular requirements and sensitivities of the rare and scarce species are little known and there could be unpredictable but significant effects on the dyke flora communities. There is potential for minor increased adverse effects of spray contamination particularly in the central reservation dyke in Option 2 both sides of which would be within 3m of the new carriageways.

9.7.6 The majority of the dyke vegetation of international importance is located on the southern side of the existing road. However, to the north of the road near Damgate Marshes there are also areas of internationally important dyke flora. With Option 2A this section of dyke would be lost but with Option 2 it would be retained within the central reservation.

9.7.7 The communities with the most restrictive water quality conditions and consequently most vulnerable to hydrological change would be the nationally and internationally significant endgroups A3a, A3b, A4, A5a, and A5b (Doarks and Leach, 1990). Endgroup A7b would be moderately vulnerable and endgroup A7a is unlikely to be significantly affected. At particular risk from these water pollution and hydrological changes would be the aquatic species *Stratiotes aloides*, *Potamogeton friesii, Ricciocarpus fluitans, Ranunculus baudotii* and *Potamogeton friesii* and internationally and nationally important aquatic communities.

9.7.8 Salinity in the dyke network varies considerably throughout the year in response to rainfall, sea tide and pumping regimes and therefore any effects resulting from road runoff are generally likely to be insignificant. Overall it is though that the existing road could result in slightly greater fluctuations in salinity than the surrounding dyke network and this could effect some of the more sensitive plant species. Vegetative filter beds associated with new lengths of dyke would slightly reduce the effects of salinity fluctuation to downstream dykes.

9.7.9 Any conversion of existing roadside dykes into linear 'filter beds', would significantly affect the botanical value of the dykes. It is considered that it would preclude any possibility of maintaining nationally or internationally important aquatic communities due to their overgrown nature.

9.7.10 Accidental spills of chemicals and other liquids on the road could have notable temporary and long term impacts on sensitive plant communities. The proposed measures to contain accidental spills would minimise the extent of such an impact.

9.7.11 With Option 2 the future habitat conditions of the retained central reservation dyke has significant potential adverse implications for botanical

interests in this dyke. In particular botanical communities may be compromised by:

- significantly reduced water levels and flow,
- altered nutrient and chemical status of dyke waters due to changes in the character of the road runoff;
- habitat severance from other dykes isolating plant populations in the central reservation and,
- cessation of grazing.

The full implications of these potential impacts on dyke flora cannot be accurately assessed until the detailed hydrological situation is determined. It is likely however, that without mitigation there would be significant deterioration of the current favourable condition of this central dyke and this would adversely effect the inhabiting invertebrate population.

9.7.12 There are very minor predicted increases in habitat severance due to the bridging of perpendicular dykes by the access tracks and other road infrastructure, increasing the distances for dispersal of plant species across the road system. This is not thought to be significant.

9.7.13 During the construction phase there is a greater risk of increased pollution of roadside ditches, particularly from sediments. This adverse effect would be greatest with Option 2 due the isolation of the roadside dyke between two embankments. Such impacts could have long term implications.

9.7.14 The major effects of the dual carriageway options on dyke vegetation would result from dyke loss, habitat degradation of the central reservation dyke with Option 2 and the risk of pollution during the construction phase. Within the vicinity of the road the magnitude of impact is considered to be major negative, however the effects would be relatively localised and would not affect the integrity of the overall dyke system within the study area. Therefore the magnitude of effects has been assessed as Intermediate Negative. This feature has a Very High Value and therefore the overall assessment category is Large Adverse for both options.

Dyke Vegetation - Additional Mitigation

9.7.15 It is recommended that with dykes of international importance, there should be a ratio of dyke replacement of 1:3 and elsewhere the ratio can be reduced to 1:2. This would result in the substantial creation of new dykes. The location of these additional dykes would need to be agreed with English Nature, the IDB and other interested parties. One possibility would be to create new dykes parallel to the existing roadside dykes, on the external edges of the new access tracks (see Figures 9.4 and 9.5). In order to optimise the potential value of any new compensation dykes, it is

recommended that they are located or bridged in such a way to allow ongoing grazing of the external margins of the roadside dykes and also to allow grazing of both sides of the new dykes.

9.7.16 Replacement grazing marsh should also be provided as compensation for that lost in the proportions described in Section 9.5. This would ensure that replacement dykes are managed with a grazing regime at dyke margins.

9.7.17 Where appropriate, plant communities in those sections of dyke to be lost / bridged, would be translocated to new replacement sections of dyke. This would apply to all areas of vegetation containing rare or scarce species of flora and those with A3, A4 and A5 endgroup classification. It may also be agreed that some sections of new dyke can be encouraged to recolonise through natural plant establishment. This is likely to be the case where new dykes are created close to existing dykes of high floristic quality.

9.7.18 This translocation should be undertaken at least 3 years prior to onset of construction works with a programme and detailed method statement for plant community translocation to be agreed with English Nature. Suitable receptor sites within the new replacement sections of dyke would be chosen with great care to ensure that the environmental conditions (including nutrient, salinity and turbidity levels) are as compatible as possible with the donor site. The timing of translocation would take into account individual needs of particular species of flora and would be agreed with English Nature.

9.7.19 If it is decided to proceed further with one of the options it is recommended that trials should be undertaken to ascertain the feasibility of translocating specific plant species. Similar studies carried out in other areas can be used as a source of data and can provide a useful indication of likely colonisation trends. For example, work has been carried out on marshland in Essex relating to the improvement of the A13 road, and English Nature have local experience on creation of new dykes in freshwater systems. However some of the assemblages of ditch flora, found within the study section of the A47 are unique to this area and no specific information relating to translocation of some of these species is thought to exist. Therefore site specific trials are necessary and until these have been carried out the translocation process should be treated with caution and should not be expected to succeed in advance.

9.7.20 In addition to the above trials, a re-survey of all ditches with rare and scarce species in those sections of dyke to be lost / bridged, should be implemented immediately prior to instigating any translocation works. This would ensure that the current populations are accurately identified, as they may vary from those recently surveyed. Following translocation a long-term monitoring programme should be put in place to establish the detailed effects upon dyke vegetation.

9.7.21 In order to minimise damage and disturbance during construction, all sections of dyke to be retained should be isolated from those dykes to be lost at the commencement of the works. Temporary solid fencing should be placed at a specified distance from all nearby retained dykes to prevent damage from machinery or contamination from falling debris. Temporary drainage of ditches during construction should be avoided or where unavoidable, occur in as small a section as possible.

9.7.22 To optimise conditions in the retained central dyke in Option 2, the hydrological situation should be resolved with the crossfall drainage (from at least one carriageway) reverting back to the central dyke. Hydrological studies would be required to ascertain optimum drainage configuration to maintain water flow conditions in this dyke. In order to further minimise potential deterioration, the central reservation habitat should be managed sympathetically to mimic grazing, as far as possible (see section 9.5 above).

9.7.23 Temporary access bridges over dykes should be constructed to allow continued free movement of water underneath them and they should be designed with raised edges to prevent accidental deposition of harmful materials into the dykes.

9.7.24 Appropriate management of the roadside vegetation / dyke banks is described in section 9.5 above and would have significant potential benefit to the dyke flora.

Dyke Vegetation - Residual Impact

9.7.25 Mitigation measures would include best efforts to translocate plant communities from those sections of dyke to be lost. However due to the unpredictable nature of translocation procedures relating to plants with restricted, sensitive or little known requirements, a 'worst case scenario' assumption has been made at this stage, i.e. that plants to be translocated from ditches to be lost, would themselves be lost.

9.7.26 It is considered that if the mitigation measures discussed above are implemented impacts could be reduced but the most important measures involve dyke habitat creation (Option 2A) and avoidance of dyke habitat degradation (Option 2). At this stage the success of these mitigation measures is unproven and consequently reduction in impacts resulting from the other mitigation measures would be insufficient to alter the magnitude of impacts which would remain Intermediate Negative, with an overall assessment category of Large Adverse for both options.

9.7.27 With Option 2, if the hydrological problems associated with the retained central dyke could be resolved and measures developed to mimic grazing of the dyke edges the magnitude of impacts would be reduced. However

because the risks of dyke contamination during the construction phase could not be eliminated there would still be a negative score.

Invertebrates - Impact

9.7.28 Many of the impacts noted above for dyke vegetation also apply to dyke invertebrates. Direct land take would be significant for both dual options. There would be losses of approximately 4000m of roadside dyke in Option 2 and 11,000m in Option 2A and further disturbance resulting from bridging of short sections of dyke running perpendicular to the road, for access road construction. This is of most significance in the vicinity of Damgate Marshes where, together with other strategic locations along the route there would be losses of roadside dyke supporting rare and scarce species of invertebrate. Such direct losses would be high with Option 2A where roadside dyke is lost along the whole length of the scheme. This effect would be much lower with Option 2, as there is a much lower rate of dyke loss and losses would only be localised.

9.7.29 In both options there is also significant overall loss of grazing marsh habitat, some of which may support one nationally notable species of terrestrial invertebrate. The grazing marsh also forms an important part of invertebrate habitat and the relatively large land losses are significant. Option 2 would result in greater losses of grazing marsh than Option 2A, (see Section 9.5).

9.7.30 The most important invertebrate records are the RDB and Schedule 5 species Norfolk Hawker (*Aeshna isosceles*) and 3 other RDB species (*Anisus vorticulus, Segmentina nitida* and *Pisidium pseudopshaerium*). These are concentrated in the Damgate Marshes SSSI and proximal habitat and may be vulnerable to change resulting from road improvements. This is due to particular habitat characteristics in this area partially relating to peaty conditions. Whilst specific information relating to habitat requirements is little known, it is considered that the rare and scarce species present in the dyke systems tend to require clean conditions with low turbidity and low conductivity.

9.7.31 It should be noted that any works that may affect Norfolk Hawker would require a licence, due to their protected status (Schedule 5 of the Wildlife and Countryside Act, 1981).

9.7.32 The significantly wider carriageway associated with the dual options (greatest in Option 2) would result in increased severance of invertebrate populations on either side of the road. There are also very minor additional predicted increases in habitat severance due to the bridging of perpendicular dykes by the access tracks and other road infrastructure, increasing the distances for dispersal of invertebrate species across the road system. This is not thought to be significant.

9.7.33 There is potential for longer term habitat degradation of dyke habitats resulting from changes in land management due to access problems or reduction in size of marginal fields / holdings adjoining the road (particularly to the north of the road, east of Halvergate Junction). Any cessation of grazing resulting from land changing from grazing to arable or hay / sileage cropping, could have significant effects on the inhabiting invertebrate population. With Option 2 the removal of grazing management from the margins of the dyke isolated in the central reservation also has serious implications for invertebrate communities. The provision of access tracks would not materially affect the condition of adjoining roadside dykes, as they would not be fenced and stock would still be able to graze the external dyke banks.

9.7.34 During the operational phase there is potential for degradation of dyke habitats resulting from water flow and water pollution and changes in land management, to adversely affect nationally and internationally important communities of aquatic invertebrate. The particular requirements and sensitivities of the rare and scarce species are little known and there could be unpredictable but significant effects on the invertebrate communities. With Option 2 the retained dyke in the central reservation would experience significant hydrological changes as a result of the loss of runoff from the existing road and adjacent fields. This would have further implications with regards to water quality. Elsewhere the effects have been assessed as minor, however even minor changes could have implications for the sensitive invertebrate communities in the dykes (see Chapter 7).

9.7.35 There is potential for minor increased adverse effects of spray contamination, particularly in the central reservation dyke in Option 2.

9.7.36 Any conversion of existing roadside dykes into linear vegetative 'filter beds', would significantly affect the potential invertebrate value of these wetland areas as they would preclude any possibility of maintaining nationally or internationally important aquatic communities due to their overgrown nature.

9.7.37 There is a direct interaction between habitat quality and invertebrate interest in the dykes. Any potential construction effects resulting in alterations to ditch nutrient and turbidity status, has the potential to exert severe adverse impact on those rare and scarce species of invertebrate with particular habitat requirements. In particular any influx of disturbed soil or other materials entering the dykes and causing increased turbidity could settle and interfere with invertebrate feeding and respiration. Proposed construction phase measures to contain accidental spills would minimise the extent of such incidences. However the works would be very close to roadside dykes and some works would directly affect them. Therefore it is not thought possible to completely eliminate effects of increased turbidity.

9.7.38 The greatest effects of the dual carriageway options on invertebrates would result from dyke and associated grazing land loss, habitat degradation of

the central reservation dyke (Option 2) and the risk of pollution during the construction phase. Within the vicinity of the road the magnitude of impact is considered to be major negative, however the effects would be relatively localised and would not affect the integrity of the overall dyke system within the study area. Therefore the magnitude of effects has been assessed as Intermediate Negative. This feature has a High Value and therefore the overall assessment category is Large Adverse for both options.

Invertebrates - Mitigation

9.7.39 The most important mitigation for invertebrates is the creation of additional dyke habitat. It is recommended that in areas of international importance, including the Damgate Marshes SSSI, there should be a ratio of dyke replacement of 1:3, however in those areas of national importance for invertebrates, where there are no over-riding features of international importance the ratio can be reduced to 1:2. This would result in the creation of extensive lengths of new dyke in both options (see Section 9.5). The location of new additional dykes for habitat creation would need to be agreed with English Nature, the IDB and other interested parties. One possibility is to create new habitat creation dykes parallel to the existing roadside dykes, on the external edges of the new access tracks (see Figures 9.4 and 9.5).

9.7.40 Grazing is considered the most critical requirement to create and maintain conditions suitable for rare and scarce species of invertebrate. In order to optimise the potential value of any new compensation dykes, it is recommended that they are located or bridged in such a way as to allow ongoing grazing of the external margins of the roadside dykes and also to allow grazing of both sides of the new dykes.

9.7.41 In order to minimise potential losses of important and sensitive populations of aquatic invertebrates, it is considered necessary to recreate conditions similar to those existing in dykes to be lost, in the new replacement dykes. This would include creating dykes to a variety of shapes and profiles, translocation of specific vegetation communities and allowing sufficient time for their successful re-establishment prior to destruction of existing dykes. However limited work has been done on translocation of the invertebrate communities found in the study area and success cannot be guaranteed to succeed even if the re-colonisation / translocation of vegetation is successful. It is considered easier to recreate vegetal assemblages than invertebrate communities, particularly in the short-term

9.7.42 If it is decided to proceed further with one of the options it is recommended that trials should be undertaken in particular to ascertain the feasibility of translocating rare and scarce species of invertebrate and indicator species. This would determine the optimum timing for translocation and destruction of existing habitat, in relation to life cycles, to minimise losses and maximise chances of re-colonisation. Whilst the movement of most of the aquatic invertebrates is likely to be by natural re-distribution of populations,

there may also be a need for physical translocation of non-flying species including molluscs. For some species, for example *Anisus vorticulus* ,that are present in very late succession dykes, mitigation may necessitate manual translocation to existing dykes of suitable vegetal and other conditions elsewhere in the study area. The new dykes may not be in a suitable condition to receive such species, even after a 3 year 'lead-in' period.

9.7.43 Until the research has been carried out the translocation process should be treated with caution and should not be expected to succeed in advance.

9.7.44 In addition to the above research a re-survey of all ditches for rare and scarce species should be implemented immediately prior to instigating any translocation works. This would ensure that current populations are accurately identified, as they may vary from those recently surveyed. Following translocation, a long-term monitoring programme should be put in place to establish the detailed effects upon dyke invertebrates. Clear targets should be set as to which species the new ditches should contain e.g. the presence of specific indicator species or the dominance of the assemblage by particular species.

9.7.45 Current levels of knowledge with respect to particular habitat management requirements for rare and scarce species of invertebrate are generally lacking and further research may also be applicable in this respect. Appropriate management of the roadside vegetation / dyke banks, in an attempt to mimic the traditional grazing regime, is described in section 9.5 and would have potential benefit to dyke invertebrates.

9.7.46 In order to optimise conditions in the retained central dyke in Option 2, there is a need to ensure that the hydrological situation is resolved and that crossfall drainage reverts back to the central dyke from at least one carriageway. In order to further minimise potential deterioration, the central reservation habitat should be managed sympathetically (as discussed in section 9.5 above) to mimic grazing, as far as possible.

9.7.47 Measures to mitigate against potential changes in management of adjoining farmland are described under Land Use (see Chapter 4). In particular small changes to the access track design are recommended which would remove access problems and therefore the risk of changes to farmland management.

9.7.48 Those measures described in section 9.5 relating to dyke protection during construction, are also vital for the conservation of invertebrates. Similarly, in order to mitigate against potential minor loss of terrestrial habitat and inhabiting invertebrates, successful mitigation would require the creation of new compensation grazing marsh.

Invertebrates - Residual Impacts

9.7.48 Invertebrate are invariably dependent on associated plant communities and the risks associated with translocation of the dyke plant communities are described above. In addition re-colonisation /translocation procedures relating to invertebrate species with restricted, sensitive or little known requirements is untried and unpredictable. Therefore a 'worst case scenario' assumption has been made, i.e. that translocated invertebrates and their supporting plant community, would themselves be lost.

9.7.49 If the mitigation measures discussed above are implemented impacts could be reduced but the most important measures involve dyke habitat creation (Option 2A) and avoidance of dyke habitat degradation (Option 2). At this stage the success of these mitigation measures is unproven and consequently reduction in impacts resulting from the other mitigation measures would be insufficient to alter the magnitude of impacts which would remain Intermediate Negative, with an overall assessment category of Large Adverse for both options.

9.7.50 With Option 2, if the hydrological problems associated with the retained central dyke could be resolved and measures developed to mimic grazing of the dyke edges the magnitude of impacts would be reduced. However because the risks of dyke contamination during the construction phase could not be eliminated there would still be a negative score.

Wintering Birds - Impact

9.7.51 The habitat losses (particularly of grazing marsh) and increased fragmentation associated with Options 2 and 2A are predicted to have a generally adverse effect on wintering birds in the study area. There is likely to be a significant localised impact on wintering birds in the Damgate Marshes area, including potential adverse effects on barn owl feeding areas, which were found to occur most frequently south of the A47 and west of Tunstall Dyke. Also of significance are the wintering locations of Cetti's warbler in this area. The construction of a roundabout at Halvergate Junction in the dual options has the capacity to impact on several species of wintering birds. The River Bure runs less than 50m from the road at this point and reedbeds along this stretch hold bearded tit and Cetti's warbler.

9.7.52 Visual and noise disturbance, as well as spray contamination, would occur both during and post construction and is of most significance in the Damgate Marshes/ Acle Carr area, near the River Bure at Halvergate Junction and Breydon Water areas. Throughout the study area the extent of such disturbance would be high due to the flat and open nature of the landscape. Birds roosting at high tide (as well as foraging birds at low tide) at the extreme eastern end of Breydon Water would be susceptible to visual and noise impacts. At specific times (i.e. high tide and / or at night) it is likely that a high disturbance impact would be made on roosting birds,

including nationally and internationally important numbers of Avocet, and also pink-footed and white-fronted geese, at Breydon Water.

9.7.53 There would generally be no need for construction lighting associated with Options 2 and 2A, due to no night time working. However, in periods of natural low light intensity some use of lighting is likely to be required. This may have some minor potential adverse effect on wintering, feeding and roosting birds, including some effect on migrating birds, which use the estuary and the surrounding grazing marsh on passage. In low visibility weather and at night (e.g. mist which is prone to occurring on the Acle Straight) diffuse lighting may attract passage birds during the spring and autumn migrations, with increased risk of mortaility.

9.7.54 Once operational there would be some increase in noise level from the road compared to the do-minimum situation caused by traffic flowing at higher speeds and from a predicted increase in volume of traffic (see Chapter 12). Any increased noise is likely to cause negative impacts on the local wintering bird populations.

9.7.55 In both of the dual carriageway options, the northern carriageway is aligned close to areas frequented by wintering birds adjacent to the River Bure in the area to the immediate west of the Halvergate junction and in the vicinity of Scaregap with the potential for disturbance to them.

9.7.56 The proposals also provide potential for increased bird mortality during the operational phase, due to increased traffic flows and speed and a significantly wider road corridor. This is a particular concern with respect to barn owls due to low level of flight and tendency to follow lines of dyke vegetation. The potential effects are predicted to be greatest with Option 2 due to the likely attraction of barn owls to the dyke and associated vegetation within the central reservation and the greater increase in width of the road corridor.

9.7.57 There would be a reduction in sky glow and light spillage outside the road corridor as a result of the proposals, although this benefit would be partially offset due to the lighting itself extending slightly further into the marshland due to road widening. The increases in traffic flows would result in increased incidence of vehicle headlights at night and increased road-associated disturbance to roosting and night feeding birds.

9.7.58 The proposals would have significant effects on the wintering bird population along the route due to habitat loss, fragmentation and disturbance during construction. However there is already disturbance from the existing road and the additional effects from the proposals would be localised. Therefore during the operational phase although there would be significant effects the overall wintering bird habitat in the study area is expected to be sustained. However during the construction period the additional noise and light disturbance could be sufficient to prevent the use of the study area marshland by many wintering birds and the sites integrity

would be adversely affected. The magnitude of impact of the dual carriageway options on wintering birds is therefore assessed as Major Negative. Wintering birds in the study area have a Very High Value, therefore the overall assessment category would be Very Large Adverse for Options 2 and 2A.

Wintering Birds - Additional Mitigation

9.7.59 The effects on the birds using Breydon Water would be substantially reduced by the installation of a 2.5m high environmental barrier along the southern boundary of the elevated section of the highway to the west of Vauxhall Roundabout. (see Figures 8.4 and 8.5).

9.7.60 The new environmental barrier in the Breydon Water area should be erected prior to onset of the main construction period. The barrier would benefit from some strategic planting on the southern side of the barrier, although this would be limited due to lack of space. Such planting would help to filter visual intrusion from intrusion movement of high sided vehicles and road lighting. Further temporary screens should be erected during construction works along the rest of the southern boundary of the road where it runs parallel to the shore of Breydon Water. This would enhance the screening effect already provided in this area by scrub growth and an existing linear mound located on the edge of the Water.

9.7.61 To further reduce construction impacts at Breydon Water, the most disruptive aspects of the construction programme should be undertaken in the summer, to avoid disturbance to wintering and passage wildfowl. Care should also be taken not to disturb high tide roosts of Avocet, which may be present throughout the year. Therefore, consideration should be given to the state of the tides during construction works at this end of the road.

9.7.62 Other areas of importance for wintering birds, should also be temporarily screened during the wintering period, to mitigate against visual disturbance of construction activity.

9.7.63 In order to reduce adverse effects on bird interests in the vicinity of the River Bure, it has been recommended that sections of permanent screening (environmental barrier and/or planting) should be provided on the northern road boundary and that this should be implemented prior to onset of construction. However a permanent environmental barrier and dense woodland planting would be inappropriate in these areas of open marshland landscape. There is also insufficient space to plant a dense screen within the highway boundary. A single row of pollard trees has been indicated on the northern embankment slopes in these areas supplemented with additional tree and shrub planting which would provide some separation but not a screen.

9.7.64 Night working, lighting and disruptive works e.g. piling, should be undertaken outside the main wintering period (or in the mid-day period, if unavoidable). In these areas the speed of construction traffic should also be limited, to reduce noise disturbance.

9.7.65 Access tracks would be constructed with a granular surface, which if infrequently used would eventually become vegetated thus allowing birds to forage in colonising vegetation. Minimal length access tracks terminating at the boundary of land holdings rather than individual fields located at greatest distance from junctions would also reduce fragmentation effects and loss of grassland.

9.7.66 In order to minimise disturbance to birds access to the public should not be allowed on the south side of the road in the Damgate Marshes area.

9.7.67 The provision of compensation dyke and grazing marsh grassland identified above as mitigation for dyke and invertebrate habitat loss would also compensate for loss of grassland feeding area.

9.7.68 Where possible planting / screening should be provided to deflect barn owls and reduce the potential for mortality. Continual lines of planting are not considered appropriate to the open character of the Broads landscape however planting would most benefit barn owls if concentrated where dykes and other linear features meet the road. Dense planting would be required if this was to be fully effective but this is not feasible within the highway boundary on the existing road embankment as the space available for planting on the roadside embankment is limited to approximately 2m between the edge of carriageway and the dyke. Current guidelines recommend shrub planting no closer than 3m to the carriageway, however in view of the constraints of this scheme a departure from this standard would be appropriate. Nevertheless there would only be space for single rows of planting. With Option 2 the new embankment could be constructed with sufficient width to enable more dense planting in the soft landscape areas. This could also be achieved on the widened side of the embankment with Option 2A.

9.7.69 The regular cutting of grass verge and dyke bank vegetation along the road corridor would also have some benefit to barn owls, by discouraging hunting in the danger zone. Whilst this would be a disadvantage to reptiles and bats and also to some extent, water voles, using the corridor, it is likely to be compatible with the interests of dyke flora and invertebrate fauna.

9.7.70 Some of the additional mitigation measures recommended in the specialist report, including permanent bunding and other screening along the carriageway are not considered to be feasible or compatible with other constraints and have therefore not been included.

Wintering Birds - Residual Impacts

9.7.71 Apart from the permanent environmental barrier at Breydon Water, measures to mitigate impacts on wintering birds during the operational phase are limited as they tend to conflict with the need to avoid adversely affecting the nationally important open landscape and the important dyke habitat. However mitigation measures during the construction period would reduce impacts to the extent that the risk of the works temporarily deterring use of the study area marshland by many wintering birds would be much diminished. If the additional mitigation measures discussed above for each of the dual lane options, were to be implemented, it is predicted that the Major Negative magnitude of impact on wintering birds would be reduced to Intermediate Negative. The overall assessment category would be Large Adverse.

Breeding Birds - Impact

9.7.72 The habitat losses and increased fragmentation associated with Options 2 and 2A are predicted to have a generally adverse effect on breeding birds. The dual options are predicted to cause disturbance to the breeding territories of the following species of conservation interest: Cetti's warbler, grasshopper warbler, skylark and reed bunting, mainly in the Damgate area. Some impact may also occur through a reduction of barn owl feeding areas.

9.7.73 In both dual options, the proposed construction of a roundabout at Halvergate Junction has the capacity to impact upon birds holding territory on the River Bure. The river runs less than 50m from the existing A47 at this point and holds one territory of bearded tit and 7 territories of reed bunting. The reedbed of this section of the river also holds many territories of reed and sedge warbler.

9.7.74 Visual disturbance during the operational phase would be of most significance in the Damgate Marshes/Acle Carr and Breydon Water areas. However street lighting proposals would reduce the current impacts. The increase in traffic resulting from the proposals would result in increased visual intrusion from moving traffic and headlights.

9.7.75 Noise and light disturbance arising from construction activities has the potential to impose a large adverse impact on breeding, feeding and roosting bird populations. Due to the flat nature of the land the construction operations would be highly visible and highly audible over a large distance beyond the development footprint. Whilst there would be no night time working or need for flood lighting for Options 2 and 2A, in low visibility weather (e.g. mist which is prone to occurring on the Acle Straight site) diffuse lighting may attract migrating birds during the spring and autumn, causing potential mortalities. This may have a slight impact on migrating birds in the Breydon Water area, for example whimbrel, which use the estuary and the surrounding grazing marsh on passage.

9.7.76 Prior to implementation of the additional mitigation measures set out below, it is considered that as with wintering birds, the magnitude of impact of the dual lane options on breeding birds would be Major Negative. This feature has a High Value therefore the overall assessment category would be Very Large Adverse.

Breeding Birds - Mitigation

9.7.77 Mitigation measures set out above for wintering birds, also generally apply to breeding birds. These include the installation of a 2.5m high environmental barrier along the southern boundary of the elevated section of the highway to the west of Vauxhall Roundabout and temporary screens between the road and important breeding bird territory during construction works. Measures also include some planting to provide separation between the road and the River Bure at Scaregap and Halvergate Junction and localised planting where the road meets perpendicular dykes to deter birds (particularly barn owls) flying low over the carriageway.

9.7.78 In areas of national importance for breeding birds (concentrated in the Damgate Marshes and Breydon area), including those areas used for breeding by birds protected under Schedule 1 of the Wildlife and Countryside Act, 1981, particularly disruptive works e.g. piling, should be undertaken outside the main breeding period. The speed of construction traffic is also to be limited during the breeding season.

9.7.79 At the western end of the road it is recommended that the most disruptive aspects of the construction work is restricted to the winter period to avoid disturbing breeding birds.

9.7.80 Adverse impacts could be further reduced through long term habitat gain if the compensation dyke and grazing marsh mitigation proposals described above were to be fully implemented

9.7.81 It may be possible to indirectly compensate for impact on breeding birds through the creation of scrapes, pools and reed beds in strategic locations associated with the scheme. The provision of such habitats could be linked to the treatment of surface water from the road, through the channelling of road runoff through drainage structures to specially created balancing ponds or natural filters e.g. reedbeds. The feasibility of this would require consultation with English Nature and the RSPB.

Breeding Birds - Residual Impacts

9.7.82 If the above additional mitigation measures were to be implemented, it is assessed that the Major Negative magnitude of impact could be reduced to Intermediate Negative, therefore the overall assessment category would be Large Adverse for both options.

Otters and Water Voles - Impact

9.7.83 The losses of grazing marsh associated with the dual options has the potential to reduce the area available for water voles feeding habitat and burrows and the area available for otters lying-up sites, holts and feeding habitat. The losses of dykes would have an overall temporary effect due to proposed replacement of lost dykes, with an overall greater length of dyke than the existing situation for both options. In this respect, there is potential for overall long term benefit for water voles in both dual options, particularly Option 2.

9.7.84 The potential for land management changes as a result of access difficulties and rationalisation of fields/land holdings resulting from the dual options is discussed in Section 9.5. Any additional loss of dyke due to field rationalisation could reduce available habitat for water voles and otters.

9.7.85 Road associated otter death is believed to be one of the most serious causes of otter mortality in Norfolk and the existing A47 Acle Straight has a history of otter deaths. Otters occur in generally low numbers in Norfolk and this part of the Broads is considered to represent a stronghold for otters. Due to their large territories even minor increases in mortality may have a significant adverse effect upon the overall population.

9.7.86 Increase in carriageway width can cause increased mortality or other severance effects resulting from the deterrent to cross the road. This can have adverse effects on territorial areas. For the dual carrriageway options the significant increase in road width would result in linger, darker culverts and therefore increase the likelihood that otters would cross the highway instead of using existing or reinstated culverts or other routes. This would increase the risk of otters being killed or injured by road traffic accidents whilst doing so.

9.7.87 The effects of increasing the speed limit to 70mph is likely to have little additional impact for water voles but is likely to increase the likelihood of operational mortality / severance for otters.

9.7.88 With Option 2, there is a danger of otters entering the central reservation via a culvert or underpass and then due to the attraction of the central reservation dyke being effectively trapped or disorientated and attempting to cross one or other carriageway. With both options habitat severance could also be slightly increased by the addition of parallel access tracks and other road infrastructure, increasing the difficulties for dispersal across the road system. Limited information is available on the detailed effects of habitat severance from roads

9.7.89 The adverse effects of severance are likely to be offset to some extent by the reinstatement of some existing collapsed culverts and the provision of otter underpasses at a minimum distance of 500m along the length of the

road scheme. With Option 2A the existing and reinstated culverts and the otter underpasses would be extended to accommodate the widened embankment. In Option 2 there would be 2 underpasses at each crossing point, meeting in the central reservation. This could have negative implications for otters, however each section of underpass is likely to be short enough to allow successful use. In Option 2A the considerable length of the single underpass may be a deterrent to use by either otters or water voles.

9.7.90 Water voles are seen as having a low vulnerability to increased road mortality, generally being strongly resistant to making terrestrial journeys and dependant upon aquatic habitats for dispersal and movement. Road deaths of water voles are unlikely to have been recorded but probably occur.

9.7.91 With Option 2A one of the roadside dykes would be lost along the entire length of the route and this would be replaced by a new dyke located approximately 10m from the existing dyke. Option 2A also involves the complete loss and replacement of one of the existing embankment slopes, the retained embankment slope would be regraded along part of the route. With Options 2 alll existing embankment slopes would be regraded except for the southern slope to the west of Halvergate Junction. This has potentially serious consequences for the water vole populations during construction, since many of the burrows would be present along these faces. The resulting temporary increase in mortality would be of major consideration.

9.7.92 The current poor linkage between the north and south of the A47 has an existing severance effect on water voles which would be increased with Option 2A as a the use of culverts and underpasses would be less likely. With Option 2 it is reasonably likely that water vole populations would successfully inhabit the central reservation dyke and embankments, providing hydrological conditions are favourable and that water voles successfully use the reinstated culverts and otter underpasses.

9.7.94 Water voles would tend to confine themselves to the immediate dyke corridor, therefore mortality impacts are not considered to be significant. However population fragmentation/isolation linked with local extinctions is the principal accelerating factor within the water vole's decline nationally. Insufficient information is known about water vole dispersal rates, distances or detail of the breeding organisation within water vole colonies to detail exact parameters for this, but there is general agreement that fragmentation has a severe negative effect (Strachan and Jefferies 1993). Option 2A with long culverts and underpasses which could deter use by water voles is likely increased separation of the populations either side of the road and hence greater fragmentation than Option 2.

9.7.93 There is no night time working in the dual options which could adversely affect Otters.

9.7.94 The creation of new public access alongside the A47 using the access tracks raises the possibility of negative impacts from increased disturbance, especially to foraging otters and otter holts in the area. Such impacts are likely to be relatively small unless otter holts are discovered close to the proposed access tracks.

9.7.95 Provided that the parallel access tracks in Options 2 and 2A are only used by tractors travelling at low speeds (<20 mph) they would have little effect upon otter mortality.

9.7.96 The magnitude of impacts on water voles resulting from Option 2 prior to mitigation, is considered to be Neutral as is the overall assessment category. This is because, although experiencing short term habitat loss water voles would benefit in the long term from the additional dyke and embankment slope habitat habitat. With Option 2A there would initially be large loss of habitat although it would eventually be replaced with a similar length of new dyke and embankment slopes. The wide road, wide embankment and associated long culverts/underpasses would significantly increase population fragmentation and the magnitude of impacts has been assessed as Intermediate Negative for Option 2A. Water voles are of medium importance and accordingly the overall assessment category for water voles as a result of implementing Option 2A would be Moderate Adverse.

9.7.97 The existing road has already been identified as causing severance to otter populations and despite the provision of otter underpasses both options would increase this effect. With both options the increased traffic speed combined with the wider road would increase risk of mortality and severance. With Option 2 the wider road corridor and wide central reservation would result in a greater risk of increased mortality for otters than Option 2. With Option 2A the long culverts/underpasses associated with the wide embankment could deter use by Otters. It is considered that Option 2 could adversely affect the viabiltiy of the local otter population and therefore the magnitude of impact would be Major Negative. An intermediate magnitude of impact has been identified for Option 2A. Otters have a Very High Value and therefore their overall assessment category is Very Large Adverse for Option 2 and Large Adverse for Option 2A.

Otters and Water Voles - Mitigation

9.7.98 A re-survey of all dykes for both water voles and otters should occur during the period prior to construction work to ensure that the populations and location are accurately identified, as they may vary from those recently surveyed. If any otter holts are found a suitable mitigation scheme to be agreed with English Nature. Sufficient time needs to be allowed for implementing any mitigation measures that might be required.

9.7.99 Dyke compensation habitat should generally be 1:2 where water voles are present or 1:3 in areas of dense water vole habitat i.e. 'hot spots' as

identified on Figures 9.2 / 9.3. This is in line with dyke compensation calculations for dyke vegetation and invertebrates.

9.7.100 Temporary exclusion fencing should be placed at a specified distance from known water vole burrow systems to prevent the animals entering the construction site and this should be reinforced against damage from machinery by man-proof fencing. This may require temporary blocking of drainage, however, the location of temporary fencing should be sensitive to water vole movement around the dyke network.

9.7.101 Temporary drainage of ditches should be either avoided altogether or where unavoidable occur in as small a section as possible. Translocation would probably be required if water voles are present in ditches that need to be temporarily drained. Temporary access bridges over dykes should conform with the standards set by the DMRB Good Roads Guide[59].

9.7.102 Where possible those dykes to be lost which are inhabited by water voles should be retained until new replacement dykes are in favourable condition to receive water voles. The preferable method is to use in-situ methods of translocation by using water control / vegetation management, to dry out the existing sections of dyke to be affected by the works, a few at a time. This would encourage water voles to move into the new dykes or into other parts of the dyke network.

9.7.103 Trapping of animals should be implemented if the above method is seen to be inappropriate. In this case water vole translocation would consist of four phases:

- Fencing of area to form enclosed cells along length as judged appropriate.
- Trapping of animals and translocation to suitable temporary or new replacement dyke receptor sites, as appropriate. This should follow the guidelines given within Strachan (1998) and be undertaken between March and September at least 2 months prior to onset of construction.
- Destruction of habitats and fencing of road to prevent animals returning.

9.7.104 Otter underpasses and new/reinstated culverts should be designed in accordance with current guidelines in the DMRB Good Roads Guide[60]. However due to the low embankment height, there is currently some doubt whether it would be possible to achieve full height (600mm minimum dry headroom on a 10-year return flood event). Flooding is also a potential issue and in this respect the road scheme is unusual, due to the expectation that the road would be prone to flood on a 1:200 year event

[59] Volume 10 DMRB, Section 4, Part 4, HA 81/89, Sub-section 10, Pages 13-14. DETR 1999

[60] Volume 10 DMRB, Section 4, Part 4, HA 81/89, Sub-section 10, Pages 19-23. DETR 1999

basis. This would inevitably on occasion prevent use of the underpasses by otters.

9.7.105 With Option 2 the problems associated with retention of one of the roadside dykes within the central reservation could potentially be resolved by:

- providing a grille over the entrances to underpasses and culverts which would enable water vole access but prevent access by otters;
- using single lengths of pipe for underpasses or culverts which would span the retained dyke and prevent otter access to the central reservation.

However prevention of access to underpasses by otters would defeat their chief purpose. The spanning of underpasses over the retained central reservation dyke would be unsightly and could cause significant dyke management problems, which would adversely affect dyke flora and fauna. Therefore very careful consideration would have to be given to the design of such features.

9.7.106 With Option 2A, single lengths of culvert would be used to cross the entire carriageway system (approx 30m). With Option 2, two sections of underpass would meet in the central reservation and In order to encourage use by otters the underpasses should be as straight (i.e. not zig zagged across the central reservation) and large as possible. If this is achieved despite not meeting design standards it is envisaged that the reinstated culverts and otter underpasses would be used to some extent by otters thus reducing the increased risk of mortality and other severance inherent with the proposals.

9.7.107 It is not considered appropriate to use otter fencing as a general policy along the Acle Straight, due to the severance effects on other wildlife, maintenance problems and (with Option 2) potential dangers of otters becoming trapped within the road corridor. Such fences would also be out of character with the open marshland landscape and would pose problems of accessing ditches for dyke management. However, the localised use of short lengths of otter fencing at known otter crossing points (e.g. the 2 known otter mortality locations) and to direct otters under the culverts / underpasses, may be appropriate. This would be resolved in consultation with English Nature should one of the options be considered for implementation.

9.7.108 Otter underpasses and reinstated culverts should be installed at an early stage in the construction period to reduce severance effects during construction. Post construction they should be regularly monitored and maintained in a fully functional state, to encourage use by animals. A monitoring programme should be put in place to monitor success of any mitigation and demonstrate if additional compensatory works are required. This should include a complete resurvey after one, three years and five years of construction of all water vole populations. Any incidence of

predation by mink would need to be addressed. This is particularly important with Option 2, as the relative isolation of the population would render them more susceptible to extreme changes in population size.

9.7.109 The use of underpasses by otters and other animals should also be monitored and a record kept of any otter mortalities. Such a programme would help to inform any modifications required and would help inform designs of future road developments in similar landscapes.

Otters and Water Voles - Residual Impacts

9.7.110 If the additional mitigation measures discussed above for each of the single lane options, were to be implemented it is predicted that for Option 2 the Neutral magnitude of impact on water voles could be increased to Slight Positive, and the overall assessment category would be Slight Beneficial. For Option 2A, the magnitude of impact on water voles could be reduced to Minor Negative with an overall assessment category of Slight Adverse. For otters the magnitude of impact could be reduced with Option 2 to Intermediate Negative. With Option 2A mitigation would not reduce the magnitude of impact on otters sufficiently to alter the Intermediate Negative assessment. The overall assessment category for otters with both options would therefore be Large Adverse.

Bats - Impacts

9.7.111 No known bat roosts would be affected by any of the routes. However, there remains the possibility that some minor undetected tree roosts may be present e.g. within the woodland areas close to the Acle roundabout. These areas would be unaffected by the development and therefore no impacts are predicted

9.7.112 Long-term increased mortality of animals may result from collisions with vehicles while crossing or foraging close or over the highway. However, the effects are not considered significant in magnitude and are therefore assessed as being neutral for all options. With Option 2 the dyke in the central reservation is likely to become unused by bats due to its location between two carriageways.

9.7.113 There would be significant habitat loss from grazing marsh habitat used by feeding bats with both options although the loss would be slightly less with Option 2A. This loss of feeding territory may be exacerbated by change in land management resulting in field rationalisation and possible changes in land use resulting from altered access arrangements to farm holdings (see Chapter 4).

9.7.114 During the operational phase the most serious cause of habitat degradation for bats would be severance effects, habitat fragmentation and from light pollution. However, The street lighting design would reduce sky glow and

light spill beyond the road corridor resulting in a slight beneficial effect which would be offset by the increase in disturbance from vehicle headlights as a result of increased traffic flow predicted as a result of the proposals.. During construction adverse effects from floodlighting would be minimal as night time working is not envisaged.

9.7.115 Bats are unlikely to be affected by any changes in water pollution levels and tend to feed over most water bodies without regard for their nutrient or pollution status as long as there is an abundant supply of insect prey.

9.7.116 The most likely potential cause of temporary increased mortality is the accidental discovery of roosting bats during demolition of buildings or culverts or felling of trees along the route. Given the paucity of potential roosting sites and provided that adequate precautions are taken during route clearance the effect is seen as being neutral.

9.7.117 The magnitude of impacts on bats for the dual carriageway options is considered to be Minor Negative, due to the loss of foraging ground and increases in severance / traffic effects at night during the operational phase. This feature has a Lower Value and therefore the overall assessment category is Slight Adverse.

Bats - Mitigation

9.7.118 Prior to commencement of construction a bat survey should be undertaken to update current information. This should include any collapsed culverts which are to be reinstated and buildings to be affected by the development. The Environmental Management Plan should include an Action Plan to prevent disturbance to any potential bat roosts that may be discovered. Any unexpected need for felling mature trees of potential for roosting bats, should be accompanied by a detailed plan of fellings and supervision by a suitably qualified bat worker. Should any bats be discovered then works should cease immediately until advice can be sought from the Environmental Manager or English Nature. Any translocation works would require a licence from DEFRA.

9.7.119 The cumulative losses of grazing marsh habitat used by foraging bats in these dual options should be compensated for by the conversion of arable land to tier 3 grassland (see section 9.5). Similarly, the proposed creation of new replacement dyke would prevent losses of dyke feeding habitat for bats and may be beneficial. There are no expected losses of woodland or trees containing bat roosts and therefore compensation is not required in this respect.

9.7.120 If any bat roosts are lost, compensation for the losses should be provided by means of approved bat boxes in suitable trees in the vicinity of the scheme.

Bats - Residual Impact

9.7.121 If the additional mitigation measures are implemented, the magnitude of impacts would be Neutral. The overall assessment category would also be Neutral.

Badgers – Impact and Mitigation

9.7.122 Due to the absence of any badger setts in the study area or its immediate vicinity, Options 2 and 2A would not directly or indirectly effect any badger setts. Similarly, the absence of any signs of badger activity during the survey period and the extremely low level of badger records in the vicinity over recent years, means that any indirect effects on badgers, in terms of loss of foraging area / severance effects are unlikely to be significant or quantifiable. The magnitude of impacts and overall assessment category would therefore be neutral. Consequently specific mitigation measures are not required for badgers although mitigation measures designed to prevent otter mortalities on the road are likely to have an additional and incidental benefit to badgers.

9.7.123 Specific mitigation measures are not considered necessary for badgers although measures designed to prevent otter mortalities on the road are likely to have an additional and incidental benefit to badgers.

Reptiles and Amphibians - Impact

9.7.124 There were no records of great crested newts and there would therefore be no impact on this protected species of amphibian.

9.7.125 Under Options 2 and 2A there would be permanent habitat loss from land take for grass snake and common lizard, both protected species of reptiles. With Option 2 this would mainly be the result of loss of localised lengths of dyke and associated rough grass (grass snake habitat) and rough grass on most of the existing highway verges and embankment slopes (lizard habitat). With Option 2A the loss of one existing roadside dyke represents significant habitat loss for grass snake and most grass on existing verges and embankment slopes would also be lost. With both options there would be loss of rough grass and scattered scrub from the area on the edge of the railway sidings (to the south of the existing road) at Great Yarmouth. This is likely to have adverse impact on populations of lizard.

9.7.126 These losses would be offset by significant provision of new replacement verge or embankment slope grass habitat with both options. With Option 2 a third roadside dyke would be provided representing a significant amount of additional dyke habitat for grass snakes. With Option 2A the lost roadside dyke would be replaced with a substitute ditch alongside the widened embankment (see Section 9.5).

9.7.127 In those areas where land under arable or hay / sileage production abut the road, the provision of access tracks parallel to the road would result in increases in the quantity of rough grass habitat adjoining the roadside dykes. This would be of some benefit to both grass snakes and common lizard and would help off set the permanent losses of habitat noted above. It is not possible, however, to predict future land uses and if these areas were converted back to traditional grazing land use, the extent of this new rough grass habitat would diminish correspondingly.

9.7.128 Localised land use changes resulting from implementation of the proposals could include abandonment of small wedges of land between, for example, the railway and the widened road at the eastern end of the scheme. These small areas would be of potential benefit to reptiles and if acquired by the Highways Agency could be specifically managed to create a small scale mosaic of fen, grassland and scrub habitat of potential benefit to both species.

9.7.129 The lizard populations in the area are thought to be strongly dependant upon the roadside embankments for habitat (although this is not confirmed as a reptile survey was not possible along the highway verges due to health and safety considerations). The re-profiling of existing embankment slopes would cause extensive temporary habitat loss and potential temporary increased mortality for common lizard, which could cause localised extinctions without mitigation. Post-construction the new replacement embankment would provide suitable habitat for reptiles to re-colonise.

9.7.130 Any potential temporary or permanent effects from water pollution and hydrological change could cause a significant negative impact on grass snakes and therefore with Option 2 the dyke in the central reservation could be come unsuitable habitat for that species. This would not affect common lizard.

9.7.131 There could possibly be some minor use of the reinstated culverts by grass snakes but this would not significantly reduce the current severance effect of the existing road. Any potential benefits in this respect would be countered by significant increased severance caused by the increased width of road corridor and the risk of mortality resulting from crossing the road. There are not expected to be any significant additional mortality effects for lizards, which currently utilise the existing road verges but any current occasional crossing of the existing road by lizards is likely to cease with the dual options.

9.7.132 With Option 2 lizards and also grass snakes may successfully inhabit the central reservation but the populations may be at risk due to the relative isolation of the habitat and potential for degradation of the dyke and verges.

9.7.133 The main effects resulting from the proposals on both common lizard and grass snake would be temporary habitat loss, severance and mortality. The magnitude of impact for both grass snake and lizard for Option 2 is

considered to be Minor Negative and for Option 2A, Intermediate Negative. These features both have a Lower Value and for both options and both features the overall assessment category would therefore be Slight Adverse.,.

Reptiles and Amphibians - Mitigation

9.7.134 The scheme design should be reconsidered in order to avoid complete loss of the existing grass vegetation on the embankment slopes to the existing road. This could be achieved by steepening of the slopes and retention of downslope vegetation which would be protected by solid fencing erected in advance of the works (see Figure 9.2). The fencing would also help reduce the potential for construction materials falling into and polluting the roadside dykes.

9.7.135 In dykes and grass area to be lost, due to the protected status of both grass snake and common lizard, it would be necessary to ensure that all reasonable effort is taken to ensure that construction works proceed without loss or injury to these animals. Provided a procedure of trapping and re-location of lizards and grass snakes is undertaken in full accordance with Herpetofauna Groups of Britain and Ireland (HGBI), 2001 Advisory Notes, there would be no predicted losses or local extinctions of populations. The construction, management and monitoring operations for this would be set out in the Environmental Management Plan.

9.7.136 This procedure would involve extensive and time consuming fencing (to form enclosed cells along the scheme length as considered appropriate), trapping and re-locating operations and the allocation of suitable and safeguarded temporary receptor sites for use during the construction period. This would be agreed with English Nature and planned and directed by the Environmental Manager. The translocation works should be undertaken between March and September at least 2 months prior to onset of construction works. Once translocation has been undertaken, the habitat within the development footprint should be destroyed and the reptile fencing left in-situ, to prevent animals returning to former habitat.

9.7.137 The temporary receptor sites, which are likely to consist of specifically prepared rough grass strips, would be managed and safeguarded during the construction period until the new replacement embankment habitat is in favourable condition to receive and support reptiles.

9.7.138 The design description includes measures to be adopted to minimise adverse impacts relating to water quality and hydrology. These are described in Chapter 2 and Chapter 7. There are no specific additional measures required for reptiles and amphibians.

9.7.139 It is expected that post-construction the road verges and embankment slopes would continue to provide habitat of value for reptiles. The Highways

Agency's ongoing role in management of road associated habitat provides the opportunity to optimise the management regime of dykes, verges and embankments for wildlife. The precise measures to be adopted would require careful consideration to ensure that habitat requirements for different species are not in conflict.

9.7.140 This is likely to be most readily achievable by prioritising the requirements of particular species or assemblages of species, in those areas that provide the greatest existing / potential strongholds for them. For example, in the retained area adjoining the railway land at the eastern end of the scheme, there are no particular issues relating to dyke flora and fauna. Therefore habitat management in this area could specifically prioritise the requirements of common lizard. In this area a mosaic of habitats could be provided including tall and short grassland and scattered scrub. Generally measures aimed at optimising the value of dykes for invertebrates and aquatic flora and also for water voles and otters, would also ensure dyke habitat in favourable condition for the generally disparate population of grass snakes.

Reptiles and Amphibians - Residual Impacts

9.7.141 Provided that the mitigation measures set out above are adopted, the magnitude of impact for Option 2 for both features would be altered to Intermediate Positive and for 2A would be Neutral. This is due largely to dyke and grazing marsh creation, slight increased connectivity for grass snakes due to culvert reinstatement, combined with generally increased rough grass habitat as a result of embankment creation countering the temporary effects during construction. The overall assessment categories would be Moderate Beneficial for Option 2 for both features and Neutral for both features for Option 2A.

Table 9.7 Summary of Species Specific Impacts							
Feature	**Value**	**Magnitude of Impacts Before Mitigation Option 2**	**Magnitude of Impacts With Mitigation Option 2**	**Magnitude of Impacts Before Mitigation Option 2A**	**Magnitude of Impacts With Mitigation Option 2A**	**Overall Assessment Category Before/With Mitigation Options 2**	**Overall Assessment Category Before/With Mitigation Option 2A**
Breeding birds	High	Major Negative	Intermediate Negative	Major Negative	Intermediate Negative	Very Large Adverse/ Large Adverse	Very Large Adverse/ Large Adverse
Wintering birds	Very High	Major Negative	Intermediate Negative	Major Negative	Intermediate Negative	Very Large Adverse/ Large Adverse	Very Large Adverse/ Large Adverse
Dyke Vegetation	Very High	Intermediate Negative	Intermediate Negative	Intermediate Negative	Intermediate Negative	Large Adverse/ Large Adverse	Large Adverse/ Large Adverse
Invertebrates	High	Intermediate Negative	Intermediate Negative	Intermediate Negative	Intermediate Negative	Large Adverse/ Large Adverse	Large Adverse/ Large Adverse
Otters	Very High	Major Negative	Intermediate Negative	Intermediate Negative	Intermediate Negative	Large Adverse/ Large Adverse	Large Adverse/ Large Adverse
Water voles	Medium	Neutral	Slight Positive	Intermediate Negative	Minor Negative	Neutral/ Slight Beneficial	Moderate Adverse/ Slight Adverse
Bats	Lower	Minor Negative	Neutral	Minor Negative	Neutral	Neutral/ Neutral	Neutral/ Neutral
Badgers	Lower	Neutral	Neutral	Neutral	Neutral	Neutral/ Neutral	Neutral/ Neutral
Reptiles	Lower	Minor Negative	Intermediate Positive	Intermediate Negative	Neutral	Slight Adverse/ Moderate Beneficial	Slight Adverse/ Neutral

9.8 Summary of Impacts and Significance

9.8.1 The Acle Straight study area is known to provide habitat of international and national importance for a range of species and assemblages of species, due to the extensive areas of grazing marsh, dyke and other associated habitat. In order to provide adequate assessment of the potential effects of the various proposed improvement schemes to the existing A47 road, it was considered necessary to undertake a range of detailed specialist ecological studies over winter 2002/3 and the spring / summer 2003. These studies supplement previous ecological surveys carried out in the study area in recent years and the scope of the surveys was agreed with English Nature.

9.8.2 The specialist surveys included the following interest areas:

- Dyke vegetation
- Invertebrates
- Wintering birds
- Breeding birds
- Otters and water voles
- Bats
- Badgers
- Amphibians and reptiles.

9.8.3 The specialist surveys are reported in stand alone documents, which have been submitted to the stakeholder consultees. The baseline data set out in these documents are summarised in section 4 of this chapter.

9.8.4 In addition to species specific interests, the study area includes or adjoins parts of several designated sites of European/International status. These are the Broads cSAC, Broadland Ramsar, Broadland SPA and the Breydon Water Ramsar and SPA. Encompassed within these sites are the Decoy Carr SSSI, Damgate Marshes SSSI, Halvergate Marshes SSSI and Breydon Water SSSI, sites of UK protected status.

9.8.5 Due to the known sensitivity of the study area the scheme has been designed to incorporate a number of measures aimed at mitigating against specific ecological impacts of the proposals and also at improving the existing situation to some degree. These are summarised below:

- Environmental Management Plan (EMP) to incorporate 'Best Practise', prior to, during and after construction.
- Environmental Manager to liaise with statutory consultees, instigate appropriate monitoring and agreed mitigation, monitoring and protection measures immediately prior to and during construction.

- Exclusion of site compounds from area administered by the Broads Authority.
- Create all replacement dykes before existing dykes are disturbed.
- Bridging rather than culverting of perpendicular dykes.
- Use of inert construction materials to minimise risks of damaging leachates entering dykes.
- Highways Agency (HA) long term obligation to maintain dykes and other retained habitat.
- Installation of sluices / stop logs to roadside drainage ditches to contain accidental spills of hazardous liquids and isolate ditch compartments.
- Reinstatement of collapsed culverts and incorporation of additional otter under-passes.
- Substitution of existing street lighting with a new system using full cut off lamps which would reduce sky glow and light spill outside highway boundary.

9.8.6 When considering the effects of construction and operation of the proposals it is important to note that the existing A47 already influences the movement patterns and habitat distribution of all the communities and individual species of plants and animals in its vicinity. However the two dual lane schemes would result in considerable additional land take and resulting disturbance to habitats.

9.8.7 Although the proposals for the dual options incorporate measures to minimise disruption during the construction and operational phases of the scheme it is acknowledged that alterations to the study area associated with both options have the potential to exert considerable adverse effects on the ecology of the area. This is due to its international and national level of importance and the little known sensitivities and habitat requirements of some key species. Sources of impact may result from :

- Direct land take
- Indirect disturbance and other effects during the construction period– noise, lighting, material pollution and timing of operations
- Operational severance (habitat fragmentation) / mortality
- Other post construction effects - habitat degradation, operational noise, lighting, pollution and ensuing effects on water quality, drainage and land management.

9.8.8 The two options under consideration have the potential to exert slightly different adverse impacts either during construction or operation of the improved road.

9.8.9 Option 2 has no losses of dykes of international importance and the scheme provides the greatest amount of retention / replacement dyke than the other options. The option retains both existing roadside dykes with one of the

roadside dykes retained within a central reservation. The future ecological value of this dyke and the associated embankment habitat would depend on the extent to which the retained dyke deteriorates in quality due to hydrological and water quality changes, noise and other disturbance and other issues including habitat severance, mortality and management changes.

9.8.10 The full ecological implications of Option 2 are difficult to predict. The dyke flora and invertebrate fauna are likely to decline in status and whilst the central reservation may be used by water voles, reptiles, bats and other wildlife to an uncertain degree, there are significant potential dangers to otters and barn owls and use by other birds is unlikely. In this option there are no losses of dykes within the Damgate Marshes SSSI or other dykes of international importance and the scheme provides for the greatest amount of retention / replacement dyke than the other options.

9.8.11 Option 2A results in one entire roadside dyke would be lost and replaced, there would be no retention of a central reservation dyke and overall land loss would be less than Option 2. There would be loss of 600m of dyke of international ecological value in the western part of the scheme but no losses of dyke within the Damgate Marshes SSSI.

9.8.12 The overall assessment categories of impact identified for the various ecological features of the study area resulting from implementation of Options 2 and 2A are summarised in Table 9.6. The pre mitigation impacts take account of the scheme description in Chapter 2 but are prior to any additional mitigation. The post mitigation impacts assume implementation of the mitigation measures described in Sections 9.5, 9.6 and 9.7. The overall assessment for each option takes account of the most negative category, cumulative adverse effects and positive effects.

Table 9.8 Summary of Overall Assessment Categories				
Feature (Nature Conservation Value of Feature in brackets)	**Option 2 Pre Mitigation**	**Option 2 Post Mitigation**	**Option 2A Pre Mitigation**	**Option 2A Post Mitigation**
Breeding birds (High)	Very Large Adverse	Large Adverse	Very Large Adverse	Large Adverse
Wintering birds (Very High)	Very Large Adverse	Large Adverse	Very Large Adverse	Large Adverse
Dyke Vegetation (Very High)	Large Adverse	Large Adverse	Large Adverse	Large Adverse
Invertebrates (High)	Large Adverse	Large Adverse	Large Adverse	Large Adverse
Otters (Very High)	Very Large Adverse	Large Adverse	Large Adverse	Large Adverse
Water voles (Medium)	Neutral	Slight Beneficial	Moderate Adverse	Slight Adverse
Bats (Lower – no roosts)	Slight Adverse	Neutral	Slight Adverse	Neutral
Badgers (Lower)	Neutral	Neutral	Neutral	Neutral
Reptiles (Lower)	Slight Adverse	Moderate Beneficial	Slight Adverse	Neutral
Broads cSAC and Broadland Ramsar (incorporating Damgate Marshes SSSI) (Very High)	Large Adverse	Slight Adverse	Large Adverse	Slight Adverse
Broadland SPA (Very High)	Neutral	Neutral	Neutral	Neutral
Breydon Water SPA, Ramsar and SSSI (Very High)	Large Adverse	Slight Adverse	Large Adverse	Slight Adverse
Halvergate Marshes and Decoy Carr SSSI (High)	Neutral	Neutral	Neutral	Neutral
River Bure (Medium)	Neutral	Slight Adverse	Neutral	Slight Adverse
General Grazing Marsh (Medium)	Slight Adverse	Slight Beneficial	Slight Adverse	Slight Beneficial
Other Habitats (Lower)	Slight Adverse	Neutral	Slight Adverse	Neutral
Overall assessment for each Option	Very Large Adverse	Large Adverse	Very Large Adverse	Large Adverse

9.8.13 There is a wide diversity of ecological interests within the study area and in some instances there are conflicting habitat requirements and sensitivities between these different features. In determining feasible mitigation measures a decision has been taken to give priority to those features for which this particular part of the Broads grazing marsh environment is considered unique i.e. the dyke flora and invertebrate fauna. The habitat requirements of breeding and wintering birds are also of primary

importance, followed by otters and to a lesser extent bats, water voles and reptiles.

9.8.14 The main feasible additional mitigation measures are summarised as :

1 Compensation habitat

- Lost sections of dyke to be replaced by new dyke habitat on the basis of 1:3 for dykes of international importance and 1:2 for all other dyke losses.
- Grazing marsh replacement (conversion of arable and improved grassland to tier 3 ESA grazing marsh) also to be 1:3 for areas of international importance and 1:1 elsewhere.
- New dykes to be created at least 3 years prior to onset of construction works, to allow translocation / natural colonisation and create established conditions prior to loss of existing dyke sections.

2 Further studies: investigation into habitat requirements and tolerance levels of key species of dyke flora and invertebrate fauna, in order to ascertain the feasibility of habitat creation/translocation and inform impact assessment procedures.

3 Construction measures: specific measures additional to standard 'Best Practise' to be included in the EMP. These would include use of temporary fencing / screens in strategic sensitive locations, specific timing of disruptive works to protect breeding and wintering birds, possible use of plastic liners / containment ditches.

4 Habitat management: specific measures to mimic grazing of dyke margins, monitoring of populations and habitats.

5 Protected species conservation: particular measures designed to protect, conserve and enhance indigenous populations of bats, reptiles, otters, water voles and protected species of birds. This includes all necessary operations and licences to comply with the legislation.

6 European and UK designated site protection: specific measures to protect the internationally and nationally important populations of breeding and wintering birds and other priority features.

9.8.15 The overall assessment category for each of the dual options pre-mitigation is considered to be Very Large Adverse. Notwithstanding significant potential long term benefits associated with habitat creation, there are also significant potential impacts on ecological considerations that would not necessarily be negated by implementation of either the incorporated or the recommended additional mitigation measures. Post-mitigation the overall assessment category for both Option 2 and 2A is considered to be Large Adverse.

9.8.16 The residual impacts for the dual options are summarised in Table 9.6 and include:

- losses of valuable dyke communities of flora and fauna on the assumption that translocation would not necessarily succeed;
- potential deterioration of retained dyke habitat due to possible hydrological and water quality changes;
- localised losses of land within the Broads cSAC and Ramsar site;
- losses of other grazing marsh habitat;
- construction phase noise and light disturbance and deterioration of retained dyke habitat mainly due to possible hydrological and water quality changes;
- the increased speed of traffic resulting in potential increases in mortality of fauna, severance and disturbance effects

9.8.17 The overall difference in level of residual impact between Options 2 and 2A is relatively small and uncertain. On balance it is considered that the potential adverse effects of Option 2A post-mitigation are slightly greater than those connected with Option 2. This is because the extensive loss of dyke in Option 2A is considered to result in overall greater adverse impact than the correspondingly increased loss of grazing marsh and deterioration in quality of the retained dyke associated with Option 2. Option 2 includes overall greatest provision of new and retained dyke habitat and results in no losses of dyke of international ecological importance.

9.8.18 The level of these potential impacts for Options 2 and 2A should be considered as a 'worst case scenario' on the basis that full adoption of the recommended mitigation measures if successful could off set some of the effects to a much greater extent than indicated. The extent to which potential impacts would be offset, for example through compensatory land provision and sympathetic management, of retained and new habitat, cannot be accurately predicted. This is due to the intrinsic uncertainties involved e.g. at this stage it is not known where habitat creation measures would be located or precisely how they would be achieved. The degree of success of such schemes would also partly depend on the co-operation of local land-owners and the extent to which appropriate habitat management can be guaranteed in the future.

10 Cultural Heritage

10.1 Introduction

10.1.1 This chapter assesses the potential effects on cultural heritage within the study area resulting from the implementation of two dual carriageway options, referred to as Options 2 and 2A. Cultural heritage includes both archaeology and built heritage. Archaeology is defined as the remains of cultural heritage within or excavated from the soil strata and for the purpose of this assessment includes sites of historical association where only documentary evidence of a relict feature survives. Built heritage can be defined as extant structures of historic or architectural importance.

10.1.2 The assessment identifies and describes the archaeology and built heritage within the study area in terms of its survival and potential significance. Areas of unknown archaeological potential are also identified. Reference is also made to the history of the study area's landscape. The assessment then identifies the potential effects of the scheme on both the integrity and the setting of archaeological and built heritage sites in the study area. Potential effects on the landscape are addressed in Chapter 8.

10.2 Methodology

10.2.1 The methodology followed in this assessment has been carried out in accordance with the requirements of the DMRB[61] as supplemented by the significance criteria used in Guidance on the Methodology for Multi-Modal Studies[62] and the standards published by the Institute of Field Archaeologists[63].

10.2.2 The archaeological study area comprises a 500m corridor on either side of the road and is indicated on Figure 10.1. The study area for built heritage comprises the scheme's visual envelope which is extensive due to the flat open nature of the landscape (figure 8.1).

10.2.3 The information sources used for this assessment include:

- Norfolk Sites and Monuments Records (SMR);
- The National Monuments Record (NMR);
- A Report of an evaluation at A47 Acle Straight by Norfolk Archaeological Unit, 1993;

[61] Design Manual for Roads and Bridges, Highways Agency, Volume 11, Section 3, Part 2, August 1994.
[62] Guidance on the Methodology for Multi-Modal Studies, DETR, 2000.
[63] The Standard and Guidance for the Preparation of Archaeological Desk-Based Assessments, Institute of Field Archaeologists, 1994.

- A47 Multi-Modal Transport Study: Report on an Archaeological Desk Top Survey,Norfolk Archaeological Unit, 2000;
- Information on Heritage from Broadland District Council;
- Information on Heritage from the Broads Authority;
- The Norfolk Broads. A Landscape History, Tom Williamson, 1997.
- Unpublished historic landscape assessment work prepared for the Broads Authority.

A full list of documents consulted is given in Appendix 10.1.

10.2.4 English Heritage and the County Archaeologist in Norfolk were consulted to confirm the presence of archaeological sites/finds of interest within the study area, the impact of the proposed scheme on any archaeological remains and any mitigation measures that could be required.

10.2.5 The archaeology and built heritage within the study area has been appraised on the following features:

- form – a factual description of the site;
- survival – the completeness of the site;
- condition – the current management and stability of the site;
- complexity – the diversity of the heritage resource within the site;
- context – the quality of the site's setting and its sense of place within its surroundings;
- rarity – the representational value of the heritage resource at the site.

10.2.6 An assessment of cultural heritage importance of each heritage site was made according to a scale of 'national', 'regional' or 'local' importance, as follows:

- Buildings or structures designated as Grade I listed or Scheduled Ancient Monuments can be categorised as being of 'national' importance. Grade I listed buildings are of exceptional interest and nationally comprise approximately 1.4% of listed buildings. Sites on the World Heritage List are of international and therefore national importance. Some Conservation Areas may also be of national importance if associated with past events of national significance or if they are historic landscapes of national importance.
- Buildings or structures designated as Grade II* can be categorised as being of 'regional' importance. Grade II* denotes buildings of more than special interest and nationally comprise of approximately 4% of the listed structures. Some Grade II listed buildings can also be considered to be of regional importance if contributing to and located within a Conservation Area of national or regional importance.

- All other Grade II listed buildings and structures and those designated by local authorities as being of Special Local Interest can be categorised as being of local significance.

10.2.7 Potential impacts on sites of cultural heritage importance and on the wider historic landscape arising from construction projects include:

- direct loss or damage;
- indirect damage through drainage, vibration or subsidence;
- severance of linked features;
- visual or other positive or negative impacts on the setting of the site.

Significance Criteria

10.2.8 The effects on archaeology and the built heritage resulting from scheme implementation have been assessed using the significance criteria described in Table 10.1.

Table 10. 1: Significance Criteria used in Archaeology and Built Heritage Assessment	
Score	**Comments**
Large beneficial (positive) effect	The proposals would: -provide potential, through removal, relocation or substantial mitigation of very damaging or discordant existing impacts (direct or indirect) on the heritage, for very significant or extensive restoration or enhancement of characteristic features or their setting; - remove or successfully mitigate existing visual intrusion, such that the integrity, understanding and sense of place of a highly valued area, a group of sites or features of national or regional significance is re-established.
Moderate beneficial (positive) effect	The proposals would: -provide potential, through removal, relocation or mitigation of damaging or discordant existing impacts on the heritage, for significant restoration of characteristic features or their setting; - enhance existing historic landscape/townscape character through beneficial landscaping/mitigation and good design.
Slight beneficial (positive) effect	The proposals would: -restore or enhance the form, scale, pattern or sense of place of the heritage resource through good design and mitigation; - remove or mitigate visual intrusion (or other indirect impacts) into the context of locally or regionally significant heritage features, such that appreciation and understanding of them is improved.
Neutral effect	The proposals would: -maintain existing historic character in a landscape/townscape; - have no appreciable impacts, either positive or negative, on any known or potential heritage assets; - are a combination of slight positive and negative impacts, on locally significant aspects of the heritage; - do not result in severance or loss of integrity, context or understanding within a historic landscape.
Slight adverse (negative) effect	The proposals would: - have a detrimental impact on the context of regionally or locally significant assets, such that their integrity is compromised and appreciation and understanding of them is diminished; - damage locally significant heritage features for which adequate mitigation can be specified; - not fit well with the form, scale, pattern and character of a historic landscape/townscape/area.
Moderate adverse (negative) effect	The proposals would: - be out of scale with, or at odds with the scale, pattern or form of the heritage resource; - be intrusive in the setting (context), and would adversely affect the appreciation and understanding of the characteristic heritage resource; - be damaging to nationally significant heritage assets, resulting in loss of features such that their integrity is substantially compromised, but adequate mitigation can be specified.
Large adverse (negative) effect	The proposals would: - have a major direct impact on nationally significant heritage assets such that they are lost or their integrity is severely damaged; - have a moderate direct impact on or compromise the wide setting of multiple nationally or regionally significant heritage assets, such that the cumulative impact would seriously compromise the integrity of a related group or historic landscape/townscape; - have a major direct impact on regional heritage assets, such that their integrity is lost and no adequate mitigation can be specified; - be highly intrusive and would seriously damage the setting of the heritage resource, such that its context is seriously compromised and can no longer be appreciated or understood; - be strongly at variance with the form, scale and pattern of a historic landscape/townscape.
Note: Significance criteria based on Guidance On the Methodology for Multi-Modal Studies, DETR, 2000.	

Consultations

10.2.9 Consultations have been carried out with interested parties to confirm statutory designations within the study area and to establish the existence of features with heritage and archaeological importance. The following organisations have been consulted:

- English Heritage
- Norfolk County Council
- Broads Authority
- Broadland District Council
- Great Yarmouth Borough Council

10.2.10 English Heritage and the County Archaeologist requested that an archaeological walk over survey be competed in the study area to identify any possible archaeological sites not recorded in the Norfolk Historic Environment Record together with trial trenching in one small site of archaeological potential. Results of this investigation are discussed in clause 10.4.3.

10.3 Legislation

10.3.1 The World Heritage List was established under terms of The Convention Concerning the Protection of the World Cultural and Natural Heritage adopted in November 1972 at the 17th General Conference of UNESCO. Within the study area there is a Conservation Area and a number of listed buildings. Such features are designated under Section 1 of the Planning (Listed Building and Conservation Areas) Act, 1990. National policy advice on Conservation Areas and Listed Buildings is given in PPG15: Planning and the Historic Environment. The principal legislation concerning archaeology is the 1979 Ancient Monuments and Archaeological Areas Act, which provides statutory protection of monuments of national importance (Scheduled Ancient Monuments). In addition PPG16: Archaeology and Planning gives advice on handling of archaeological matters in the planning process.

10.3.2 Other sites of archaeological significance are entered onto county-based Sites and Monuments Records (SMR's) under the 1990 Town and Country Planning Act. The National Monuments Record (NMR) is an index of the more detailed information held in the various County Sites and Monuments records.

10.3.3 Conservation Areas are identified by the Local Planning Authority as areas of special architectural or historic interest, where it is important to preserve or enhance their character or appearance. Designating a Conservation Area provides a focus for Council and private efforts to improve the environment with the following main objectives:

- control demolition of any building, whether it is listed or not;
- protect trees;
- strengthen control over new development, so that it must positively preserve or enhance the character or appearance of the area.

10.3.4 The Secretary of State for Culture, Media and Sport selects buildings for inclusion as Listed Buildings according to their special architectural or historic interest. In compiling the list he is advised by the Historic Buildings and Monuments Commission (English Heritage).

10.3.5 The expression 'Listed Building' can be applied to objects or structures not conventionally described as buildings – for example bollards, railings, war memorials, mileposts etc. Buildings can be listed for their individual importance or as part of a group and it is usually the whole of the building, together with all other structures within its boundary or 'curtilage' which is listed, not just its most important features. Once the building has been listed, the owner has to obtain Listed Building Consent from the Council before carrying out any demolition, alteration or extension.

10.3.6 Policies relating to archaeology and built heritage which are significant to implementation of this scheme are discussed in Chapter 3, Planning.

10.4 Baseline Situation

Development of the Landscape

10.4.1 The present A47 road travels from Acle to Great Yarmouth across pasture/ salt marsh that is drained by dykes into the River Bure to the north and the River Yare and Breydon Water to the south. The road was constructed in the 1830s and was originally known as the Norwich – Acle Turnpike. It crosses an area of landscape referred to as the Halvergate 'triangle', which roughly comprises today's Halvergate Marshes Conservation Area. This landscape has an ancient and complex origin.

10.4.1 During the Roman period the area of Halvergate was an estuary but became drier during middle Saxon times. To protect the marshes from further flooding inhabitants of the area embanked the rivers with clay. The present surface of Halvergate is covered in a complex pattern of relict watercourses and dry depressions, which mark the earlier times when it was covered with mud flats and salt marsh. During Saxon times the marshes were probably crossed by a number of tidal creeks. Domesday (1086) records a number of salt pans in the area.

10.4.2 It is believed that the beginnings of a salt industry coincided with the Saxon period. There are a number of salt working sites and mills in the area which

indicate the marshy or flooded landscape that previously existed. Salt working became an important industry in Norfolk although it was confined to two areas, east Norfolk around Great Yarmouth and the north western corner of Norfolk. Its production depended either on inland brim springs or coastal pans. Salt pans consisted of trenches which would fill with salt water during high tides and then dry out leaving the salt as the water evaporated. Mounds resulting from the digging of these pans and from the residue of silt left from the salt-making process show the extent of former workings.

10.4.3 By the late Saxon period it is believed that farmstead settlements began to be established in the marshes. Evidence inferred from local place names suggests that by the 11th or 12th century the Halvergate marshes were a valuable resource divided into discrete areas. In the 12th and 13th centuries landlords grazed vast numbers of sheep on the marshes and sheep continued to dominate the marsh until the 16th century when evidence indicates that cattle became the most important stock kept by farmers.

10.4.4 The grazing and the production of salt resulted in continued establishment of farms and cottages. In early medieval times the marsh farms were built on low mounds to reduce vulnerability to flooding. A number of mounds remain on the present day landscape one of which (Ashtree Farm, site A24), was found to contain pottery dating from the 11th to 13th century when excavated. The extent of early settlement within the marsh is difficult to ascertain as many medieval sites are hidden beneath existing marsh farms and most of the marsh has not been systematically fieldwalked.

10.4.5 Sources indicate that there was remarkably little change in the economy of Halvergate from the 17th to 20th centuries where cattle were fattened up on the marshes. During the course of the 20th century the number of marsh houses declined gradually but the characteristic lifestyle of the inhabitants (marshmen) survived into the 1950s and 1960s. There are still a small number of houses on the marshes today.

10.4.6 Rising sea levels and an increase in waterlogging led to widespread construction of drainage mills through the course of the 18th century. Although it is thought that windpumps were first introduced to the Broads in the 16th century, most of those on the Halvergate Marshes are 18th and 19th century structures. The drainage mills, or wind pumps were used to pump water from the marshes and dykes to the rivers. During the nineteenth century some windmills were replaced by steam pumps. In the 20th century diesel pumps were introduced and the process of change continues with all pumps now driven by electricity.

The Dyke System

10.4.7 The complex variety in the pattern of the dykes is born from the land use and settlement on the marsh. The dyke pattern on the 1830s/1840s Tithe Award Maps is generally very similar to that which exists in the non-arable areas of the marsh today. The dyke pattern on Halvergate has developed

gradually over the centuries with numerous piecemeal additions and alterations.

10.4.8 The marsh dykes can be categorised according to their form into a number of distinct groups but some dykes do not fall into any clear category. There are the long dykes that cross the marsh in straight lines or smooth curves and terminate at a drainage mill situated beside a major watercourse. The most common type are straight dykes created in the 17th to the early 19th centuries. Additionally, there are serpentine dykes the curvilinear watercourses that represent adaptations of the old, natural pattern of drainage. These are survivors from a denser pattern of natural watercourses which now exists as a network of shallow indentations in the marsh turf. The survivors from the original pattern have an interesting characteristic as the majority form parish boundaries and boundaries of embanked areas. These dykes were less easily altered and thus retained their irregular form. The Halvergate Fleet is an example of this (clause 10.4.22).

Relict Watercourses

10.4.9 The transition from open water to dry land has left its mark on the landscape in the form of relict water courses of varying sizes ranging from small dry depressions approximately a metre wide to much larger meandering channels. One such example, The Northern Rond, was a recognisable feature of the landscape as late as 1840. The feature can still be depicted on land maps (figure 10.1), with the former watercourse now utilised for field drainage.

10.4.10 Several relict watercourses have had substantial banks built up along them and were used as trackways through the marshes. Before the construction of the Acle Straight one such track, which ran along the main routeway alongside the Halvergate Fleet (another relict creek that remains as a watercourse crossing the marsh) was the main routeway across the marshes to Great Yarmouth. The route of this track is still evident today, marked by the designated long distance path known as the Weaver's Way. There are a number of drainage mills built beside Halvergate Fleet such as High Drainage Mill (site B45) and Howards Drainage Mill (site B46) and also a large number of marsh farms e.g. site B43 (figure 10.1). Buildings were constructed here to utilise the firmer and higher land.

Communication Routes

10.4.11 When constructed, the Acle Straight became the main communication link across the Halvergate marshes. The road was originally fully lined with low pollarded willows planted to prevent it from subsiding into the ditches. Trees along the route are now much more intermittent, however, an example of this former landscape is evident along the Halvergate Branch Road which was constructed at a similar time to the Acle Straight.

10.4.12 On the outskirts of Acle town at Acle Roundabout the existing A47 meets the north-south A1064 which is called the Acle to Billockby Road. This road is more or less on the same line as that shown on William Faden's county map of 1797. The road could have been realigned slightly but it is unlikely that much has changed. It like the other routes is lined with low pollarded willows.

10.4.13 The Norfolk Railway (site B9) also known as the Norwich to Yarmouth (via Reedham) Railway Line opened in 1844 and crosses through the Halvergate marsh. The Acle branch of the Norfolk Railway (site B10) is another line that also crosses through the marsh. It was opened in 1883 and it travels parallel to the south of the A47 between the towns of Great Yarmouth and Acle.

10.4.14 The River Yare has carried traffic since Roman times but navigation was difficult due to the shallow depth of Breydon Water. In the 1840s the Yarmouth authorities dredged the Breydon channel so that sea ships could use the River Yare and travel to Norwich. This river has no locks in its navigation from Yarmouth to Norwich.

Built Heritage in the Study Area

10.4.15 No area of the Broads appears on the World Heritage List however it is an objective of the Broads Authority to submit a bid for this status to be applied to the whole of the area it covers. Much of the study area lies within the Halvergate Marshes Conservation Area designated in 1995 by the Broads Authority because of the areas special historical and architectural interest. The area is historically interesting because it represents the largest area of grazing marsh left in Eastern England. It has been developed by humans over many centuries to form a flat landscape dissected by embanked rivers and a complex arrangement of dykes. The architectural interest is provided by the largest concentration of drainage mills (or wind-pumps) in the Broads Area. These features form major landmarks in the open landscape and an important part of the industrial archaeology of the Broads.

10.4.16 Numerous World War II features have been identified at the Acle Town end of the study area. Individually these might comprise locally important heritage features, collectively however within the region they constitute a system of national importance. In addition, two World War I pillboxes are located on either side of the existing A47 carriageway toward the Great Yarmouth end of the scheme. These are currently being reviewed for scheduling as Scheduled Ancient Monuments (SAMs) by English Heritage. Only twelve such structures remain in Norfolk (NAU, 1993).

10.4.17 Built Heritage features are listed in table 10.3. Those features within the Halvergate Marshes Conservation Area are denoted by an asterisk. All of the sites have been allocated a number and their locations marked on Figure 10.1.

Archaeology finds in the Study Area

10.4.18 An archaeological walkover survey revealed some previously unrecorded earthworks in close proximity to the A47 Acle Straight. A linear feature was identified adjacent to a relict channel and interpreted as being a levee. The levee would have been exposed as the area became dry during the Saxon period. Three sub-rectangular earthworks were superimposed on the levee and were interpreted as being remains of structures (site A45 on table 10.2). Lack of artifactual evidence means that they can not be dated with certainty at this time.

10.4.19 A suspected saltern, adjacent to the A47 was to be evaluated by trial trenching. However, this feature was absent when the site was visited. Anecdotal evidence obtained from local landowners suggested that the feature was not of archaeological interest and had been removed some years earlier. The site (A10) is listed in table 10.2 for completeness.

Prehistoric Period (pre –AD 43)

10.4.20 A number of flint axe heads and arrowheads were found in the study area such as find spot sites A1 and A27. All three of these finds were in the vicinity of Acle town. A gold coin of the same period was also found south of Acle but the exact location is unknown.

Roman Period (AD 43-410)

10.4.21 The find for this period consisted of items such as coins, rings, pottery, pendants and tiles. Most of the items were found in and around Acle town but there were also finds on the outskirts of Great Yarmouth e.g. site A23.

Saxon (AD 410-1066)

10.4.22 Earthworks identified during the archaeological walkover survey (A45) can not be firmly dated or characterised without further archaeological excavation. However, it is possible that these features are of Saxon origin.

Medieval Period (AD1066-1540)

10.4.23 A number of salt mounds from this period have been found in the study area, e.g. A16.

10.4.24 Pottery, sherds and tiles dating to the medieval period were found during construction along the Bacton to Great Yarmouth pipeline at sites A19, A20, A21 and A24.

Post Medieval Period (from AD1540)

10.4.25 A former drainage windmill (A8) and a lime kiln (A9), both of which have been demolished, a workhouse (site A2), a brickworks (A4) and former Hermitage Inn (A7) date from this period.

Industrial (mid AD1800 onwards)

10.4.26 The dismantled Midland and Great Northern Railway Line was constructed in 1879 and in addition a number of World War I and II relicts, including, tank traps (A22) and pill boxes (B17) have been identified from this period.

10.4.27 Archaeological features are listed below in table 10.2 and built heritage features in Table 10.3.

Table 10.2: Archaeological Sites in the Study Area

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
A1. Find spot	Flint axe-head, 7" long	Axe-head chipped and partly polished	Not known	N/A	Found in field near marshes at Rose Farm	Neolithic 4000BC to 2351 BC	Local	Recorded on SMR no. 10368	Common
A2. A workhouse	A house of industry	Destroyed by fire in 1834	Not known	N/A	Located in Acle town	1788	Local	Recorded on SMR, no. 12198	Common
A3. Midland and Great Northern Joint Railway	Railway line	Demolished	Railway line does not remain	Part used for A149 road and long-distance footpath the Weavers Way	On outskirts of Great Yarmouth	1879	Local	Recorded on SMR, no. 13581	Common
A4. Brickworks	A brick kiln and yard	Demolished	Built over	Below ground	Acle town and old peoples bungalow on the site	1540 AD to 1900 AD.Marked on 1830 map	Local	Recorded on SMR no. 14224	Common
A5. Find spot	Reused masonry with former doorway.	Stray find	Not known	Items could have come from Weybridge Priory or Manor. .	East of Calthorpe Cottages	1066 AD to 1900 AD	Local	Recorded on SMR, no. 14707	Common
A7. Hermitage	Hermitage Inn	Demolished	A brick cottage occupies the site	N/A	Located at edge of town	Early 18th Century	Local	Recorded on SMR no. 15130	Common
A8. Wind pump	Site of a drainage wind mill	Demolished	Not known	N/A	Located on south bank	1540 AD to 1900	Local	Recorded on SMR no. 15639	Common

Table 10.2: Archaeological Sites in the Study Area									
Site	**Form**	**Survival**	**Condition**	**Complexity**	**Context**	**Period**	**Scale it Matters**	**Significance**	**Rarity**
					of River Bure	AD			
A9. Lime kiln	Lime kiln	Demolished	Not known	N/A	Located at North Quay, Gt Yarmouth	1540 AD to 1900 AD	Local	Recorded on SMR, no. 15667	Common
A10.Mound	Low mound, (1m high, 25m across), crowned by corrugated iron cowshed	Not present on site.	Removed.	Possible saltern site	In field south of Stracey Arms P.H	N/A	Local	Recorded on SMR no. 21295	Common
A11. Find spot	Lead/ pewter seal	Stray find	Not known	N/A	Located alongside Acle Dyke,	13th Century	Local	Recorded on SMR no. 21717	Common
A12. Find spot	Bronze finger ring, gilt bronze mount, book clasp fragment	Stray find	Not known	N/A	Found in Acle Marshes	Roman, Medieval and Post Medieval	Local	Recorded on SMR no. 22355	Common
A13. Find spot	Bronze harness, pendant and silver halfpenny	Stray find	Not known	N/A	Found in Acle town	Roman, Medieval and Post Medieval	Local	Recorded on SMR no. 23167	Common
A14. Find spot	Coins, rings, pottery, harness pendant	Stray find	Not known	N/A	Found in Acle town	Roman, Medieval and Post Medieval	Local	Recorded on SMR no. 24118	Common
A15. Find spot	Coins, sherds, metalwork	Stray find	Not known	N/A	Found in Acle town	Roman, Medieval, Post Medieval	Local	Recorded on SMR no. 25023	Common

Table 10.2: Archaeological Sites in the Study Area

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
A16. A salt working mound	Salt mound, approx. 60 metres long, up to 1.75m high, SE end cut by present dyke.	Partly cut by dykes	Not known	Resembles a mill mound but no record of a drainage mill here	On Acle Marshes	1066 AD to 1539 AD	Local	Recorded on SMR no. 25151	Rare
A18. Icehouse	A former icehouse	Demolished	Not known	Burnt 1853 and rebuilt, converted to coal store by 1884.	Beside railway on outskirts of Great Yarmouth	Before 1851	Local	Recorded on SMR no. 28939	Common
A19. & A19.1 Find spot	Pottery	Stray find	Not known	N/A	Found along Bacton to Gt Yarmouth pipeline	12th-13th Century	Local	Recorded on SMR no. 34042	Common
A20. & A20.1 Find spot	Pottery	Stray find	Not known	N/A	Found along Bacton to Gt Yarmouth pipeline.	12th-13th Century	Local	Recorded on SMR no. 34043	Common
A21. & A21.1 Find spot	Tiles and sherds	Stray find	Not known	N/A	Found along Bacton to Gt Yarmouth pipeline.	Medieval and Post Medieval	Local	Recorded on SMR no. 34044	Common
A22. Tank Trap	Three World War 2 Tank traps, concrete cubes	Below ground	Not known	Covered over	In road in centre of Acle.	1939 to 1945 World War Two	Local	Recorded on SMR no. 37597	Common
A23. Cemetery Cremation	Bronze coins and fragments of cinerary urns	Stray find	Not known	Could have been a cremation cemetery	Outskirts of Gt Yarmouth	43 AD to 650 AD	Local	Recorded on SMR no. 4291	Common

Table 10.2: Archaeological Sites in the Study Area

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
A24. Ashtree Farm	A mound 60m x 40m and 1-2m high which contained pottery	Not known, suspected fair/poor	Not known, suspected fair/poor	Probably related to salt workings. A WWII pillbox is situated on top.	Near junction of the two rail lines	11th to 13th Century	Local	Recorded on SMR no. 4322	Common
A25. Wind pump and Mound	A mound about 5ft high, animal bones, oyster shells, flints and pottery.	Was bulldozed in 1964	Poor condition	Possibly a pumping mill site or salt working site.	Located on outskirts of Gt Yarmouth	14th to 18th Century	Local	Recorded on SMR no. 4323	Common
A26. Find spot	Black flint axe, polished, butt broken	Covered by housing estate	Not known	N/A	Located in Acle town	4000 BC to 2351 BC	Local	Recorded on SMR no. 8593	Common
A27. Find spot	Barbed and tangled flint arrowhead	Covered by houses	Not known	N/A	Located in Acle town	2350 BC to 701 BC	Local	Recorded on SMR no. 8595	Common
A28. Find spot	Short cross penny	Stray find	Not known	N/A	Located in Acle town	1150 to 1189	Local	Recorded on SMR no. 8598	Common
A29. Manor House	Site of Manor House	Stray finds	Below ground	N/A	East of church, in Acle town. Part is built over.	Marked on 1836 OS maps	Local	Recorded on SMR no. 8608	Common
A30. Find spot. (not shown on plan)	Gold Icenian Coin	Stray find	Not known	N/A	South of Acle, exact location unknown	800 BC to 42 AD	Local	Recorded on SMR no. 8596	Common

Table 10.2: Archaeological Sites in the Study Area									
Site	**Form**	**Survival**	**Condition**	**Complexity**	**Context**	**Period**	**Scale it Matters**	**Significance**	**Rarity**
A31. Find spot. (not shown on plan)	Silver coin of Antoninus Pius	Stray find	Not known	N/A	South of Acle, exact location unknown	43 AD to 409 AD	Local	Recorded on SMR no. 8597	Common
A32. Find spot. (not shown on plan)	Ladle or pipkin handle	Stray find	Not known	Imported from Rhineland	South of Acle, exact location unknown	1066 AD to 1539 AD	Local	Recorded on SMR no. 8599	Common
A33. Findspot. (not shown on plan)	Coin	Stray find	Not known	N/A	Exact site unknown, somewhere in Acle	43 AD to 409 AD	Local	Recorded on SMR no. 17262	Common
A36. Acle Marsh House	Marsh Farm	Not known	N/A	N/A	Located on Tunstall Marshes beside 'Northern Rond'	18th Century	Local	No SMR no.	Common
A40. Pillbox	Site of a Pillbox	Not known	N/A	N/A	Located on northside banks of Acle Dyke	1939 to 1945 World War Two	Local	Recorded on SMR, no. 16802	Common
A41. Pillbox	Site of a type 22 Pillbox	Demolished in 1991	N/A	N/A	Locatedin Acle town	1939 to 1945 World War Two	Local	Recorded on SMR, no. 32637	Common
A42. Spigot, Mortar, Emplacement	Site of a spigot, mortar, emplacement structure.	Demolished	N/A	N/A	Located in Acle town	1939 to 1945 World War Two	Local	Recorded on SMR, no. 36769	Common

Table 10.2: Archaeological Sites in the Study Area									
Site	**Form**	**Survival**	**Condition**	**Complexity**	**Context**	**Period**	**Scale it Matters**	**Significance**	**Rarity**
A43. Site of Palmers Mill	Site of hollow post drainage mill	Not known	N/A	Mill removed to Upton for restoration in 1976	South of New Road in the marshes	18th Century	Local	Recorded on SMR, no. 15119	Common
A44. Site of 7 Mile House	Site of Marsh farm	Not known	Not Known	N/A	Located beside the A47	Cited on Faden 1797 survey	Local	No SMR no.	Common
A45. Earthworks	Three sub-rectangular structures	Poor	Not known	Not Known	Probably located on levee of relict channel	Possible Saxon	Local	Not known	Not known

Table 10.3: Built Heritage in Study Area

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
Halvergate Marshes Conservation Area	Historic landscape. Flat, open, man made, pastoral landscape drained by pumps via a complex system of ditches or dykes.	Good	ESA designated to encourage traditional grazing on permanent pasture.	Complex landscape reclaimed from salt marshes over the centuries	Open rural landscape. situated at sea level.	Mediaeval and post mediaeval.	National	Forms significant part of nationally important landscape administered by the Broads Authority.	Rare
B1. St. Edmunds Church	Parish Church, round tower. Norman origins.	Good, restoration in the 1860's.	Well maintained	Has undergone a number of additions over the centuries	Located in Acle town	12th, 13th, 14th and 19th Century	National	Recorded on SMR, no. 8600 Grade I Listed Building	Rare
B2. Tunstall Dyke Drainage Mill *	A drainage mill, formerly wind pump. Tapering tarred tower, 4 storeys, windows with segmental brick arches to ground 1st and 2nd floor.	Poor	The site is derelict	N/A	Located on flat open land on Tunstall Marshes. Traditional Broadland landmark feature	19th Century	Regional	Recorded on SMR, no. 10384 Grade II Listed Building	Locally common but part of rare historic landscape

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B3.Tunstall Dyke Smock Mill *	A wind pump of smock type, with octagonal weather-boarded trestle, truncated to 2 storeys. Door opening and remains of sluice gates.	Largely demolished, cut down to a stump 4 metres high	The site is derelict	It drove a turbine and drained 100 hectares, was replaced by a steam engine	Located on flat open land on Tunstall Marshes. Traditional Broadland landmark feature	Late 18th Century	Regional	Recorded on SMR, no. 10385 Grade II Listed Building	Rare, only surviving drainage smock mill in Norfolk
B4. Stracey Arms Drainage Mill (also known as Arnups Mill) *	Windpump with red brick, tapering , circular tower of 3 storeys. Machinery, sails and scoopwheel intact. ,	Good, has been fully restored in 1961 by Norfolk Windmills Trust	Well maintained	Site of a pillbox, wind pump and pumping station. It was converted to a pill box during World War II.	Located on south banks of the River Bure. Traditional Broadland landmark feature	Dated 1883	Regional	Recorded on SMR, no. 10387 Grade II* Listed Building Recorded on NMR	Locally common but Grade II* indicates a rarer quality. Also part of rare historic landscape
B5. Keys Mill on Black Mill (also known as Kerrisons Level Drainage Mill) *	Windpump, tarred brick tower. Cap frame with sheers, tail beam, sprattle beam, headstock and weatherbeam.	Good, has been restored in 2000.	Well maintained	There was a previous mill on the site probably 1795 to 1816	Located on South Walsham Marshes south of railway. Traditional Broadland landmark feature	19th Century	Regional	Recorded on SMR, no. 10407 Grade II Listed Building	Locally common but part of rare historic landscape

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B6. Bridewell	House, flint, limestone and brick, 3-storey south-east gable.	Good	N/A	Divided into 3 cottages at one stage. Cellar said to be former prison.	Located in the centre of Acle town.	Dated 1633 on west wall. Part may predate this.	Local/ Regional	Recorded on SMR, no. 12197 Grade II Listed Building	Common
B7. Mitre House formerly Old White House	House, timber framed jettied street block, rear wing of brick with moulded beams.	N/A	N/A	House with cellar, timber frame dates to 16th century and brick rear wing to 17th century.	Located in the centre of Acle town.	1540 AD to 1900 AD	Local/ Regional	Recorded on SMR, no. 12199 Grade II Listed Building	Common
B8. The Old Bakery/ Calthorpe Cottages/ Vine	Row of three cottages and modern shop. Two storey with attic.	N/A	N/A	N/A	Located in the centre of Acle town.	18th Century but could have 16th and 17th century joints.	Local/ Regional	Recorded on SMR, no. 12899 Grade II Listed Building	Common
B9. Norfolk Railway (Norwich to Gt Yarmouth Railway Line *	Railway line	Good, still in use	Managed	Part of Norwich and Yarmouth Railway	Travels into Great Yarmouth, from the south	Opened 1844	Local	Recorded on SMR, no. 13571 Recorded on NMR No. Linear 1097	Common

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B10. Norfolk Railway Acle Diversion Norwich to Gt Yarmouth Railway Line *	Railway line and Acle Station. The station has a house on the platform with embossed brick letters 'GER 1883'. Small signal cabin on platform.	Line is good, still in use. Station building is largely disused and part converted to boat building.	Managed	Acle and Breydon Junctions are along the line.	Travels alongside the existing A47 and south of Acle town	Opened 1883	Local	Recorded on SMR, no. 13572 Recorded on NMR No. Linear 1098	Common
B11. The Manor House	House, red brick 3 bays, 2 storeys, attic, Georgian classical doorcase, chimney against south-east gable. Brick vaulted cellar.	Poor	To be restored the pill-box is disguised as a shed	East gable contains a World War II pill-box	Located in centre of Acle	Late 17th Century	Local/ Regional	Recorded on SMR, no. 14219 Grade II Listed Building	Common
B12. The Limes	Fine Georgian House and offices, 3 bays, 2 storeys, large, red brick with blue pantile roof, central classical doorway, venetian windows.	Good	Well maintained	South of the house has a red brick boundary wall with half-round copings and stone gate piers.	Located in centre of Acle	18th Century	Local/ Regional	Recorded on SMR, no. 14220. Grade II Listed Building	Common

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B13. Memorial and Milestone	Victoria Jubilee memorial and milestone. Gothic canopies surmounted by stone block supporting lamp-post.	Moderate	N/A	N/A	Located in centre of Acle	1887	Local/ Regional	Recorded on SMR, no. 14221. Grade II Listed Building	Common
B14. Red Lion Cottage/ Clematis Cottage	House incorporating a wall of an older timber framed building.	No known	N/A	N/A	Located in centre of Acle	1716	Local	Recorded on SMR, no. 14223	Common
B15. Pillbox	A type 22 Pillbox	No known	N/A	N/A	Located in centre of Acle	1939 to 1945 World War Two	Local	Recorded on SMR, no. 16801	Common (but part of rare system of defences)
B16. Pillbox *	A Pillbox, polygonal and concrete. Situated on a saltern 60m x 40m and 1-2m high which contained pottery..	No known	N/A	20th century structure located on top of a medieval saltern.	Roadside defence west of Gt Yarmouth. Situated near to northern side of the existing A47 road.	1914 to 1918 World War One	National	Recorded on SMR, no. 18493. English Heritage have indicated intention to designate as Scheduled Ancient Monument	Rare

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B17. Pillbox *	A Pillbox, polygonal and concrete. Part of camouflage mound remains on top.	No known	N/A	N/A	Roadside defence west of Gt Yarmouth. Located on southern side immediately adjacent to existing A47 road.	1914 to 1918 World War One	National	Recorded on SMR, no. 18494. English Heritage have indicated intention to designate as Scheduled Ancient Monument	Rare
B18. Barn at Oakely or Oakleigh House	A former stable, red brick with thatched roof, single storey. Limestone plaque 1758.	Good	N/A	It was a former stable	Located south of Acle town and the railway	1758	Local/Regional	Recorded on SMR, no. 30615 Grade II Listed Building	Common
B19. Vauxhall Bridges	A wrought iron rail/tram bridge with rusticated stone abutments.	Good	Maintained	A bridge originally for rail and tram, footpath section added.	A bridge over the River Bure.	Listed 1850 but NIAS date it to 1848	Local/Regional	Recorded on SMR, no. 34557 Grade II Listed Building	Rare
B20. Pillbox *	A type 22 Pillbox	Not known	N/A	N/A	Located adjacent to railway on northside near to Acle town.	1939 to 1945 World War Two	Local	Recorded on SMR, no. 36661	Common (but part of rare system of defences)

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B21. Spigot, Mortar, Emplacement	A spigot, mortar, emplacement structure.	Not known	N/A	N/A	Located in rear garden in Acle town	1939 to 1945 World War Two	Local	Recorded on SMR, no. 36771	Locally Common but part of rare system of defences
B22. Ashtree Farm Mill *	A windpump, 4.6 metres diameter, and 8.5 metres to the top, battered tower, circular plan, three storeys. Cap frame with sheers, tailbeam, sprattlebeam, headstock, cast iron weatherbeam.	Restoration work has been carried out on the building.	Managed. Work by the Windmill Trust has recently started to restore the windmill to working condition.	Largely rebuilt in 1912 on older foundations, it has been stated that this was the last mill to be built in Norfolk	Located on banks of River Bure. Traditional Broadland landmark feature	1912	Regional	Recorded on SMR, no. 4331 Grade II Listed Building	Locally common but part of rare historic landscape
B23. Great Yarmouth Town Wall and defences (not on map)	Wall foundations of an octagonal projecting bastion type tower. 30ft high tower, flint and red brick with a conical tile roof.	Good restored in 1960s	Managed	A wreck town, defences town, signal station and tower wall. East mount added 1588 and later an outer moat and other alterations.	Located in Great Yarmouth adjoining the River Bure	Erected around 1344	National	Recorded on SMR, no. 4294 Scheduled Ancient Monument Recorded on NMR	Rare

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B24. Halvergate Six Mile House Drainage Mill *	Windpump with tarred brick tower, remains of cap, tapering circular tower of 3 storeys, two stocks and four sails, cap frame and machinery.	Poor	Derelict	N/A	Beside the River Bure. Traditional Broadland landmark feature	mid 19th Century	Regional	Recorded on SMR, no. 10408 Grade II Listed Building	Locally Common but part of rare historic landscape
B25. Five Mile House *	A marsh farm	Not known	N/A	N/A	Located on the River Bure	19th Century	Local	Mentioned in Broads Authority historic landscape character assessment.	Common
B26. The Old White House	Dwelling. Two storeys, T-shaped plan. colourwashed brick, roof steeply pitched, two shallow bays on ground floor.	Good	Restored and renewed	N/A	Located in centre of Acle town	Late 16th Century/ early 17th Century	Local/ Regional	Grade II Listed Building	Common
B27. Ivy House and attached out buildings	House, colourwashed brick, thatched roof, two storeys and attics, L-shaped plan, range of attached brick and pantile outbuildings.	Good	Managed	N/A	Located in centre of Acle town	18th Century	Local/ Regional	Grade II Listed Building	Common

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B28. Childwall House and Bedlam	Dwelling. Colourwashed with reed-thatched roof, two storeys and attic, internal gable chimney stacks	Good, altered and remodelled	Managed	Sub-divided into two dwellings, Japonica cottage is attached to south gable	Located in centre of Acle town, on Reedham Road	17th Century	Local/ Regional	Grade II Listed Building	Common
B29. Hillside	House, colourwashed brick with steep reed-thatched roof, central axial chimney stack.	Good	Managed	N/A	Located in centre of Acle town, Damgate Lane	Mid 17th Century	Local/ Regional	Grade II Listed Building	Common
B30. Rudham Swim Drainage Mill *	Tower mill, medium sized, three storey, tarred red brick, seven metres high to top of brickwork,	Not known	N/A	A mill was established here between 1795 and 1816	Located beside the River Bure. Traditional Broadland landmark feature	Late 19th Century	Regional	Recorded on SMR, no. 10409 Grade II listed building	Locally Common but part of rare historic landscape
B31. Six Mile House *	House which stands on low mound which has been incorporated into the southern wall of the River Bure. Unglazed grey pottery found.	Good	Managed	Much of the house was rebuilt in the 19th Century. Salt making may have occurred on the site and also sheep ranching.	Located beside the six mile house drainage mill on the River Bure	19th Century	Local	Recorded on SMR, no. 21103	Common

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B32. Ashtree Farm *	House	Not known	N/A	It is marked on Faden's 1797 county map as 'Three Mile House'	Located on the River Bure	Possible Medieval origin	Local	Mentioned in Broads Authority historic landscape character assessment.	Common
B33. Walpoles Farm *	Building	Not known	N/A	The building is marked as 'Marsh Cottage' on the on the modern OS map	Located on Halvergate Fleet	18th Century	Local	Recorded on SMR, no. 31878	Common
B34. Hewitts Farm *	House	Not known	N/A	N/A	Located on Halvergate Fleet	Medieval origin	Local	Mentioned in Broads Authority historic landscape character assessment.	Common
B35. Marsh Farm *	Mill cottage but now represented as a pile of bricks and earth	Demolished in 1990	N/A	Associated with the drainage windmill to north west	Located on Halvergate Fleet	Medieval origin	Local	Recorded on SMR, no. 35369	Common
B36. Five Mile House Drainage Mill Runham *	Tarred tower mill of 4 storeys, red brick, temporary aluminium cap, external scoop wheel	Not known	N/A	This was not the first mill on this site, a mill is shown on Faden's map	Located beside the River Bure.Traditional Broadland landmark feature	1849	Regional	Recorded on SMR, no. 10411 Grade II Listed Building	Locally Common but part of rare historic landscape

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B37. Highs Drainage Mill *	Tarred tower mill, remains of scoop wheel, cap frame under aluminium cap with wooden curb and track	Not known	N/A	Some refitting, especially in 1890s	Located close to Halvergate Fleet. Traditional Broadland landmark feature	18th Century	Regional	Recorded on SMR, no. 10403 Grade II Listed Building	Locally Common but part of rare historic landscape
B38. Howards Drainage Mill *	Red brick tower, 9.5m high, 3 storeys, 4 white framed windows at upper two storeys.	Good, partially restored	Managed	The mill had a refit by Smithdales.	Located beside the Halvergate Fleet. Traditional Broadland landmark feature	mid 19th Century	Regional	Recorded on SMR, no. 10404 Grade II Listed Building	Locally Common but part of rare historic landscape
B39. Lockgate Mill *	Tarred tower mill, red brick, 4 floors, 13.5m high. Two opposed doors, 4 windows.	Not known	Derelict	A mill is shown on the 1816 OS maps	Located beside north wall of Breydon Water. Traditional Broadland landmark feature	Mid to late 19th Century	Regional/ Local	Historic built landmark feature in Conservation Area	Locally Common but part of rare historic landscape
B40 Charlie Waters Mill	Red brick tower mill, two storeys, flat roof, opposed doors, drove scoop wheel	N/A	N/A	N/A	Located beside the River Bure. Traditional Broadland landmark feature	Erected between c.1795 & c.1826	Local	Recorded on SMR, no. 8609	Locally Common but part of rare historic landscape

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B41 Windmill	A tall brick tower windmill, spur wheel of timber, wooden bridgetrees, two pairs under-driven French burr stones	N/A	N/A	An auxiliary steam was added 1886, last used 1916 and now has a Nissen hut on top.	Located north of Acle. Traditional Broadland landmark feature	1826	Local	Recorded on SMR, no. 8614	Locally Common but part of rare historic landscape
B42 Breydon Water Navigable Waterway *	River	Good	Managed	Improvements were made in the 19th Century	Breydon Water lies outside Great Yarmouth	River	Local	NMR No. Linear797, Unique Identifier 1342427	Locally Common but part of rare historic landscape
B43 Yarmouth Vauxhall Station	Terminal Station of Yarmouth and Norwich Railway	Unknown	N/A	N/A	Situated in Great Yarmouth	Opened in 1844	Local	NMR No. TG50 NW611	Common
B44 Church of St. Andrew, Stokesby	Flint and thatched church	Unknown	N/A	N/A	Situated in Stokesby. Rural views.	Unknown	Regional/ Local	Grade II listed building	Common
B45 Stokesby Hall and two barns	2 storey brick detached house & 2 barns.	Unknown	N/A	N/A	Views of Acle Straight to south west. Rural views	Unknown	Regional/ Local	All Grade II listed buildings	Common
B46 Saithe House, Stokesby	2 storey, brick detached house	Unknown	N/A	N/A		Unknown	Regional/ Local	Grade II listed building	Common

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
B47 Barn North east of Ferry Inn	Barn building	Unknown	N/A	N/A	In grounds of pub garden. Rural open views	Unknown	Regional/ Local	Grade II listed building	Common
B48 Glebe Farm & Barn, Stokesby	2 storey, brick thatched, detached house and barn	Unknown	N/A	N/A	Rural views	Unknown	Regional/ Local	Grade II listed building	Common
B49 Mautby Windmill or Mautby Marsh drainage Mill *	Brick wind pump and white rendered one and half storey extension.	Restored	Unknown	Unknown	Rural views	Unknown	Regional	Grade II listed building	Locally common but part of rare historic landscape
B50 Runham Drainage Mill *	Black painted brick winp pump, timber elements in place- no sails	Unknown	Unknown	Unknown	Expansive rural views over River Bure an Marsh	Unknown	Regional	Grade II listed building	Locally common but part of rare historic landscape
B51 Old Hall Drainage Mill *	Unknown	Unknown	Unknown	Unknown	Traditional Broadland landmark feature	1540 AD to 1900 AD	Regional	Recorded on SMR, no. 10386	Locally common but part of rare historic landscape
B52 Commission Drainage Mill	Unknown	Unknown	Unknown	Unknown	Traditional Broadland landmark feature	Unknown	Local	Unknown	Locally common
B53. Salt	Salt pans	Covered	Not known	N/A	Areas of	1066 AD to	Local	Recorded on	Common

Site	Form	Survival	Condition	Complexity	Context	Period	Scale it Matters	Significance	Rarity
works		by 2 inches of topsoil			creeks outskirts of Great Yarmouth	1539 AD		SMR no. 28930	

10.5 Predicted Impact

10.5.1 The tables below indicate the effects of Option 2 on archaeology and built heritage. Unless indicated to the contrary the effects are the same for Option 2A.

Archaeology

10.5.2 Table 10.4 details the impacts of the dual carriageway options on archaeology within the study area.

Table 10.4 Archaeological Impacts resulting from proposed scheme

Site	Impact	Magnitude of Impact
A1. Find spot	None	Neutral effect
A2. A workhouse	None	Neutral effect
A3. Midland and Great Northern Joint Railway	None	Neutral effect
A4. Brickworks	None	Neutral effect
A5. Find spot	None	Neutral effect
A7. Hermitage	None	Neutral effect
A8. Wind pump	None	Neutral effect
A9. Lime kiln	None	Neutral effect
A10. Mound	The site would be traversed by new carriageway. However mound no longer exists.	Neutral effect
A11. Find spot	None	Neutral effect
A12. Find spot	None	Neutral effect
A13. Find spot	None	Neutral effect
A14. Find spot	None	Neutral effect
A15. Find spot	None	Neutral effect
A16. A salt working mound	None	Neutral effect
A17. Salt works	None	Neutral effect
A18. Icehouse	None	Neutral effect
A19. Find spot	None	Neutral effect
A20. Find spot	None	Neutral effect
A21. & A21.1 Find spot	None	Neutral effect
A23. Cemetery Cremation	None	Neutral effect
A25. Wind pump and Mound	None	Neutral effect
A26. Find spot	None	Neutral effect
A27. Find spot	None	Neutral effect
A28. Find spot	None	Neutral effect
A29. Manor House	None	Neutral effect
A30. Find spot	None	Neutral effect
A31. Find spot	None	Neutral effect
A32. Find spot	None	Neutral effect
A33. Findspot	None	Neutral effect
A36. Acle Marsh House	None	Neutral effect
A40. Pillbox	None	Neutral effect
A41. Pillbox	None	Neutral effect

Table 10.4 Archaeological Impacts resulting from proposed scheme		
Site	**Impact**	**Magnitude of Impact**
A42 Spigot, Mortar, Emplacement	None	Neutral effect
A43. Site of Palmer's Mill	None. Site already located on existing A47 Norwich to Acle carriageway	Neutral effect
A44. Site of 7 Mile House	None	Neutral effect
A45. Earthworks	New carriageway and access track traverses part of site. Impacts are slightly more severe under option 2.	Large adverse effect

Built Heritage

10.5.3 The direct and indirect impacts on built heritage are outlined below in Table 10.5. Indirect impacts indicate the effect on the setting on features of built heritage interest.

Table 10.5 Built Heritage Impacts resulting from proposed scheme			
Site	**Direct Impact**	**Indirect Impact**	**Magnitude of Impact**
Halvergate Marshes Conservation Area	Moderate land take from agricultural land in the Conservation Area. This would be marginally greater with option 2.	Moderate impact on character of historic landscape due to increase in traffic, size of carriageway and effect of access tracks on setting of Stracey Mill. Additional noise impact would further effect tranquillity.	Moderate adverse effect
B1. St. Edmunds Church	None	None	Neutral effect
B2. Tunstall Dyke Drainage Mill	None	Slight effect on setting due to slight increase in traffic on road. Additional noise impact would further effect tranquillity.	Slight adverse effect
B3.Tunstall Dyke Smock Mill	None	Slight effect on setting due to slight increase in traffic on road. Additional noise impact would further effect tranquillity.	Slight adverse effect

Table 10.5 Built Heritage Impacts resulting from proposed scheme			
Site	**Direct Impact**	**Indirect Impact**	**Magnitude of Impact**
B4. Stracey Arms Drainage Mill	Small area of land –take from southern boundary of plot.	Increased scale of carriageway and Halvergate Junction, small area of land-take from plot and access tracks to west and east of site would adversely effect setting of Stracey Mill. additional noise impact would further effect tranquillity. Reduced night time impacts due to reduced lightspill from lighting at Halvergate Junction.	Moderate adverse effect
B5. Keys Mill on Black Mill	None	Slight effect on setting due to slight increase in traffic on road.	Slight adverse effect
B6. Bridewell	None	None	Neutral effect
B7. Mitre House formerly Old White House	None	None	Neutral effect
B8. The Old Bakery/ Calthorpe Cottages/ Vine	None	None	Neutral effect
B9. Norfolk Railway (Norwich to Yarmouth Railway Line)	Small area of land take to accommodate new carriageway and bridleway near Breydon Water	Slight effect on setting due to slight increase in traffic on road.	Slight adverse effect
B10. Norfolk Railway Acle Diversion	None	Slight effect on setting due to increase in traffic on road. Particularly apparent between Halvergate and Great Yarmouth where new carriageway is to the south of existing. Impact would be slightly greater under option 2.	Slight adverse effect
B11. The Manor House	None	None	Neutral effect
B12. The Limes	None	None	Neutral effect
B13. Memorial and Milestone	None	None	Neural effect
B14. Red Lion Cottage/ Clematis Cottage	None	None	Neutral effect
B15. Pillbox	None	None	Neutral effect

Table 10.5 Built Heritage Impacts resulting from proposed scheme			
Site	**Direct Impact**	**Indirect Impact**	**Magnitude of Impact**
B16. Pillbox	None	Effect on setting due to access track, increased scale of road and perceptible increase in traffic.	Moderate adverse effect
B17. A Pillbox	New carriageway would require removal of feature.	N/A	Large adverse effect
B18. Barn at Oakely or Oakleigh House	None	None	Neutral effect
B19. Vauxhall Bridges	None	None	Neutral effect
B20. Pillbox	None	Impact on setting due to access track, increased scale of road and also increase in traffic on road.	Slight adverse effect
B21. Spigot, Mortar, Emplacement	None	None	Neutral effect
B22. Ashtree Farm Mill	None	Negligible effect on setting due to increased scale of road and perceptible increase in traffic on road.	Neutral effect
B23. Great Yarmouth Town Wall and defences (not on map)	None	None	Neutral effect
B24. Halvergate Six Mile House Drainage Mill	None	Negligible effect on setting due to increased scale of road and increase in traffic on road.	Neutral effect
B25. Five Mile House	None	Negligible effect on setting due to increased scale of road and increase in traffic on road.	Neutral effect
B26. The Old White House	None	None	Neutral effect
B27. Ivy House and attached outbuildings	None	None	Neutral effect
B28. Childwall House and Bedlam	None	None	Neutral effect
B29. Hillside	None	None	Neutral effect
B30. Rudham Swim South	None	Negligible effect on setting due to increased scale of road and increase in traffic	Neutral effect

Table 10.5 Built Heritage Impacts resulting from proposed scheme			
Site	**Direct Impact**	**Indirect Impact**	**Magnitude of Impact**
		on road.	
B31. Six Mile House	None	Negligible effect on setting due to increased scale of road and increase in traffic on road.	Neutral effect
B32. Ashtree Farm	None	Negligible effect on setting due to increased scale of road and increase in traffic on road.	Neutral effect
B33. Walpoles Farm	None	None	Neutral effect
B34. Hewitts Farm	None	None	Neutral effect
B35. Manor Farm	None	None	Neutral effect
B36. Runham Five Mile House	None	Negligible effect on setting due to increased scale of road and increase in traffic on road.	Neutral effect
B37. Highs Drainage Mill	None	None	Neutral effect
B38. Howards Drainage Mill	None	None	Neutral effect
B39. Lockgate Mill	None	None	Neutral effect
B40 Charlie Waters Mill	None	None	Neutral effect
B41 Windmill	None	None	Neutral effect
B42 Breydon Water Navigable Waterway	None	Slight effect on setting due to increased scale of road and increase in traffic on road. Reduced night time impacts due to reduced lightspill from lighting on approach to Vauxhall Roundabout.	Slight adverse effect
B43 Yarmouth Vauxhall Station	None	None	Neutral effect
B44 Church of St. Andrew, Stokesby	None	None	Neutral effect
B45 Stokesby Hall and Two Barns	None	None	Neutral effect
B46 Saithe house, Stokesby	None	None	Neutral effect
B47 Barn North east of Ferry Inn	None	None	Neutral effect
B48 Glebe Farm and	None	None	Neutral effect

Table 10.5 Built Heritage Impacts resulting from proposed scheme			
Site	**Direct Impact**	**Indirect Impact**	**Magnitude of Impact**
Barn, Stokesby			
B49 Mautby Windmill or Mautby marsh drainage mill	None	None	Neutral effect
B50 Runham Drainage Mill	None	None	Neutral effect
B51 Old Hall Drainage Mill	None	Slight effect on setting due to increased scale of road and perceptible increase in traffic on road offset by reduced night time impacts due to reduced lightspill from road lighting at Halvergate Junction.	Neutral effect
B52 Commission Drainage Mill	None	Negligible effect on setting due to increased scale of road and increase in traffic on road.	Neutral effect
B53 Salt Works	None	Negligible effect on setting due to increased scale of road and increase in traffic on road.	Neutral effect

10.6 Mitigation Measures

Archaeology

10.6.1 The implementation of Option 2 and 2A would disturb part of the earthworks (site A45) identified during archaeological field evaluation. The earthworks would be covered by a low embankment and would probably not be directly destroyed by construction activity. However settlement of the embankment and resulting compaction of the ground beneath would probably distort the archaeological remains and the Norfolk County Archaeologist has indicated that a full intrusive evaluation of the affected area would be necessary prior to the implementation of either scheme option[64]. The methodology for the work would be determined with the agreement of the County Archaeologist.

10.6.2 There is potential for archaeological remains to be uncovered anywhere within the scheme where ground works are undertaken. As a consequence of this there would be an archaeological watching brief maintained during all ground works. The objective of the watching brief would be to identify and

[64] Letter received from County Archaeologist dated 17th October 2003 (Ref: GD00555/HGE/rg/203/113)

record any archaeological sites/deposits. It would be undertaken by suitably qualified archaeological personnel who would have relevant experience. All archaeological works would be undertaken with the agreement of Norfolk County Archaeologist. The watching brief would be undertaken in accordance with the Institute of Field Archaeologists documents *Standard and Guidance for Archaeological Watching Briefs* (1994) and the *Code of Conduct*.

Built Heritage

10.6.3 Some limited planting is proposed on the existing and new embankment, however there is insufficient space to form a dense screen which would anyway be out of character with the open landscape of the marshes. Therefore any beneficial effects from planting on the Conservation Area or setting of buildings would be minimal.

10.6.4 An environmental barrier is proposed to the west of Vauxhall Roundabout in order to screen road traffic from wintering birds on Breydon Water (see Figure 8.6). This would also effectively screen the road from site B42 Breydon Water Navigable Waterway which would reduce the slight adverse magnitude of impact identified in Table 10.5 to Neutral or Slight Beneficial.

10.6.5 The effects of the dual carriageway options on the setting of Stracey Arms Drainage Mill has been assessed as moderate adverse. However this impact could be reduced if the A47 approach on the east side of Halvergate Junction was realigned slightly further south to enable:

- implementation of more effective screen planting than currently proposed (See Figure 8.6) and
- construction of the access track adjacent to and outside the southern boundary of the property rather than at the western and eastern sides of it.

Any realignment of the route could result in additional impacts in terms of biodiversity and landscape and any beneficial effect for heritage would have to be weighed against other adverse effects.

10.6.6 The World War I pillbox (Site B17) which is situated immediately adjacent to the existing carriageway, would be directly affected by both dual carriageway options. Mitigation could involve relocation of the pillbox to a new position with an equivalent relationship to the new carriageway. English Heritage have registered dissatisfaction to this and consider that relocation should be a measure of last resort[65]. If there is no other feasible solution they have recommended a structural assessment of the pillbox be completed to determine whether it can be safely removed and re-erected without harming its historic fabric.

[65] Letter received from English Heritage dated 21st October 2003 (Ref: GD00555/CS/3482)

10.6.7 With both dual carriageway options the only way that direct impact on the pillbox could be avoided would be to construct this stretch of the new carriageway on the north side of the existing embankment rather than to the south side as with options 2 and 2A. However, this would result in significant additional environmental effects including demolition of two residential properties and increased ecological impacts due to the close proximity of the River Bure.

10.7 Summary

10.7.1 Most of the route lies in a historic landscape designated as Halvergate Marshes Conservation Area and the study area contains several sites of archaeological and built heritage interest, including a Grade I listed church in Acle town, a Grade II* listed drainage mill situated adjacent to the Acle Straight and a number of Grade II Listed Buildings scattered throughout the study area. In addition, World War II relicts near Acle contribute to a nationally important system of defensive structures and two World War I pillboxes which flank the road near to Great Yarmouth are being considered by English Heritage for scheduling as ancient monuments. Most of the route also lies within the area administered by the Broads Authority who have an objective to apply for World Heritage status over the whole area.

10.7.2 Both of the dual carriageway options would impact on recently discovered archaeological earthworks, which could be of Saxon origin. If either option were to proceed an intrusive evaluation of these features would be carried out prior to construction works. In addition, an archaeological watching brief would be maintained during all ground works. A Large Adverse magnitude of effects has been identified for the earthworks site which is located within a historic landscape considered to be of national importance. However this is a small site and mitigation in the form of intrusive investigations would help to determine their value and has the potential to provide additional information on the early settlement history of the marshes. Therefore overall effects on archaeology have been assessed as Slight Adverse.

10.7.3 Both dual carriageway options would have a Moderate Adverse effect on the Halvergate Marshes Conservation Area and the Grade II* Stracey Drainage Mill, a Large Adverse effect on one of two World War I pill boxes and a Moderate Adverse effect on the other World War I pillbox. There would also be Slight Adverse effects on the setting of three drainage mills, the two railway lines, a World War II pillbox and Breydon Water Navigable Water Way. The effects on the remaining 43 built features of heritage interest identified within the visual envelope have been assessed as Neutral.

10.7.4 The Moderate Adverse effect on Stracey Drainage Mill could be reduced by mitigation but this would involve realignment of parts of the proposals and would be subject to engineering constraints and weighing of the benefits gained for heritage against other adverse environmental effects, which could be caused by realignment. The Large Adverse effect on the World

War I pill box could be mitigated by its relocation to a nearby site which would have the same relationship to the new carriageway as the existing site has to the existing carriageway. However this would be subject to a structural assessment to determine whether it can be safely removed.

10.7.5 The World War I pillboxes and the Conservation Area have been identified as being of national importance and drainage mills in Halvergate Marshes Conservation Area as being of regional importance. The proposals would be out of scale with, or at odds with the scale, pattern or form of the Conservation Area. Both options would also be intrusive in the setting (context), and would adversely affect the appreciation and understanding of the Conservation Area. The proposals would also be damaging to nationally significant heritage assets (World War I pill boxes), resulting in loss of one of the features such that its integrity would be substantially compromised. However mitigation in the form of relocation has been specified for the pill box. Accordingly all dual carriageway options have been assessed as having a Moderate Adverse impact on the area's built heritage. If the mitigation measure for relocating the World War I pill box were found to be impractical the effects would increase to a Large Adverse effect, however at this stage this seems unlikely.

10.7.6 Option 2 would have a slightly greater adverse effect on heritage due to the greater area of land take required to accommodate proposal. However, this would be insufficient to alter the individual magnitude of effects or the overall significance of effects.

11 Air Quality

11.1 Introduction

11.1.1 This chapter assesses the air quality impacts associated with the construction and operation of the dual carriageway options for the A47 Acle Straight. Option 2 is a two-lane dual carriageway, involving the construction of a second carriageway. One carriageway would be built within the existing road embankment and the new carriageway would be constructed on a new embankment, at virtually the same height as the existing. The new carriageway would be located to the north of the existing road on the west side of the Halvergate junction and to the south of the existing road on the east side of the Halvergate junction. There are 2 variations to Option 2:

- Option 2 with an 8m wide central reservation containing a reatined roadside ditch:
- Option 2A carriageway with a minimum width 2.5m wide central reservation.

11.1.2 Emissions from vehicles have a significant impact on air quality and road traffic is the primary cause of urban air pollution [ref4 Appendix 11.1]. Generally, the main direct effects are limited to an area close to the road. It is widely accepted that beyond 200m, the contribution of vehicle emissions to air quality are not significant [ref1 Appendix 11.1].

11.1.3 Any new road proposal may result in changes to existing traffic flows and/or traffic speeds, thereby affecting air quality. Effects are likely to be negative if a new road takes traffic closer to properties and/or an existing road is subject to increased traffic flows, and effects are likely to be beneficial if a new road takes traffic away from properties and/or reduces traffic along an existing road.

11.1.4 The air quality assessment has been completed in accordance with the latest update to DMRB Volume 11 and compares current and predicted air quality concentrations against the National Air Quality Strategy (NAQS) objectives [ref2 Appendix 11.1]. The NAQS define a range of health based air quality objectives. Further details are provided in Section 11.3.

11.1.5 Air pollution has a wide range of effects including detrimental impacts on the health of humans, animals and vegetation, damage to buildings and materials, and climatic impacts such as global warming or stratospheric ozone depletion (Appendix 11.2). There are no objectives for assessing air quality impacts on wildlife and as such the NAQS objectives are not transferable to the protection of wildlife.

11.1.6 The current revision of the DMRB air quality assessment (February 2003) incorporates the latest vehicle emission factors and traffic fleet compositions.

11.1.7 The assessment of air quality considers the number of properties subjected to a change in air quality along the proposed route. Particular attention is paid to sensitive locations e.g. residential properties, schools, hospitals, public amenities, and shopping areas[Ref 3 Appendix 11.1].

11.1.8 The route options would impact on local sensitive receptors through the construction activities associated with the construction of the road (Appendix 11.3). These may arise from breaking of the existing road, earthworks and construction traffic. Any impacts are usually restricted to those properties within 150m of construction activities, and tend to be limited due to the time spent at any one location undertaking the work.

11.2 Methodology

11.2.1 This section outlines the assessment undertaken to determine the impacts on sensitive receptors within 200m of the scheme that may be subject to a change in air quality.

11.2.2 Levels of pollutants and the associated health impacts are dependent on a number of parameters. Traffic composition and density, climatic conditions, vehicle travelling speeds and road layout all influence the resultant air quality. The DMRB method takes account of average annual daily traffic flow (AADT), the percentage of heavy goods vehicles (HGVs) and speed on each road. Variation in emissions are influenced by various traffic characteristics and temporal changes and these are reflected in the emission used in the DMRB air quality model.

11.2.3 Calculations have been carried out in accordance with Volume 11, Section 3, Part 1 of the DMRB, as updated in February 2003. Levels of pollutants have been predicted for the baseline year of 2000 and for the Do-Minimum situation, (the situation that would exist without the implementation of any of the proposed options) and Do-Something situation (Option 2 and 2A) for the proposed opening year of 2012.

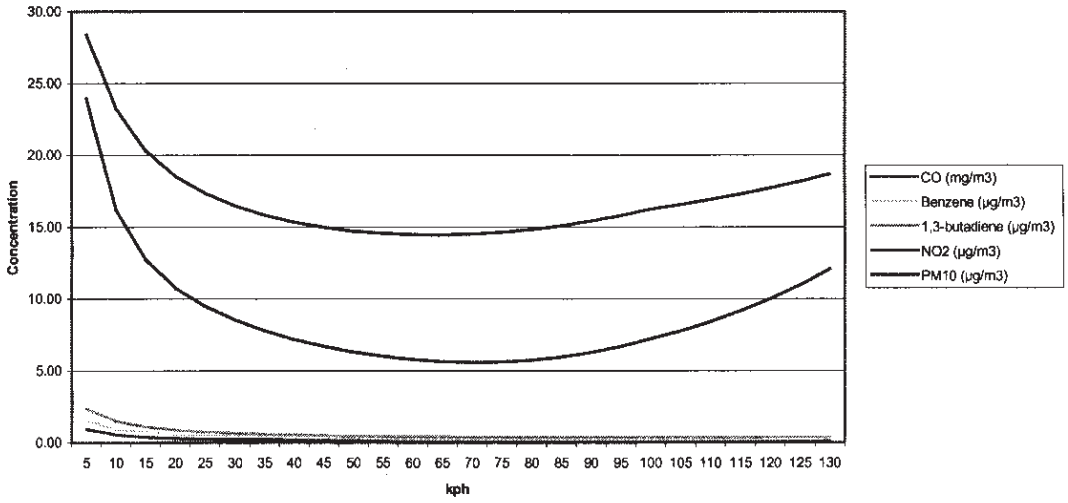
Emission Factors

11.2.4 In order to estimate the exhaust emissions from a stream of traffic, it is necessary to know the traffic composition (because different vehicle types emit very different levels of pollution), the volume of traffic, and how the vehicles are being operated. For the DMRB screening assessment, only the effects of average vehicle speed are included as an indication of the vehicles operating conditions.

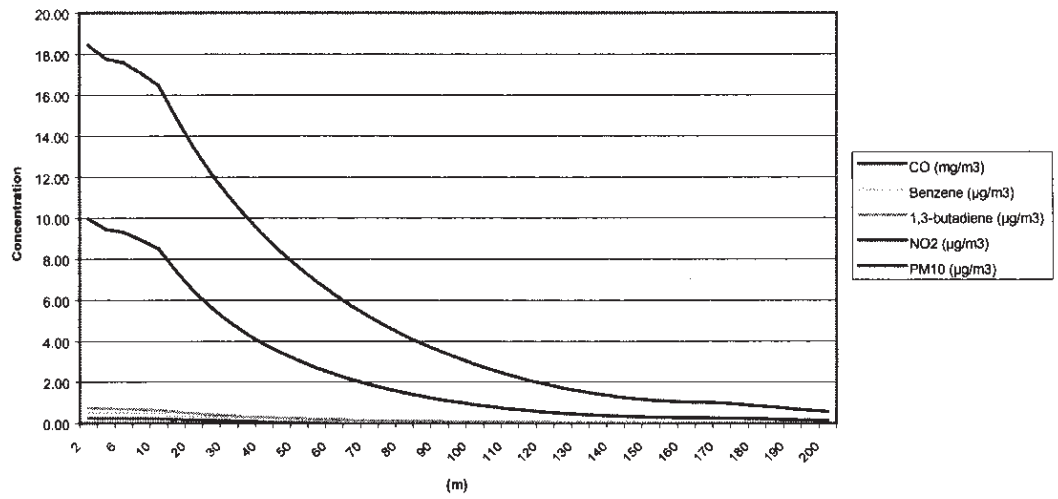
11.2.5 The DMRB procedure for pollution estimation uses a set of functions agreed by the Transport Research Laboratory and NETCEN [Ref 5, [Appendix 11.1]] which have been incorporated into the UK National Emissions Inventory. These agreed emission functions now underpin the DMRB Screening Methodology.

11.2.6 The graphs below show the variations in emissions due to either variations in speeds and distances. A standard set of circumstances is assumed for each graph; an AADT flow of 50,000 vehicles, 10% HGV's and road type A (road type for motorway/trunk roads) is used. A distance of 10m is used during the variation of traffic speeds, and a speed of 30 kph is used during the variation of distances.

Changes in Speed (kph)



Variation with Distance from Centre of Road (m)



11.2.7 Under some circumstances receptors show a variation in change of pollutant concentrations between a Do-Something and a Do-Minimum scenario where some pollutants would exhibit an increase in concentration while others may exhibit a decrease at the same receptor. This is due to the variation in emission factors as explained by the two graphs.

11.2.8 For example, if the traffic flow were to increase from 30 to 50 kph a greater drop would be expected of pollutant concentrations for NO_2 and PM_{10} than you might see for the remaining pollutants. At the other end of the scale concentrations of NO_2 and PM_{10} increase at speeds above 80kph while the remaining pollutants remain at a steady level.

11.2.9 When considering effects of distance from the centre of the road there is a much steeper decline in NO_2 and PM_{10} concentrations than there is for the remaining pollutants, which tend to zero at a closer distance.

11.2.10 If for example, traffic speeds were to increase from around 70kph to 90kph with distance to the centre of the road decreasing from around 150m to 140m, it can be seen from the graphs that concentrations of NO_2 and PM_{10} would be expected to increase. At the same time the remaining pollutants would either stay the same or show a decrease.

11.2.11 This becomes more complex when there are other changes to the model including variations in AADT and % of HGV's, but is an indicator of how it is possible for concentrations of pollutants to vary between increases and decreases at the same receptor.

11.2.12 Over time pollutant concentrations would decrease. This is accounted for by factors in the DMRB which describe reductions in vehicle emissions, due to improving technologies and their introduction into the traffic fleet as time increases.

Traffic Data

11.2.13 Traffic data for the base year (2000), and Do-Minimum and Do-Something for the opening year (2012) was provided by a SATURN model of existing and future network flows[66]. The traffic data used is shown in Table 11.2.1 and Figure 11.1 shows the corresponding link locations.

Table 11.2.1 Traffic Data used for the Assessment

Scenario		Traffic Data		
		AADT	%HGVs	Speed (kph)
Base Year 2000	A47 Acle – Halverbridge	16647	10	96.6
	A47 Halverbridge – A12	16619	10	96.6
	Acle New Road	2942	10	25
	A1064 Nth of New Road	8903	10	50
	A47 West of Acle	21152	10	96.6

[66] Report no. GD00555/RT/014A, Hyder Consulting, May 2003

Opening Year (2012) High Growth				
Do-Minimum	A47 Acle – Halverbridge	25680	10	80.5
	A47 Halverbridge – A12	26269	10	80.5
	Acle New Road	3215	10	22
	A1064 Nth of New Road	14496	10	44
	A47 West of Acle	28906	10	80.5
Do-Something Dual C'Way (Option 2 and 2A)	A47 Acle – Halverbridge	30674	10	108
	A47 Halverbridge – A12	30071	10	91
	Acle New Road	2816	10	20
	A1064 Nth of New Road	15429	10	42
	A47 West of Acle	30339	10	67

Background Concentrations

11.2.14 No monitoring data was available close to the A47 or in the near locality. The 'Air Quality Archive' website [Ref5, Appendix 11.1] contains a database of NAQS concentrations for the whole of the UK. Two background sites were identified at OS Grid Reference: 648500 /307500, and 644500 /311500. They are near to the study area and reflect local contributions from the surrounding areas, but are at a sufficient distance not to be influenced by the emissions from the A47. 2001 background concentrations were taken from the database and averaged. Scaling factors defined in LAQM.TG(03) [ref4 Appendix 11.1] were used to scale the data from 2001 to the base model year of 2000, and the opening year of 2012 for the Do-Minimum and Do-Something scenarios (Table 11.2.2).

Table 11.2.2 Background Air Quality Concentrations for the Area		
Pollutant	Year 2000	Year 2012
Benzene (µg/m³)	0.2	0.1
1,3 Butadiene (µg/m³)	0.1	0.0
Carbon Monoxide (mg/m³)	0.3	0.1
Oxides of Nitrogen (µg/m³)	24.1	15.1
Nitrogen Dioxide (µg/m³)	17.3	12.5
Particles (PM_{10}) (µg/m³)	19.1	14.9

Localised Assessment

11.2.15 The localised assessment of air quality calculates the concentrations of benzene, 1,3-butadiene, CO, NO_2, and PM_{10} at identified local sensitive receptors for the Baseline, Do-Minimum and Do-Something scenarios.

11.2.16 Sensitive receptors e.g. residential properties, hospitals, schools etc., as defined in LAQM.TG(03) [ref4 Appendix 11.1] were identified along the route (see Figure 11.1). These receptors represent sensitive locations along the existing A47 and they are most likely to be affected by the proposals. Table 11.2.3 illustrates the distance of each receptor from the centre of the road for the links for the Do-Minimum and both Do-Something dual options.

Table 11.2.3 Distance (m) from the roadside for the Do-Minimum and Do-Something option			
Receptor	**Link**	**Do Minimum (m)**	**Do-Something (Options 2 and 2A) (m)**
R1	A47 Acle – Halvergate	50	40
	Acle New Road	35	35
R2	A1064 Nth of New Rd	10	10
	A47 Acle – Halvergate	144	132
	Acle New Road	135	135
R3	A1064 Nth of New Rd	20	20
	A47 Acle – Halvergate	204	192
R4	Acle New Road	50	50
	A47 West of Acle	44	44
R5	Acle New Road	80	80
	A47 Acle – Halvergate	172	170
R6	A47 West of Acle	188	188
R6	A47 Halvergate – A12	4	14
R7	A47 Halvergate – A12	92	80
R8	A47 Halvergate – A12	34	30

11.2.17 The background concentrations are entered into the DMRB model and results calculated in accordance with the NAQS objectives.

Generalised Assessment

11.2.18 The generalised assessment of air quality incorporates the exposure of sensitive receptors to the predicted change in air quality due to the proposed development. The assessment methodology follows the approach defined in the current DMRB and the roadside concentrations of NO_2 and PM_{10} are calculated for the Do-Minimum and Do-Something scenarios for the opening year 2012.

11.2.19 The number of properties in 50m bands up to 200m away from the roadside are determined for each link within the network (Figure 11.1) and the roadside concentration for PM_{10} and NO_2 are then multiplied by a pollutant weighted factor corresponding to each of the four bands. The weighted pollutant factors relate to the diminishing contribution that vehicles make to local air pollution as distance increases away from the roadside. Beyond 200m, the contributions of vehicle emissions from the roadside to local pollution levels are not considered significant.

11.2.20 The properties weighted scores for each band are aggregated and multiplied by the difference in the pollutant concentrations between the Do-Minimum and Do-Something scenarios. The assessment scores scenarios show either an improvement in exposure weighted air quality as a negative score, or deterioration in air quality as a positive score.

11.2.21 The overall NO_2 and PM_{10} assessment scores for the scheme are then calculated by aggregating the individual assessment scores for each road across the network, and indicate either a net improvement or deterioration.

Regional Assessment

11.2.22 The DMRB assessment of the contribution of the scheme to regional air quality is based on the total annual emission of pollutants over the road network. The pollutants considered are:

- CO;
- NO_x;
- Total hydrocarbons;
- PM_{10}; and
- CO_2

11.2.23 The DMRB regional assessment calculation uses the traffic characteristics and road length for each road in the study. The A47 is a total length of approximately 11.7 km. Total annual emissions for the Do-Minimum and Do-Something scenarios for the opening year (2012) are calculated.

Construction Phase

11.2.24 The impact of construction activities is based on an amendment to the requirements of DMRB Volume 11, Part 3, Section 3 [Ref 7 Appendix 11.1]. The number of sensitive properties within 150m of the road side have been calculated. The types of construction activities and their relative impacts are considered.

11.2.25 The possible construction activities associated with A47 road construction that may have an air quality impacts are described below:

- Breaking of the existing road
- Excavation
- Earthworks
- Crushers
- Stockpiles of stones and materials
- Haul routes
- Site and construction vehicles

- Disruption to existing traffic during the construction

11.3 Legislation

Part IV Environment Act 1995

11.3.1 Part IV of the Environment Act 1995 sets out the principles of local air quality management, and includes provision for a National Air Quality Strategy (NAQS).

11.3.2 It is a requirement of the 1995 Act that local authorities review current and future air quality within the authority's area, and assess whether air quality standards and objectives are being achieved or are likely to be achieved. Where it is anticipated that an air quality objective will not be met, it is a requirement of the Act that an Air Quality Management Area (AQMA) be declared. Where an AQMA is declared, the local authority is obliged to produce an Action Plan in pursuit of the achievement of the air quality objectives.

National Air Quality Strategy

11.3.3 The NAQS is intended to protect and improve ambient air quality in the UK in the medium-term, without imposing unacceptable economic or social costs (DETR, 2000b). It sets a number of health-based ambient air quality standards and objectives, as given in Table 11.3.1. These are given statutory backing in England, through the Air Quality (England) (Amendment) Regulations 2002.

11.3.4 The Strategy's objectives for particles (PM_{10}), benzene and carbon monoxide were reviewed in 2000/01, in particular, to take account of the latest health evidence and advice on the impact of particles on people's health and of developments in Europe. After careful consideration the objectives for these pollutants were updated and set out in an addendum to the Air Quality Strategy in February 2003. The updated objectives are also shown in Table 11.3.1.

Table 11.3.1 National Air Quality Strategy Limit Values			
Pollutant	**Air Quality Objective**		**Date to be achieved by**
	Concentration	**Measured as**	
Benzene	16.25 μgm^{-3}	Running annual mean	31/12/2003
	5 μgm^{-3}	Annual mean	31/12/2010
1,3-Butadiene	2.25 μgm^{-3}	Running annual mean	31/12/2003
Carbon monoxide	10 mgm^{-3}	Running 8-hour mean	31/12/2003
Lead	0.5 μgm^{-3}	Annual mean	31/12/2004
	0.25 μgm^{-3}	Annual mean	31/12/2008
Nitrogen dioxide	200 μgm^{-3}	1-hour mean; not to be exceeded more than 18 times a year	31/12/2005
	40 μgm^{-3}	Annual mean	31/12/2005
Particles (PM_{10})	50 μgm^{-3}	24-hour mean; not to be exceeded more than 35 times a year	31/12/2004
	40 μgm^{-3}	Annual mean	31/12/2004
	50 μgm^{-3}	24-hour mean; England (apart from London) not to be exceeded more than 7 times a year London not to be exceeded more than 10 times a year	31/12/2010
	20 μgm^{-3}	Annual mean; England (apart from London)	31/12/2010
	23 μgm^{-3}	Annual mean; London (It is proposed that London should work towards a 20 μgm^{-3} annual mean aspirational objective after 2010, with the aim of achieving it by 2015, where cost effective and proportionate local action can be identified)	31/12/2010
Sulphur dioxide	350 μgm^{-3}	1-hour mean; not to be exceeded more than 24 times a year	31/12/2004
	125 μgm^{-3}	24-hour mean; not to be exceeded more than 3 times a year	31/12/2004
	266 μgm^{-3}	15-minute mean; not to be exceeded more than 35 times a year	31/12/2005

11.3.5 In addition national objectives are set for Ozone as an objective for the protection of human health, and for NO_X and SO_2 in respect of the protection of vegetation and ecosystems. Although these objectives are not set in the regulations.

11.3.6 Ozone is not included in the regulations due to its transboundary nature, and is seen as a national issue rather than a local authority problem.

Table 11.3.2 National Air Quality Strategy Objectives			
Pollutant	**Objective**		**Date to be achieved by**
	Concentration	**Measured as**	
Ozone	100 μgm^{-3} not to be exceeded more than 10 times per year (provisional)	Daily maximum of running 8-hour mean	31 December 2005
Nitrogen oxides	(Assuming NO_x is taken as NO_2) $30\mu gm^{-3}$	Annual mean	31 December 2000
Sulphur dioxide	20µgm-3	Both annual mean and winter average (1 Oct–31 Mar)	31 December 2000

For the purposes of Local Air Quality Management (not included in the Regulations)

Clean Air Act 1993

11.3.7 Regulations made under Section 30 of the Clean Air Act impose requirements as to the composition, content and marketing of fuel used in motor vehicles. The Motor Fuel (Composition and Content) Regulations 1999 relate to the quality of petrol and diesel fuels, and banned the marketing of leaded petrol from 1 January 2000.

Climate Change: the UK Programme

11.3.8 This climate change programme aims to bring about a reduction in UK emissions of greenhouse gases, including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.[†]

11.3.9 Under the Kyoto Protocol the UK has a legal obligation to reduce the emissions of greenhouse gases to 12.5% below 1990 levels by 2008-2012. The UK has gone beyond this in setting a domestic target of a 20% reduction in CO_2 emissions below 1990 levels by 2010.

11.3.10 Road transport is a major source of a number of air pollutants. Their estimated contributions to total emissions in 1999 as indicated in DMRB [Ref 7, Appendix 11.1] were:

- Non-methane Volatile Organic Compounds 27%
- Carbon monoxide 69%
- Carbon Dioxide 22%
- Oxides of Nitrogen 45%
- Particles (PM_{10}) (diesel) 17%

11.3.11 The predicted growth in traffic and distance travelled in the future could result in a deterioration in local air quality, though this must be balanced

[†] The greenhouse gases Chlorofluorocarbons (CFCs) and Hydrofluorocarbons (HCFCs) are being phased out under the Montreal Protocol, and are not covered by the Kyoto Protocol and UK Climate Change Programme.

against the concurrent improvements in engine technology and cleaner fuels. These improvements in technology and fuels are driven by EU and national legislation and targets.

11.3.12 In the UK, the attainment of the NAQS objectives is closely linked to the need for a reduction in traffic related pollution. Regulations made under the Road Traffic Act 1988, Transport Act 1982 and Clean Air Act 1993 seek to regulate the emissions from road traffic. The legislative framework set in these regulations is intended to reduce the impact of the transport sector on air pollution, and in so doing to assist the achievement of the air quality objectives. In conjunction with this the Government White Paper "A New Deal for Transport" which aims to improve public transport and reduce congestion and traffic generated pollution.

11.3.13 The effect of the proposed development on local traffic may have an effect on local air quality by altering vehicle emissions. Factors affecting vehicle emissions include speed, engine temperature, acceleration rates, vehicle condition, type and size.

11.4 Baseline Conditions

11.4.1 Traffic on the existing A47 is expected to be the major contributor to ambient air quality concentrations. The surrounding area is largely made up of drained marshland converted to farmland, where activities such as spraying, ploughing or muck spreading may have an impact on air quality. However these activities would be expected to be restricted to specific times of the year and would be of only limited duration. Seasonal impacts from holidaying visitors to this area may contribute to local air quality although again this is for a limited time and are predominantly accounted for within the traffic movements. Hence their overall impacts on ambient air quality concentrations will be minimal.

11.4.2 Great Yarmouth Borough Council Stage 2 Air Quality Review and Assessment [ref6, Appendix 11.1] indicates that none of the NAQS objective levels are likely to be exceeded. Broadland District Council were also consulted and they were able to confirm that their air quality review and assessment process has indicated that none of the NAQS objective levels are likely to be exceeded [ref10, Appendix 11.1]. Consequently neither local authority has declared any Air Quality Management Areas (AQMAs) within the study area.

11.4.3 Concentrations of NAQS pollutants were modelled for the baseline year of 2000 at 8 separate receptors (see figure 11.1), as laid out in Table 11.4.1.

Table 11.4.1 Air Quality Concentrations for the Base Year of 2000						
Receptor	CO mg/m³	NO_2 µg/m³	Benzene µg/m³	1,3-butadiene µg/m³	PM_{10} µg/m³	
	Annual mean	Annual mean	Annual mean	Annual mean	Annual mean	Days > 50µg/m³
R1	0.50	31.3	0.47	0.40	25.5	14
R2	0.36	24.4	0.35	0.25	22.0	6
R3	0.31	20.8	0.29	0.17	20.4	4
R4	0.38	26.8	0.34	0.24	22.7	8
R5	0.27	18.3	0.25	0.12	19.4	3
R6	0.48	33.3	0.43	0.35	25.8	14
R7	0.28	19.8	0.26	0.14	19.9	3
R8	0.36	26.1	0.33	0.23	22.3	7

11.4.4 The predicted DMRB air quality concentrations in 2000 at the identified sensitive receptors (Table 11.4.1) are below the NAQS objectives (Table 11.3.1) for all pollutants. To put this in to context the highest predicted annual average concentration for key traffic related pollutant PM_{10} is 25.8 µg/m³ at receptor R6 (Figure 11.1), and for NO_2 is 33.3 µg/m³ also at R6. These values are below the annual average objective levels of 40 µg/m³ in both cases. Pollutant concentrations are highest at receptor R6 because it is currently very close to the A47 (4m away).

11.4.5 The existing speed limit on the A47 is 60 mph, however as a result of recommendations in the Norwich to Great Yarmouth Road Based Study[ref11, Appendix 11.1] it is intended to implement a 50mph speed restriction and it has been assumed that this will be in place by the proposed year of opening of any new proposals in 2012. Therefore the do minimum situation has been calculated on the basis of the 50mph speed limit.

11.5 Environmental Impacts and Mitigation

Localised Assessment

11.5.1 The results for the localised air quality assessment are indicated in tables 11.5.1 to 11.5.3 below.

Table 11.5.1 Air Quality Concentrations for Do-Minimum 201						
Receptor	**CO mg/m^3**	**NO_2 µg/m^3**	**Benzene µg/m^3**	**1,3-butadiene µg/m^3**	**PM_{10} µg/m^3**	
	Annual mean	**Annual mean**	**Annual mean**	**Annual mean**	**Annual mean**	**Days > 50µg/m^3**
R1	0.22	21.8	0.26	0.19	18.0	1
R2	0.16	17.5	0.20	0.12	16.4	0
R3	0.13	14.8	0.17	0.08	15.5	0
R4	0.14	16.8	0.19	0.10	16.1	0
R5	0.11	13.0	0.15	0.05	15.0	0
R6	0.18	20.3	0.24	0.18	17.2	1
R7	0.11	13.6	0.16	0.06	15.2	0
R8	0.14	16.6	0.19	0.11	16.0	0

Table 11.5.2 Air Quality Concentrations for Do-Something (dual carriageway) 2012 Options 2 and 2A						
Receptor	**CO mg/m^3**	**NO_2 µg/m^3**	**Benzene µg/m^3**	**1,3-butadiene µg/m^3**	**PM_{10} µg/m^3**	
	Annual mean	**Annual mean**	**Annual mean**	**Annual mean**	**Annual mean**	**Days > 50µg/m^3**
R1	0.24	23.9	0.28	0.22	19.5	3
R2	0.17	17.9	0.21	0.13	16.7	1
R3	0.13	15	0.17	0.08	15.6	0
R4	0.15	16.8	0.19	0.11	16.1	0
R5	0.11	13	0.15	0.05	15.1	0
R6	0.16	19.7	0.23	0.17	17.2	1
R7	0.12	14.1	0.16	0.07	15.3	0
R8	0.14	17.4	0.20	0.12	16.4	0

Table 11.5.3 Comparison of Do-Something against Do-Minimum (2012) for Options 2 and 2A					
Receptor	**CO mg/m^3**	**NO_2 µg/m^3**	**Benzene µg/m^3**	**1,3-butadiene µg/m^3**	**PM_{10} µg/m^3**
	Annual mean	**Annual mean**	**Annual mean**	**Annual mean**	**Annual mean**
R1	9.1%	9.6%	7.7%	15.8%	8.3%
R2	6.3%	2.3%	5.0%	8.3%	1.8%
R3	0.0%	1.4%	0.0%	0.0%	0.6%
R4	7.1%	0.0%	0.0%	10.0%	0.0%
R5	0.0%	0.0%	0.0%	0.0%	0.7%
R6	-11.1%	-3.0%	-4.2%	-5.6%	0.0%
R7	9.1%	3.7%	0.0%	16.7%	0.7%
R8	0.0%	4.8%	5.3%	9.1%	2.5%

11.5.2 With the Do-Minimum scenario the predicted DMRB air quality concentrations in the opening year of 2012 for all pollutants are below existing levels and below the NAQS objective levels. In the case of benzene, for example, predicted concentrations are at least 10 times below

the revised 5μg/m³ to be achieved by 2010. The highest predicted concentrations for key traffic related pollutants NO_2 and PM_{10} are 21.8μg/m³ and 18.0μg/m³ respectively at R1. This is almost half of the objective of 40μg/m³ for NO_2 and below half of the objective of 40μg/m³ for PM_{10}. Predicted ambient air concentrations are also of similar levels for PM10 and NO_2 at receptor R6. These patterns reflect that receptor R1 is influenced by contributions from 3 links, whilst R6 is because it is located close to the road.

11.5.3 Over time pollutant concentrations decrease with the Do-Minimum scenario, even though the amount of traffic increases. This is accounted for by factors in the DMRB which describe reductions in vehicle emissions due to improving technologies and their introduction into the traffic fleet as time increases.

11.5.4 With the Do-Something scenario for Options 2 and 2A the difference in width of the central reservation has no effect on the air quality assessment because air quality modelling is based on distances of receptors from the centre of the carriageway.

11.5.5 The predicted concentrations for all NAQS pollutants (Table 11.5.2) are below their corresponding objective concentrations in the opening year. The highest predicted NO_2 and PM_{10} concentrations are 23.9 μg/m³ and 19.5 μg/m³ respectively at receptor R1 in 2012.

11.5.6 Receptors R6 and R7 close to the existing A47, reflect the changes that the development of either Option 2 or 2A has on local air quality. The proposed route in each instance moves the road closer to receptor R7, and this is reflected by the increase in all pollutant concentrations, except benzene which remains the same. Conversely, pollutant concentrations at R6 decrease as the road would be slightly further away.

11.5.7 Table 11.5.3 illustrates the percentage change in receptor concentrations between the Do-Minimum and Do-Something scenarios. Pollutant concentrations are predicted to remain the same or increase at all receptors with the operation of either scheme, with the exception of receptor R6 where all pollutant concentrations decrease. The increase in concentrations are attributable to both increase in speeds and volume of traffic from the Do-Minimum.

11.5.8 Pollutant concentrations at all the receptors again decrease over time from the baseline (2000) due to improving vehicle technologies.

11.5.9 For the Localised Assessment all pollutants remain well below their NAQS objective concentrations and below existing concentrations therefore mitigation is not required for any of the options.

11.5.10 The generalised assessment results are indicated in Tables 11.5.4 to 11.5.7 below and apply to both Options 2 and 2A.

Table 11.5.4 Generalised Assessment A47 Acle to Great Yarmouth for the opening year of 2012					
	Distance				
	RD – 50m	50 – 100m	100 – 150m	150 – 200m	RD – 200m
Properties	3	7	27	29	66
PM_{10} Weight	1	0.65	0.55	0.5	n/a
PM_{10} Weighted Properties	3	4.55	14.85	14.5	36.9
NO_2 Weight	1	0.8	0.65	0.55	n/a
NO_2 Weighted Properties	3	5.6	17.55	15.95	42.1
	Do-Minimum		**Do-Something**		**Difference**
Roadside PM_{10}	17.4		18.5		+1.1
Roadside NO_2	20.7		21.9		+1.2
PM_{10} Assessment for route					+40.6
NO_2 Assessment for route					+50.5
Quantitative Measure:	+66 properties				
Assessment Score:	PM_{10}: +40.6				NO_2: +50.5

Table 11.5.5 Generalised Assessment A47 South of Acle for the opening year of 2012					
	Distance				
	RD – 50m	50 – 100m	100 – 150m	150 – 200m	RD – 200m
Properties	19	41	56	82	198
PM_{10} Weight	1	0.65	0.55	0.5	n/a
PM_{10} Weighted Properties	19	26.65	30.8	41	117.45
NO_2 Weight	1	0.8	0.65	0.55	n/a
NO_2 Weighted Properties	19	32.8	36.4	45.1	133.3
	Do-Minimum		**Do-Something**		**Difference**
Roadside PM_{10}	17.3		17.4		+0.10
Roadside NO_2	20.7		20.8		+0.10
PM_{10} Assessment for route					+11.7
NO_2 Assessment for route					+13.3
Quantitative Measure:	+198 properties				
Assessment Score:	PM_{10}: +11.7				NO_2: +13.3

Table 11.5.6 Generalised Assessment A1064 for the opening year of 2012					
	Distance				
	RD – 50m	50 – 100m	100 – 150m	150 – 200m	RD – 200m
Properties	40	47	59	67	213
PM_{10} Weight	1	0.65	0.55	0.5	n/a
PM_{10} Weighted Properties	40	30.55	32.45	33.5	136.5
NO_2 Weight	1	0.8	0.65	0.55	n/a
NO_2 Weighted Properties	40	37.6	38.35	36.85	152.8
	Do-Minimum		**Do-Something**		**Difference**
Roadside PM_{10}	17.1		17.2		+0.10
Roadside NO_2	19.2		19.5		+0.30
PM_{10}Assessment for route					+13.6
NO_2Assessment for route					+45.8
Quantitative Measure:	+213 properties				
Assessment Score:	PM_{10}: +13.6			NO_2: +45.8	

Table 11.5.7 Summary of Generalised Assessment				
Link	Scores		Properties	
	PM_{10}	NO_2	Improvement	Deterioration
A47 Acle - Gt. Yarmouth	+40.6	+50.5	-	66
A47 South of Acle	+11.7	+13.3	-	198
A1064	+13.6	+45.8	-	213
Totals:	+65.9	+109.6	0	477

11.5.11 As detailed in Tables 11.5.4 to 11.5.6, and summarised in Table 11.5.7 there is an overall increase of +1.1 $\mu g/m^3$ in PM_{10} and +1.6 $\mu g/m^3$ for NO_2 concentrations in the opening year (2012) due to Options 2 and 2A. Weighted by the number of properties, the assessment scores are +65.9 and +109.6 for PM_{10} and NO_2 respectively. A total of 477 properties suffer a slight deterioration in air quality.

11.5.12 The increase in pollutant concentrations is small compared to the Do Minimum situation and no mitigation is recommended for the Generalised Assessment .

Regional Assessment

11.5.13 Results from the regional assessment calculations are presented below in Table 11.5.8.

Table 11.5.8 Regional Impact Results					
	Total Emissions (tonnes/year)				
	CO	HC	NO_x	PM_{10}	CO_2
Do-Minimum 2012	29293	4571	30478	748	7924
With Scheme 2012	34535	5147	39302	1147	10278
% Change from Do-Minimum	+17.9%	+12.6%	+29.0%	+53.3%	+29.7%

11.5.14 Table 11.5.8 illustrates that the dual carriageway would result in increases in vehicle emissions from the Do-Minimum. This relates to the predicted 17% increase in traffic flows with the scheme.

11.5.15 There are no standards against which to evaluate the results of the regional assessment. The results in Table 11.5.8 shows that the mass of emissions produced by the implementation of Options 2, and 2A is less than 0.01% of the national emissions as shown below in Table 11.5.9.

Table 11.5.9 Emissions from UK Road Transport Sources, 1999	
Pollutant	Total UK Road Transport Emissions (KT)
Carbon monoxide (CO)	3293
Total oxides of nitrogen (NO_X)[1]	714
Volatile organic compounds (VOC)[2]	473
Particulates (PM_{10})	32
Carbon dioxide (CO_2)[3]	114561

[1] NO_2 equivalents

[2] Excludes methane and therefore equivalent to 'non-methane hydrocarbons

[3] Expressed in terms of weight of carbon. A factor of 44/12 may be used to convert to weight of CO_2

11.5.16 The increase in pollutant concentrations is small compared to the do minimum situation and there is no recommended mitigation for the Regional Impacts.

Construction Phase

11.5.17 The number of properties within 150m of the roadside are indicated in table 11.5.10 below.

Table 11.5.10Numbers of Properties in 50m Bands Within 150m of the Roadside.			
	0-50m	50-100m	100-150m
A47	3	7	27

11.5.18 There are 3 properties within 50m of the edge of the A47 roadside. These properties may potentially suffer significant impacts due to construction activities. There are also 7 properties between 50 and 100m from the road that may have moderate impacts due to construction dust. A further 27 in each instance are 100 to 150m from the road where construction activities may cause a minor impact. Dust monitoring as part of a research programme indicates that there is negligible impact due to construction dust beyond 150m from construction activities [Ref 8]. The extent of any impacts from dust would be limited to the duration that any section of road is being constructed.

11.5.19 The measures described below are available to mitigate the impact of dust due to construction [Ref9 Appendix 11.1].

11.5.20 Haul routes would generally utilise the existing road or the newly constructed embankment, however short lengths of temporary haul route may require construction to link site and storage compounds to the works. The following measures should be adopted for all haul routes including existing roads:

- Sweep paved access roads (whilst allowing two-way traffic) and public roads regularly using a vacuum sweeper.
- Limit vehicle speeds – the slower the vehicles the less the dust generation.
- Damp down – the use of water sprays, increase frequency and duration during warm and sunny weather when water evaporates quickly.

11.5.21 The following measures should be adopted specifically for temporary haul routes:

- Select suitable haul routes away from sensitive sites if possible.
- Pave heavily used areas, or use geotextiles e.g. around batching plant or haul routes. Sweep these regularly.
- Produce a length of paved road before the exit from the site.
- Reduce the width of haul roads (while still allowing two-way traffic) to minimise surface area from which dust may be produced.

11.5.22 Demolition

- Locate crushing plant away from sensitive sites such as residential properties.

11.5.23 Plant

- Clean the wheels of vehicles leaving the site so that mud is not spread on surrounding roads – dry mud turns to dust.
- Ensure that exhausts do not discharge directly at the ground.

11.5.24 Earthworks and Excavations

- Revegetate or seal temporary or completed earthworks as soon as possible.
- Keep earthworks damp – try to programme to avoid exceptionally dry weather.

11.5.25 Materials handling and storage

- Locate stockpiles out of the wind (or provide wind breaks) to minimise the potential for dust generation.
- Keep the stockpiles to the minimum practicable height and use gentle slopes.
- Compact and bind stockpile surfaces (in extreme cases).
- Revegetate long-term stockpiles.
- Minimise the storage time of materials on site.
- Store materials away from the site boundary and downwind of sensitive areas.
- Ensure that all dust-generating materials transported to and from site are covered by tarpaulin.
- Minimise the height of fall of materials.
- Avoid spillage, and clean up as soon as possible.
- Damp down – the use of water sprays, increase frequency and duration during warm and sunny weather when water evaporates quickly.

11.5.26 Cutting/grinding/grouting/packing

- Minimise cutting and grinding on site.
- On cutters and saws, use equipment and techniques such as dust extraction to minimise dust. Consider a wet cutting saw or use vacuum extraction.
- Spray water during cutting of concrete to minimise dust.

11.5.27 Implementation of these mitigation measures would reduce the potential risk of dust impacts on properties within the 50m bands identified in table 11.5.18.

11.6 Summary

11.6.1 Improvements to the A47 Acle Straight are being proposed, upgrading the existing carriageway to two-lane dual carriageway and there are two variations to this. Option 2 is a dual carriageway with a 8m wide central reservation, while Option 2A is the same alignment with a 2.5m wide central reservation. The current air quality impacts of the existing A47 have been considered, together with the Do-Minimum and Do-Something scenarios for the opening year 2012 for both Options.

11.6.2 Previous air quality review and assessments indicated that none of the air quality objectives would be exceeded and on this basis no Air Quality Management Areas (AQMA) have been declared.

11.6.3 The DMRB assessment of this stretch of the A47 for 2000 confirms these findings. All the pollutant concentrations are predicted to be substantially below their respective NAQS objectives. Again in 2012 without development of the scheme the air quality concentrations are predicted to achieve their NAQS objectives.

11.6.4 The predicted air quality for all pollutants for both the proposed dual carriageway options in the opening year (2012) are below the National Air Quality Stratergy (NAQS) objectives at all receptors for all options and would be below existing levels. The decrease in pollutants for the Do-Minimum and Do-Something proposals compared with the existing situation relates to factors in the DMRB air quality model that describes reductions in emissions over time due to improving vehicle technologies.

11.6.5 Comparing the Do-Something against the current A47 for both Options, modelled air quality concentrations at receptors R1 to R8 are predicted to either increase slightly or remain the same. Receptor R6 is the exception where concentrations of all pollutants, except PM_{10} which remains the same, decrease slightly. The increases are largely due to the predicted increase in the volume of traffic and vehicle speed along the A47 as a result of implementing Options 2 or 2A. Concentrations for Options 2 and 2A would be the same for both options because the assessment is carried out with respect to the centre of the carriageway.

11.6.6 The generalised assessment indicates a slight deterioration in ambient air quality concentrations compared to the do-minimum situation for a large number of properties as a result of the proposals.

11.6.7 The regional assessment indicates a small increase on the do-minimum situation in all emissions for all options as a result of the scheme.

11.6.8 The construction phase could potentially have a significant impact on three residential properties within 50m of the roadside. However, the limited duration of construction activity likely to be undertaken at any one location

and with the implementation of suitable mitigation measures, this impact could be considerably decreased.

12 Traffic Noise and Vibration

12.1 Introduction

12.1.1 This chapter presents the results of the DMRB stage 3 assessment of road traffic noise associated with the proposed single carriageway improvments to the A47 Acle Straight for the years 2012 (year of opening) and 2020 (design year). In addition the impact on the local community from the construction of the proposals is discussed. The assessment is based on current UK legislation and guidance.

12.1.2 The proposals are detailed in Chapter 2 but can be summarised as two dual carriageway options both involving widening of the existing carriageway. Option 2 retains the existing road and embankment as one carriageway and has the new carriageway on a separate embankment with a wide central reserve (up to 8M) separating them. Option 2A involves widening of the existing embankment and a minimum width, (2.5M) central reservation. The speed limit for both options would be 70 mph. A key element of the design involves the reduction of private accesses onto the carriageway with the provision of separate access tracks on both sides of the road, parallel to the road embankment.

12.2 Methodology and Assessment Criteria

12.2.1 The Stage 3 assessment has been carried out in accordance with DMRB[67]. It identifies the likely recipients of any impacts; which might include neighbouring households, or users of recreational facilities and open space. It also includes an indicative assessment of properties that may qualify for noise insulation, under the Noise Insulation Regulations[68].

12.2.2 Two scenarios were assessed, a do minimum option and two dual carriageway options, referred to as 2 and 2A. All residential properties and public amenities and recreational areas were assessed within 300m of the carriageway.

12.2.3 Ambient noise levels have been estimated and in conjunction with this the noise levels within the first 8 years (15 year flows were unavailable) of the 0road opening with maximum expected flow changes on a normal working day can be predicted. Parallel calculations were also undertaken for the Do-Minimum scenario.

[67] Design Manual for Roads and Bridges, Volume 11 Highways Agency, June 1993

[68] The Noise Insulation Regulations 1075 (amended 1988)

12.2.4 Noise predictions for the year of opening (2012) and the worst year in the first eight years after opening (2020) were calculated and expressed in terms of the L10 (18hour) dB (A). Road traffic noise levels in the United Kingdom are currently measured and predicted in units of A-weighted decibels, specifically the 18 hour, ten percentile level, or the level exceeded for 10% of the measurement period, (L_{10}(18-hour)dB(A)). This is described in the former Department of the Transport and Welsh Office document the 'Calculation of Road Traffic Noise, 1988' (CRTN).

12.2.5 The 18-hour period is between 0600 and 2400 hours. All noise levels at properties are quoted in terms of L_{10}(18-hour)dB(A) as described below:

- L_{10}(18-hour) is the arithmetic mean or average of the noise levels exceeded for 10% of the time in each of the 18 one hour periods between 6am and midnight;
- dB(A) is decibels adjusted to give a comparatively more weight to the sound frequencies which are detected most readily by the human ear. The 'A' weighting adjustment has been found to give one of the best matches to the perceived noisiness of vehicles. A scale of typical common sounds on the dB(A) scale is presented in Diagram 12.1.

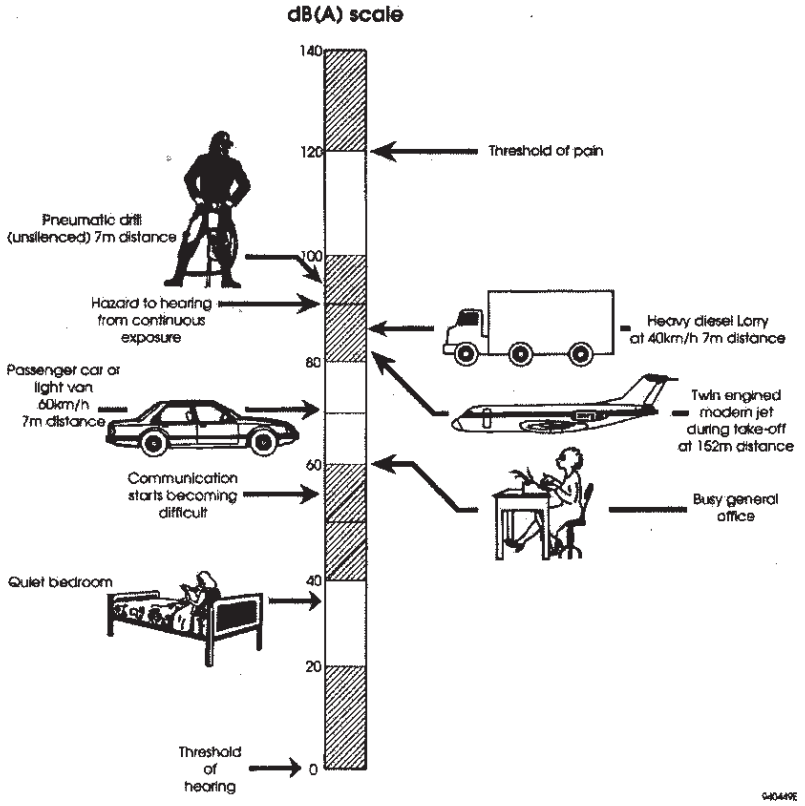


Diagram 12.1: The level of typical common sounds on the dB (A) scale (Source;DMRB)

12.2.6 The numbers are based on a 'logarithmic' scale. This means that an increase of 10 dB (A) is required for a doubling of loudness and a decrease of 10 dB (A) is required for a halving of loudness. The significance of changes in noise levels on the dB (A) scale is described in the DMRB as follows:

- Less than (<)1 dB (A) – considered to be a 'not discernible' change;
- 1 dB (A) to less than 3 dB(A) – considered to be a 'marginal' change;
- 3 dB(A) to less than 5 dB(A) – considered to be a 'noticeable' change;
- 10 dB(A) to less than 15 dB(A) – considered to be a 'substantial' change;
- (>=) 15 dB(A) or more – also considered to be a 'substantial' change.

12.2.7 The study area extends for approximately 300m from the edge of the proposals, in line with DMRB guidelines, which advise that noise predictions are only reliable for distances up to 300m from th road, beyond which the varying effects of wind and temperature can compromise accuracy. Any change in noise level as a consequence of the proposals is discussed, including an indicative assessment of mitigation.

12.2.8 Guidance presented in the DMRB indicates that the greatest degree of annoyance occurs when there is an abrupt change in flow compared to the steady state situation. As a consequence, the DMRB, in its assessment of new roads, includes the effects of 25% changes in traffic flow, which equate to a change in level of approximately 1dB(A). In general terms, a doubling or halving of the traffic flow is equivalent to a noise change of 3dB(A) and, historically, changes of less than 3 dB(A) to broadband environmental noise such as road traffic have generally been viewed as imperceptible.

12.2.9 Noise impact has also been assessed using the Guidance on Methodology for Multi-Modal Studies (GOMMMS)[69], for each of the route option corridors under consideration, in terms of the changes in the number of people annoyed by changes in source noise at a number of locations. These appraisal tables can be found in Appendix 12.2.

12.2.10 Any properties eligible for noise insulation under local or national criteria (Land Compensation Act 1975 Part 2- Noise Insulation Regulations) have been assessed where appropriate, and mitigation measures formulated where appropriate.

12.2.11 The noise assessment calculations have been undertaken using traffic noise modelling software known as 'ROADNOISE 2000'. This software generates a three-dimensional computer model from digitised inputs of road segments, barriers and the positions for which the noise level is to be calculated. The base data required in the calculation includes the following:

[69] Guidance on the Methodology for Multi-Modal studies, DETR 2000

- Traffic Composition: 18-hour traffic flow, percentage of heavy goods vehicles and average 18-hour traffic speeds. The traffic flows used for the noise assessment are derived from the traffic model developed for the bypass.
- Road Configuration: gradient, surface texture, vertical and horizontal alignment and depth/height of cuttings or embankments.
- Receiver Location: distance from road, angle of view, ground absorption and shielding from natural or purpose built barriers.

12.2.12 The CRTN level is predicted one metre from the facade of a building, normally at first floor height, as noise levels are usually greater at the upper storey of a building. At free-field locations, i.e. open locations free from reflective surfaces such as buildings, noise levels are predicted at a height of 1.5m above ground level.

12.2.13 This traffic noise assessment compares the change in noise levels that would occur between the 'do something' and 'do minimum' scenarios. The scenarios are defined as follows:

- Do minimum is the noise climate that would exist without the implementation of the proposed bypass. Two do-minimum scenarios have been considered for the Year 2012 (opening year for bypass) and the Year 2020(design year for bypass). The Year 2012 scenario is also known as the 'base year'.
- Do something is the noise climate that would exist with the implementation of either of the two dual carriageway options. For comparison with the do-minimum, both Year 2012 and the Year 2020 do-something scenarios have been considered.

Significance Criteria

12.2.14 In order to classify the potential noise effect as a consequence of the construction and operation of the bypass, significance criteria have been defined and presented below in Table 12.1. Due to the problems of sensitivity to vibration, significance criteria are not appropriate. However, any changes in vibration should be within the 'low probability of adverse comment' section of table 12.2. Any change greater than that stated would not be permitted under British Standard BS6472: 1992 Evaluation of Human Exposure to Vibration in Buildings.

Table 12.1 Significance Criteria

Effect	Significance Criteria
Severe adverse effect	Areas especially sensitive to noise, e.g. schools, hospitals, homes for Aged Persons, dwellings where noise levels are expected to increase by greater than 15 dB (A). Little or no scope for mitigation.
Major adverse effect	Mitigation measures may partially ameliorate the effects of noise on areas especially sensitive to

	noise where noise levels increase between 10 and 15 dB (A).
Moderate adverse effect	Mitigation measures may partially ameliorate the effects of noise on areas especially sensitive to noise where noise levels increase between 5 and 10 dB (A).
Minor adverse effect	Effective mitigation for areas especially sensitive to noise where noise levels increase between 1 and 5 dB (A).
No effect	No significant change in ambient noise levels, that is, between 0 and 1 dB (A).
Minor beneficial effect	Reductions in noise levels at areas especially sensitive to noise by between 1 and 5dB(A).
Moderate beneficial effect	Reductions in noise levels at areas especially sensitive to noise by 5 and 10 dB (A)

Construction Noise

12.2.15 There are no national criteria for limiting noise levels from construction sites/activities. However, a criterion that has been widely applied in large civil engineering projects uses 75dB(A), measured as an equivalent level, ($L_{AeqT.}$) at the nearest noise sensitive location as a limit for daytime construction activities. This normally reduces to approximately 65dB(A) in the evening and 50dB(A) at night (see Appendix 12.1 for description of noise measurement terminology).

12.2.16 Construction work involves various activities, undertaken by different types of plant, at different locations and at varying times. As a consequence, construction noise levels at noise sensitive locations vary with time as the noise sources move progressively closer or further away from a property, and as the activities themselves change. The main activity is likely to be confined to groundwork and haulage movements to and from the site.

12.2.17 In order to determine which properties would be significantly affected by noise during the construction phase, noise predictions at selected receiver locations should be carried out once the developers have finalised a construction plan. This should be implemented in accordance with the methodology set out in British Standard (BS) 5228: Part 1: 1997, 'Noise & Vibration Control on Construction and Open Sites'.

12.2.18 The BS5228 methodology involves calculating noise levels at chosen receptors taking into account the source noise level, the local topography as well as the nature of the ground cover. BS5228 also enables the assessment of haul vehicles that access a site during the construction phase. The predicted facade level is then compared with a criterion. In the UK a limit of 75dB(A), measured as a 12 hour equivalent continuous level at any receptor is usually adopted as a reasonable compromise between completing the construction whilst at the same time minimising serious disturbance to the community. Noise mitigation is considered if significant disturbance is predicted.

Vibration – Operational Road Traffic

12.2.19 Traffic generated vibration is either transmitted through the ground or through the air, with the former produced by the interaction between the travelling vehicle and the road surface and the latter by the engines or exhausts of vehicles. Both have dominant frequencies in the 50 to 100Hz range.

12.2.20 Under the scheme proposals the new carriageways would be provided with an overlay such that the ride quality would be improved over the existing situation resulting in a decrease in ground borne vibrations. DMRB suggests that vibration disturbance is similar to the noise nuisance assessment except that the percentage of people bothered by vibration is lower at all exposure levels.

12.2.21 British Standard 6472:1992, the 'Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)' gives acceptable magnitudes of vibration for different uses of buildings including commercial buildings and residential dwellings. It also provides an interpretation for residential buildings of the probability of adverse comment for different levels of exposure to vibration. Vibration dose values suggested by BS6472 for occupiers of residential buildings are outlined in Table 12.3 below.

Table 12.2 Vibration Dose Values (Residential Buildings)

Place	Low Probability Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
	$Ms^{-1.75}$ *		
Residential buildings 16 hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hour night	0.13	0.26	0.51

Vibration Standard (British Standard 6472:1992)

* The mathematical relationship for the Vibration Dose Value, (metres per second to the power of 1.75). Allows vibration to be assessed for a 16 hour day and a 8 hour night time.

Construction Vibration

12.2.22 Construction vibration will need to be assessed using the following documents once construction plans have been finalised and include information on the type of plant/equipment, nature of the work and duration/hours of work.

- Part 4 of British Standard 5228, 1997 is a code of practice for noise and vibration control specifically applicable to piling operations.

- BS 7385: parts 1 and 2: 1990 and 1993 respectively, give guidance on the measurement and evaluation of vibration and its effects on buildings, and a guide to damage levels from ground borne vibration.

12.3 Legislation

12.3.1 In the case of traffic noise from new or altered highways, the Noise Insulation Regulations (NIR) 1975 (amended 1988) give both mandatory and discretionary powers to provide noise insulation to affected dwellings.

12.3.2 Under Regulation 3, the following conditions must be satisfied:

- the traffic noise level must be 68 dB(A) or more [L_{A10} (18-hour)];
- the level must also rise by at least 1 dB(A) with a 1 dB(A) contribution from the scheme itself.
- The Regulations also require an 'eligible building' to be:
- a dwelling or a building used for residential purposes;
- be within 300 m of the edge of the new or altered highway;
- be occupied prior to the opening to traffic of the new or altered highway;
- not subject to a compulsory purchase or demolition order or be within a clearance area;
- not receiving a grant for noise insulation work under any other statutory scheme.

12.3.3 A preliminary assessment has been carried out to identify the approximate number of buildings eligible for insulation under the NIR. The results are described in Section 1.5. This preliminary assessment would be subject to a more detailed assessment following selection of a final option and completion of the detailed scheme design.

12.4 Baseline Conditions

12.4.1 The existing environment is characterised by road traffic noise, both on the A47 and the A1064. The majority of housing is situated in Acle at the junction of the A47 and A1064. There are some 130 houses within 300 metres of the road in Acle that are influenced by road traffic noise from other roads, notably the existing A47 bypass (to south of Acle), the A1064 and New Road (to west of Acle Roundabout). Roadside noise levels in the vicinity of Acle are in excess of 75dB(A) adjacent to the road, decreasing to 60dB(A) in less exposed areas.

12.4.2 On the A47 Acle Straight itself road noise levels are also in excess of 75dB(A) however there are only 3 houses and 1 public house within 300m, plus a holiday chalet and caravan park (Vauxhall Holiday Park) at the

eastern end. Typical noise levels at these properties are between 65-80dB(A). Noise levels at the holiday park are between 50-75dB(A).

12.4.3 The existing road surface is hot rolled asphalt (HRA). However the skid resistance is poor in places and a new asphalt surface will be required along the whole route within the next few years prior to the year scheduled for completion of the proposals in 2012. It is Highways Agency policy that all new schemes shall be surfaced with a modern 'low noise surface' rather than a conventional road surface. Typically this will reduce existing noise levels at nearby properties by approximately 2-3 dB (A).

12.5 Assessment of Noise Effects and Mitigation

Do Minimum Situation

12.5.1 Noise levels in the do minimum situation have been calculated for the years 2012 and 2020. It has been assumed that the existing road network will be a 'low noise surface' by the year of opening in 2012.

12.5.2 The traffic flows used are high growth in order to assume a worse case scenario. Traffic flow predictions are based on18 hour Annual Average Weekly Traffic (18hr AAWT) and 9% HGV are assumed. Traffic speeds have been based on 50 mph speed limits.

12.5.3 Noise levels for individual properties or groups of property have been calculated and these indicate that facades fronting onto the existing A47 would have noise levels in the range 65 to 80 dB (A) in 2012. The chalets and caravans located close to the perimeter of the Vauxhall Holiday Park have existing levels between 64 dB (A) and 73 dB (A), and this is because the park is within close proximity to the road and there is no existing form of environmental barrier.

12.5.4 The majority of receptors currently fronting the A47 are residential but there is also the Pontiac Roadhouse (formerly Three Feathers Public House and Stracey Arms Inn), the Stracey Arms Drainage Mill, the moorings along the River Bure and the holiday park to be considered.

12.5.5 The 2020 do minimum noise levels in the study area are predicted to be slightly greater than in 2012 due to a growth in traffic. The majority of properties would experience an increase in noise levels of approximately less than 1.0 dB (A) that is at the lower end of minor adverse impact.

The Do-something option

12.5.6 Noise levels have been calculated for properties in the study area for both options 2 and 2A. It has been assumed that the road surfacing would be Stone Mastic Asphalt (SMA) and this would reduce road traffic noise by 2.5

dB(A). Traffic speeds are based on a 70 mph limit. The number of properties along the Acle Straight that would experience a change in noise levels within 300m of the route between the do something and the do minimum scenario in 2012 and 2020 are shown in Table 12.3

Table 12.3 ; Noise Levels at Residential Properties on the A47

Location	Year	Do Min	Option 2		Option 2A	
			Noise Level	Do Som less Do Min	Noise Level	Do Som less Do Min
Pontiac Roadhouse (Three Feathers PH)	2012	74.6	72.3	*-2.3*	71.5	*-3.1*
	2020	75.3	72.1	*-3.2*	71.4	*-3.9*
Stracey Arms Mill House	2012	76.2	81.3	*5.1*	79.9	*3.7*
	2020	76.7	81.8	*5.1*	80.4	*3.7*
Kerrisons Level	2012	54.6	62.2	*7.6*	61.9	*7.3*
	2020	55.1	62.5	*7.4*	62.2	*7.1*
Scaregap Cottages	2012	69.0	74.8	*5.8*	73.8	*4.8*
	2020	69.5	75.2	*5.7*	74.2	*4.7*
Holiday Park (worst case)	2012	71.8	77.3	*5.5*	76.0	*4.2*
	2020	72.3	77.8	*5.5*	76.4	*4.1*

12.5.7 Option 2 causes an overall increase in noise, of 2 to 7.4 dB(A) due to higher speeds and the additional lanes of traffic located closer to properties fronting the A47. The decrease of 3.2 dB(A) at the Pontiac Roadhouse is due to the roundabout at Halvergate Junction, which would slow the traffic down and also it directs the traffic flow further south, away from the pub. Noise levels have increased at Kerrisons Level because the additional carriageway has moved the traffic noise further south and closer towards the property, but this property is separated from the road by the railway line and these noise levels would still remain low.

12.5.8 The noise levels with Option 2A generally increase between 0.5 and 7.1 dB(A). This is slightly less than for Option and and is due to the distance between the edge of carriageway and the properties being greater than Option 2. This is especially the case at the holiday park where the distance between the edge of carriageway and the front row of chalets and caravans is 20 metres compared to only 15m with Option 2. Elsewhere although noise levels are slightly lower, the increases or decreases in noise at individual properties shows a similar pattern to Option 2. Overall the difference between the majority of noise levels at facades for both options is only between 0.3 and 1.4 dB(A), which is negligible.

12.5.9 The noise levels at the Pontiac Roadhouse do not change between 2012 and 2020 because the traffic flows only change slightly at this section of the A47.

12.5.10 Tables 12.4 and 12.5 below shows the changes in noise levels at all sensitive properties within the study area for the options when compared to the do minimum situation. Overall both of the dual options would cause noise levels to increase at all properties other than the Pontiac Roadhouse.

12.5.11 Option 2 would result in increased noise levels of 5-10 dB(A) at approximately 372 properties which represents a moderate adverse impact. A large number of these properties are chalets and caravans at Vauxhall Holiday Park. Noise would also increase at a further 106 properties by either less than 1 dB(A) or 1 to 3 dB(A). These are mainly residential properties in Acle which are influenced by existing road noise from the A1064, New Road and the A47 bypass and some of this increase is attributable to traffic on these roads. Therefore the increase in noise generated by the proposals at these properties in Acle would be slight.

12.5.12 Option 2A would result in increased noise levels of 3-5 dB(A) at approximately 367 properties. The majority of these are situated in the holiday park. It would also result in increased noise at 108 mainly residential properties situated in Acle by less than 1 dB(A) or 1 to 3 dB(A).

Table 12.4 Estimated Numbers of Properties and Community Facilities in the Study Area with a Change in Noise Levels in the 2020 DUAL OPTION 2 Scenario Compared to the 2020 Do Minimum Scenario

Change in Noise Level	Residential	Commercial	Industrial	Community Facilities	Comments
Properties in Noise Band 50-60 dB (A) $L_{A10\ 18hr}$					
Increase in Noise Level					
<1	43	N/A	N/A	N/A	
1 - <3	45				
3 - <5	29				
5 - <10	267				
10 - <15	0				
Properties in Noise Band 60-70 dB (A) $L_{A10\ 18hr}$					
Increase in Noise Level					
<1	7	N/A	N/A	N/A	
1 - <3	11				
3 - <5	0				
5 - <10	64				Includes house at Kerrisons Level
10 - <15	0				
Properties in Noise Band >70 dB (A) $L_{A10\ 18hr}$					
Increase in Noise Level					
<1	0	N/A	N/A	N/A	
1<3	0				
3<5	4				
5<10	41				Includes Scaregap Cottages & Stracey Arms Mill house
10<15	0				
Decrease in Noise Level					
<1	0	0	N/A	N/A	
1 - <3	0	0			
3 - <5	0	1			Pontiac Roadhouse (Three Feathers PH)
5 - <10	0	0			
10 - <15	0	0			

Table 12.5 Estimated Numbers of Properties and Community Facilities in the Study Area with a Change in Noise Levels in the 2020 DUAL OPTION 2A Scenario Compared to the 2020 Do Minimum Scenario					
Change in Noise Level	**Residential**	**Commercial**	**Industrial**	**Community Facilities**	**Comments**
Properties in Noise Band 50-60 dB (A) $L_{A10\ 18hr}$					
Increase in Noise Level					
<1	59	N/A	N/A	N/A	
1 - <3	20				
3 - <5	284				
5 - <10	0				
10 - <15	0				
Properties in Noise Band 60-70 dB (A) $L_{A10\ 18hr}$					
Increase in Noise Level					
<1	7	N/A	N/A	N/A	
1 - <3	22				
3 - <5	40				
5 - <10	1				House at Kerrisons Level
10 - <15	0				
Properties in Noise Band >70 dB (A) $L_{A10\ 18hr}$					
Increase in Noise Level					
<1	0	N/A	N/A	N/A	
1 - <3	0				
3 - <5	43				Includes Stracey Arms Mill house & Scaregap Cottages
5 - <10	0				
10 - <15	0				
Decrease in Noise Level					
<1	0	0	N/A	N/A	
1 - <3	0	0			
3 - <5	0	1			Pontiac Roadhouse (Three Feathers PH)
5 - <10	0	0			
10 - <15	0	0			

DMRB Noise Nuisance Assessment

12.5.13 Table 12.6 presents the predicted change in nuisance levels expected from the options within the first fifteen years of opening. The term % annoyed relates to the percentage of people bothered "very much or quite a lot" and is taken from guidance in Volume 11 of the DMRB. Both of the dual options would cause a decrease in noise nuisance at the Pontiac roadhouse otherwise Option 2 would cause more noise nuisance than Option 2A but the difference is small and both would cause minor adverse impact on properties.

Table 12.6 DMRB Noise Nuisance Assessment

Property	% Annoyed	
	Option 2	Option 2A
Pontiac Roadhouse (Three Feathers PH)	-31	-33
Stracey Arms Mill house	36	32
House at Kerrisons Level	41	40
Scaregap Cottages	38	34
Holiday Park (worst case)	37	35

Noise Insulation Regulations (NIR) Assessment

12.5.14 As stated previously, the acceptable level for operational noise on roads that has been adopted for this scheme is the UK standard of 68 dB (A). This is quoted in the NIR and is used for the majority of UK highway schemes when considering mitigation measure. Locations at which the operational noise of the proposed options is predicted to be greater than 68 dB(A), with a 1 dB(A) contribution from the proposals would therefore require mitigation measures to be employed to reduce noise levels below this defined threshold.

12.5.15 The regulations state that it must be based on traffic flows 15 years after the road has opened. The traffic data available is only based on 8 years after the road has opened (2020), which has therefore restricted the predictions.

12.5.16 From the assessment the following properties were found to be eligible for insulation if the dual options were implemented:

- Stracey Arms Mill house may have eligibility on the east, west and southern facades for both of the dual options. Option 2 would cause an increase in noise levels at the southern façade from 76.2 dB(A) to 81.8 dB(A) causing a 5.6 dB(A) rise. Option 2A may cause all facades at Mill House to be eligible, but the noise increases are less then Option 2, and are between 3.7 and 4.9 dB (A).
- The Pontiac Roadhouse (Three Feathers PH) would be eligible on the east and west facades although it benefits from a reduction on southern

facades for both options. With dual option 2A noise would increase at the western façade by 1.0 dB(A) to 67.7 dB(A) and at the eastern façade by 2.3 dB(A) to 69.1 dB(A). With Option 2 noise levels would increase at the eastern façade by 1.4 dB(A) to 68.2 dB(A) and by 2.3 dB(A) to 69.0 dB(A) at the western facade.

- Scaregap Cottages are eligible on the southern, western and eastern facades with the implementation of both options. With option 2 the noise levels range from 71.1 to 75.2 dB(A) with a contribution between 4.8 – 6.5 dB(A) from the proposals. With Option 2A noise levels increase at the southern, western and eastern facades with a range from 70.3 to 74.2 dB(A) with a contribution of between 4.7- 5.7 dB(A) from the proposals.
- Existing noise levels at the holiday park are already high, those closest to the road being in excess of 70 dB(A). With Option 2 this front line of chalets and caravans and also several in the second row would experience an increase in noise levels of between 4-6 dB(A) to levels of 68 to 78 dB(A). As a consequence approximately 45 would be eligible for insulation. With Option 2A approximately 43 caravans in the front line would be eligible, with noise levels increasing by 5.0 to 6.0 dB(A).

Mitigation Measures

12.5.17 This section outlines the potential mitigation measures that may be included within the development.

12.5.18 During the operational phase mitigation measures that would be used to reduce noise levels below 68 dB (A) would include the construction of a noise barrier, for example a close boarded timber fence and/or earth bund. Alternatively, changes to the affected facades of the building in the form of double glazing could be made since this may be more cost effective, particularly with regards to small groups of properties or isolated buildings.

12.5.19 The properties indicated above as eligible for insulation would require glazing and ventilation that comply with the noise insulation regulations.

12.5.20 With regards to the holiday park the eligible chalets and caravans are unlikely to meet the NIR requirements for glazing and ventilation and therefore an environmental noise barrier is recommended to reduce the noise at this location. A 2.5 metre high noise barrier for example situated alongside the north side of the road from near to Vauxhall Roundabout to the entrance of the holiday park would reduce noise levels by approximately 10dB(A) thus bringing all chalets and caravans out of the threshold qualifying for insulation. This would also significantly reduce the high noise levels for the whole holiday park and therefore also be of benefit to the recreational areas within the site.

Construction Phase Impacts and Mitigation

12.5.21 At this stage of the planning process, details of construction plant, phasing of works and construction traffic has yet to be finalised and it is not possible to indicate detailed construction impacts. All construction noise would need to comply with the local authority's guidelines and with appropriate regard to the noise control measures outlined in BS5228. The majority of construction noise levels at sensitive receptors are likely to be within adopted criteria to be agreed with the local authority. However the predicted magnitude of noise levels may cause noise disturbance from time to time. Therefore the contractor, in accordance with the principle of 'best practicable means', as defined in the control of Pollution Act 1974 would need to reduce noise emissions throughout the construction period. Control measures routinely applied to minimise noise impacts include the following:

- Selecting inherently quiet plant;
- The use, where necessary and practicable, of enclosures and screens around noisy fixed plant or between the works and sensitive receptors;
- Limiting site work where possible to daytime hours; and
- Adherence to relevant British Standards.

12.5.22 Construction work involves various activities, undertaken by different types of plant, at different locations and at different times. In consequence, construction noise levels at different properties vary with time as construction noise sources move progressively closer or further away from a property, and as the activities themselves change.

12.6 Assessment of Vibration Effects and Mitigaiton

Operational Road Noise Vibration

12.6.1 Levels of vibration from the A47 are likely to reduce due to the improved "quiet" surfacing that would be implemented. However the proposals would move the carriageway slightly closer to properties on the north side and this may cause a slight increase in vibration levels at these receptors.

12.6.2 Vibration nuisance levels have been calculated using DMRB methodology and are displayed in table 12.7. It shows that there would be some changes in vibration levels at properties close to the A47 but these are likely to be imperceptible.

Table 12.7 DMRB Vibration Nuisance Assessment		
Property	**% Annoyed**	
	Dual 2	**Dual 2A**
Pontiac Roadhouse (Three Feathers PH)	-21	-23
Stracey Arms Mill house	26	22
House at Kerrisons Level	31	30
Scaregap Cottages	28	24
Holiday Park (worst case)	27	25

Construction Vibration

12.6.3 Vibration during construction would be caused by a variety of activities and would be most perceptible at the properties immediately adjacent to the road.

12.6.4 Construction works that involve noisy operations such as piling should be phased to stagger these operations and avoid undue vibration nuisance at any one time and /this would be assessed in accordance with BS6472 and BS7385. The contractor would also be required to bring to the site the most environmentally friendly equipment to ensure compliance with BS6472 and BS7385.

12.7 Summary

12.7.1 The do minimum situation is predicted to result in a small increase in traffic flows along the A47 with noise effects ranging from no effect to minor adverse effect.

12.7.2 Implementation of both dual carriageway options would result in further traffic flow increase and small noise increases at a number of residential properties in Acle however these properties are already influenced by traffic noise from other nearby roads and only part of this increase would be attributable to the proposals.

12.7.3 The properties near to the proposals along the A47 Acle Straight would experience increased noise during the operational phase as a result of the increased speed of traffic and at some locations traffic would be in closer proximity to properties. The effects on properties has been assessed as follows:

- Option 2 - Moderate Adverse effect
- Option 2A – Minor Adverse effect.

12.7.4 Option 2A would have less overall impact because only one property would experience an increase of noise in excess of 5 dB(A) whereas a large number of properties would experience this effect with Option 2. With Option 2A the majority of properties experiencing noise increases in excess of 5 dB(A) are situated at the caravan park, and because the traffic would be situated further away from the park than with Option 2 it would have less impact.

12.7.5 Mitigation in the form of an environmental barrier between the holiday park and the road would reduce noise impacts at Vauxhall Holiday Park to well below the Do-Minimum situation with both options. However this would not benefit properties at other locations along the route and the overall the effects on properties would remain as indicated in clause 12.7.3 above.

12.7.6 With both dual carriageway options four properties bordering the Acle Straight would be eligible for noise insulation under the Noise Insulation Regulations together with a number of caravans and chalets at Vauxhall Holiday Park. However mitigation in the form of the above environmental barrier would put all the caravans and chalets below the threshold qualifying for insulation.

12.7.7 The majority of construction noise levels at sensitive receptors would need to meet adopted criteria to be agreed with the local authority. However even with adoption of these criteria construction noise is still likely to be perceptible particularly at properties immediately adjacent to the route.

12.7.8 During the operational phase there is likely to be an overall slight reduction in vibration but some properties adjacent to the road would experience an imperceptible increase in vibration as a result of road traffic being slightly closer. During construction the small number of properties immediately adjacent to the road are likely to experience temporary effects of vibration levels from general construction activity.

13 Vehicle Travellers

13.1.1 Travel is a derived demand that arises from peoples desire to engage in productive and non-productive activities. Therefore a high quality journey, when experienced, is often (but not always) taken for granted. However, a poor journey quality, when experienced, can easily be recognised. This section describes the conditions currently experienced by vehicle travellers on the existing road and anticipates the changes that may occur with the proposals.

13.2 Methodology

13.2.1 The methodology used for the assessment of impacts on Vehicle Travellers is based on the guidance in the DMRB (Volume 11, Part 9) and GOMMMS (Journey Ambience). The GOMMMS guidance recommends that separate assessments are made for the following factors that affect the quality of a journey:

- Views from the road
- Traveller care
- Driver stress

13.2.2 Travellers' Views deals with the attractiveness of the general travelling environment. According to GOMMMS, views can be categorised as providing:

- no view – where the route is in deep cutting, a tunnel or surrounded by environmental barriers;
- restricted view – where there are frequent cuttings, tunnels or barriers;
- intermittent view – where there are shallow cuttings or barriers;
- open view – where the view extends over many miles.

13.2.3 Two sub-factors are assessed under Traveller Care as follows:

- Facilities – the presence, spacing and quality of facilities for road users such as lay-bys, roadside toilets, service areas and dedicated facilities for pedestrians and cyclists, such as cycle lanes and crossings.
- Information – the presence of warning and direction signs and the spacing and quality of these signs.

13.2.4 Travellers' Stress applies to both motorised and non-motorised users. The three main sub-factors assessed under traveller stress are as follows:

- Frustration – influences on frustration include the road layout and geometry, the condition of the road surface and the ability to make good progress along the route.

- Fear of Accidents – consideration of traffic congestion, traffic speeds, sight distances, the quality of road lighting, width of carriageways and lanes, presence of hard shoulders, safety barriers, lane markings etc.
- Route Uncertainty – travellers' uncertainty about their route as influenced by inadequate signage.

13.2.5 Assessments of impacts are defined using a simple three-point scale; better, neutral or worse. These assessments are described in the following sections.

13.2.6 An overall assessment of the impacts of the scheme on journey ambience has been made using the following criteria:

- The overall assessment is likely to be neutral if the assessment is neutral for all or most of the sub-factors, or improvements on some sub-factors are generally balanced by deterioration on others
- If the change in impact across the sub-factors is, on balance, for the better, the assessment is likely to be beneficial, and, conversely, it is likely to be adverse if there is an overall change for the worse
- The overall assessment is likely to be slight (beneficial or adverse) where the numbers of travellers affected is low (less than 500 a day, say)
- The overall assessment is likely to be large (beneficial or adverse) where the numbers of travellers affected his high (more than 10,000, say)
- The overall assessment is likely to be moderate (beneficial or adverse) in all other cases.

13.3 Views from the Road

13.3.1 The DMRB defines the "view from the road" as the extent to which travellers are exposed to the different types of scenery through which the road passes. In areas of high scenic quality views from the road can provide interest to travellers and alleviate driver stress.

Baseline Conditions

13.3.2 Traveller views along this route are fairly pleasant and open. They are described here as they would be seen when travelling in an average sized car, from Great Yarmouth (starting at the roundabout with the A12) to Acle (ending at the Acle roundabout).

13.3.3 At the first roundabout, and in the initial few hundred metres, the road is on a high embankment. This allows extensive views of Breydon Water to the south of the road; a large flat expanse of open water or mud flats.

13.3.4 After a short distance, the road descends onto a low embankment. To the north of the road, is the Vauxhall Holiday Park, with a high wooden fence and planting which block any views beyond. The entrance to the holiday park is clearly visible. To the south of the road, views are of intermittent scrub adjacent to the road, with the railway sidings compound beyond.

13.3.5 Shortly after the caravan park, views become more open to the north, allowing an outlook upon the broad, flat marshes that are characteristic of the area. To the south, a bund is present adjacent to the road for a short distance, followed by similarly open views.

13.3.6 The road is on a low embankment and the surrounding landscape can be seen for great distances on either side of the road for much of the route. The land is mainly drained marsh used as traditional grazing meadow, with some arable and occasional scattered groups and individual trees. A network of dykes can be seen throughout the area. A number of features of interest are scattered throughout the landscape, including several drainage mills, agricultural buildings, vehicles working in the fields and livestock. To the south of the road, a line of electrical pylons run parallel to the road, with the railway line on a low embankment beyond. Beyond the flat, open marshes, the view extends southwards to green fields on rising ground. To the north views extend over the marshes as far as the levees of the River Bure which runs in a meandering line up to 1km from the road. Beyond the Bure rising ground can be seen with the visible parts of villages and woodland, more than 2km away.

13.3.7 West of the railway sidings, a WWI Pillbox located immediately adjacent to the westbound side of the road is a feature of interest in the otherwise open landscape. At Halvergate junction, a meander in the River Bure brings it very close to the road closing views to the north, and the numerous and varied boats moored or travelling along the river can be seen above the road level. The Stracey Arms Drainage Mill and the Pontiac Road House Restaurant and Bar (formerly Stracey Arms) are also prominent features close to the northern side of the road.

13.3.8 West of Halvergate Junction, the rising ground to the south appears to be closer, but the views remain open and distant although further towards Acle, the intermittent trees and shrubs adjacent to the road become more frequent. Ahead are views of Acle with modern redbrick houses and roofs and at the approach to the Acle roundabout the views to the south are completely obscured by woodland which flanks the road.

13.3.9 Views experienced when travelling in the opposite direction are similar, but as the road moves towards Great Yarmouth, the buildings and infrastructure of the settlement are visible beyond the flat, open marshes.

Predicted Impacts

13.3.10 The quality of the surrounding landscape is considered to be of national importance and because of it's flat, open character, the proposals have been developed to minimise visual intrusion from road structures and other road features. Land-take has also been restricted to minimise adverse effects on important ecological habitats surrounding the route. Consequently, barriers and dense planting that would restrict travellers' views would be limited to the provision of environmental barriers flanking both sides of the road at the eastern end of the scheme within the urban fringe of Great Yarmouth. This would result in no view in this area and in particular the existing extensive views to the south over Breydon Water would be obscured.

13.3.11 Elsewhere the road would remain unscreened and because it would continue to be on low embankment the open views of the surrounding landscape would be retained and largely unchanged. However, travellers on the road would see a second carriageway to their right throughout the route, and the new access tracks would be visible on either side of the road.

13.3.12 These impacts on views would be significant for both scheme options. Overall, traveller views can be considered to be worse after implementation of both options.

13.4 Traveller Care

13.4.1 Four sub factors are considered for traveller care; cleanliness, facilities, information and environment. Cleanliness and Environment would not be affected by the scheme. Facilities and Information are discussed below.

Facilities

13.4.2 For road users, journey ambience can be affected by whether facilities and information are provided along a route and their spacing and quality. Facilities that improve en-route journey ambience include lay-bys, roadside toilets and service areas. The quality of a service area will depend on what services are available. These may include petrol, restaurant, lodgings, toilets, (including baby changing facilities and provision for the disabled), and shops. However, journey ambience also depends on the condition of the service area, their spacing along a route, and whether or not people perceive the service area to be overcrowded.

13.4.3 The existing facilities for traveller care are described in the table 13.1 below.

Table 13.1: Existing traveller care facilities		
Facility	**Spacing / Location**	**Quality**
Lay-bys and rest facilities	There are currently five lay-bys on this stretch of the A47.	Geometric layout substandard and considered only suitable for vehicles stopping in emergencies. Site observation indicates that these lay-bys are well used.
	Travellers can also stop and rest in Acle or Great Yarmouth, or at the Acle Service Station (at the Acle roundabout) or the Pontiac Road House Restaurant (formerly Three Feathers and Stracey Arms PH).	Other rest facilities in the area are of good quality, with ample parking. In general, they are also combined with other traveller care facilities (see below).
Toilets	Toilets can be found at the Acle Service Station, or the Pontiac Road House (formerly Stracey Arms PH), or at other locations within Acle or Great Yarmouth.	These toilets are part of commercial establishments, and are therefore well looked after.
Petrol	Petrol can be found at the Acle service station, or at other locations within Acle or Great Yarmouth.	Standard petrol filling station
Restaurant	Acle service station	Little Chef chain restaurant
	Pontiac Road House Restaurant and Bar (formerly Stracey Arms PH) (Halvergate junction)	Themed restaurant selling American style food
	Other locations within Acle or Great Yarmouth	A variety of restaurants and pubs
Lodgings	Acle service station	Travelodge chain motel
	Other locations within Acle or Great Yarmouth	A variety of lodgings
Shops	Acle service station	Shop part of petrol station
	Other locations within Acle or Great Yarmouth	A variety of shopping facilities

13.4.4 The impacts of the single carriageway options on facilities for traveller care are described in the table 13.2 below.

Table 13.2: Existing traveller care facilities		
Facility	**Proposals**	**Impact**
Lay-bys and rest facilities	Proposed lay-bys (see scheme layout plans) are subject to geometric and environmental constraints. Only four lay-bys are considered necessary due to the close proximity of other rest facilities, and to minimise environmental impact. However, those reinstated as part of the scheme would be designed to comply with current emergency standards. Other rest facilities are unlikely to be significantly affected by the proposals.	Better
Toilets	Facilities are unlikely to be significantly affected by the proposals.	Neutral
Petrol	Facilities are unlikely to be significantly affected by the proposals.	Neutral
Restaurant	Facilities are unlikely to be significantly affected by the proposals.	Neutral
Lodgings	Facilities are unlikely to be significantly affected by the proposals.	Neutral
Shops	Facilities are unlikely to be significantly affected by the proposals.	Neutral

13.4.5 Overall, the effects of the both options on facilities would be neutral.

Information

13.4.6 Information signs are regularly provided along the existing road, but sizes are variable and an uncoordinated system has developed over the years. With the proposals, information sign layout would be similar to existing but a more co-ordinated design would be provided in place of the existing system which has developed over the years. To reduce visual intrusion in the landscape, departures from standard may be applied to keep sign size to a minimum. However, proposed sizes would be more appropriate to the design speed than at present, making them easier to read. Both dual options would have a neutral impact on Information.

13.5 Traveller Stress

13.5.1 Traveller stress can result from frustration, fear of accidents and route uncertainty and is likely to be exacerbated by congestion, road works or changes in road layouts. Taken together, these can lead to feelings of discomfort, annoyance, frustration or fear culminating in physical and emotional tension that detracts from the quality and safety of a journey. Extreme cases of driver stress can contribute towards, or be caused by, transport rage. The extent of stress would depend on the travellers driving

skill and experience, temperament, knowledge of the route and state of health.

Frustration

13.5.2 Major influences on frustration include a driver's inability to drive at a speed consistent with his or her own wishes relative to the standard of the road (e.g. congestion). For all road users, other influences on frustration include the road layout and geometry and the ability to make good progress along a route.

13.5.3 The existing geometry of the A47 is straight, with bends at Halvergate Junction and Vauxhall Holiday Park. The radii of both bends do not meet current design standards for trunk roads with a 60mph speed limit, however the bend at Vauxhall Holiday Park is within a 30mph speed limit. The existing carriageway is approximately 6.8m wide and the verges on the south and north side of the embankment are 1-2 metres and 5 metres wide respectively. There is no separate provision for cyclists or pedestrians. The single carriageway road links into an existing dual carriageway 150m to the east of Vauxhall Roundabout. There are 84 direct farm/property accesses onto the A47 within the project area and four properties have a frontage onto the road. Proposed safety improvements resulting from the Norwich to Great Yarmouth Study[70] will be implemented within the next few years, which include isubstitution of the 60 mph limit with a 50 mph speed limit (with speed cameras) and improved variable message signage to help incident management.

13.5.4 Most significantly, the dual carriageway proposed would improve driver frustration by allowing drivers to freely overtake slow moving vehicles, and therefore allowing them to travel at a speed more consistent with their wishes. The proposed increase in speed limit to 70mph would also have a beneficial impact on driver frustration.

13.5.5 The proposed roundabout would remove the problem of the substandard radii at Halvergate Junction by forcing traffic to slow on approach to the junction. However, this would lead to greater frustration by the perceived hindrance to a driver's progress along the road.

13.5.6 The numerous farm and property accesses result in slow moving farm vehicles on the road which can cause tailbacks when turning on and off the road, and this is currently a significant cause of driver frustration. The proposals would substantially reduce this frustration as a result of providing separate access tracks alongside the road, reducing the number of accesses to four.

[70] Norwich to Great Yarmouth Road Based Study, Faber Maunsell Oct. 2001

13.5.7 The existing carriageway width does not meet current design standards and the narrow road, combined with limited verge width and lack of separate path for pedestrians results in a dangerous and unpleasant journey experience for pedestrians, equestrians or cyclists. Consequently very few non-motorised users appear to use the road. The widened carriageway would theoretically provide more space for non-motorised users however in practice any such journey would remain dangerous and unpleasant. Use of the access tracks and bridleway links by non-motorised users would provide a route segregated from motorised traffic and significantly reduce frustration for non-motorised users using this route.

13.5.8 The existing road surface is in good condition (and will be re-surfaced in due course), so does not have any significant impact on ride quality for travellers. The road surfaces installed with the proposals would be to the same standards as the resurfaced existing road.

13.5.9 The proposals (both options) would result in reduced driver frustration due to the provision of significant overtaking facilities and separate access tracks (with consequent reduction in congestion). There would also be reduced frustration for non-motorised users who would be able to use paths segregated from the main carriageway for most of the route. Overall, traveller frustration can be considered to be better following implementation of both options.

Fear of Accidents

13.5.10 The existing road is straight, allowing views of the road some distance ahead. However, the radius of the bend at Halvergate Junction is currently substandard and traffic travelling in each direction is not physically separated. The regularity of vehicles entering the opposite lane to overtake may increase the fear of accidents and in addition, the traffic flows and HGV content are high. The numerous accesses onto the A47 also increase the fear of accidents, especially since there is no provision for vehicles turning right across a lane of traffic.

13.5.11 The improved junction at Halvergate, separate access tracks and reduced number of accesses onto the road would reduce the fear of accidents. Channelisation of traffic at the remaining junctions would increase the perception of safety. In addition, traffic travelling in each direction would be physically separated, and drivers would not need to enter a lane of opposing traffic in order to overtake. However these benefits would be partially offset by the slight increase in traffic flows resulting from the proposals and the increase in traffic speeds.

13.5.12 Street lighting on the existing road is provided in accordance with current standards at Halvergate Junction and the approaches to Acle and Vauxhall Roundabouts. The proposals would include lighting at the same locations and to the same standards as with the existing road and therefore there would be a neutral effect with regards to fear of accidents.

13.5.13 The existing road is on embankment flanked by deep ditches on both sides. There are no safety barriers along the edge of the road to prevent vehicles falling into the ditches in the event of swerving. Safety barriers would be provided along both sides of the roads with the proposals thus reducing the fear of accidents.

13.5.14 The ability to use segregated paths for most of the route would reduce the fear of accidents for non-motorised users. However these routes depend on the use of unsurfaced bridleway links which would be difficult to cross for many users, particularly cyclists. Despite the widened carriageway, non-motorised users using the road would experience little reduction from fear of accidents, particularly with the increased speed of traffic on the carriageway.

13.5.15 On balance with both dual options there would be a beneficial effect with regards to fear of accidents for motorised users and a neutral effect for non-motorised users.

Route Uncertainty

13.5.16 Travellers' uncertainty about their route can be influenced by the extent to which they have planned their journey and the quality of route information.

13.5.17 Existing and proposed directional signage is described in Chapter 2, clauses 2.3.15 – 2.3.19. Route signage on the existing road is adequate but has been developed over the years resulting in an unco-ordinated arrangement with many sign sizes not meeting current design standards. The signage strategy for the proposals would be similar to the existing situation, however a co-ordinated signage design would be provided. Sizes would be increased where necessary, although departures from standard (such as reductions in mounting height and sign size) would be considered in view of the sensitivity of the surrounding landscape.

13.5.18 The simplicity of the existing route alignment and open nature of the landscape means that there is little route uncertainty with the existing road. The proposals would result in a co-ordinated layout of direction signs in place of the existing system, which would further reduce route uncertainty. But this effect would be very minor and overall the effect of both options on route uncertainty would be neutral.

13.6 Overall Assessment

13.6.1 The effect of all options on the sub-factors considered for Journey Ambience / Vehicle Travellers are summarised in table 13.3 below.

Table 13.3 Summary of Assessment of Journey Ambience Sub-Factors				
Factor	**Sub-Factor**	**Better**	**Neutral**	**Worse**
Traveller Care	Facilities		X	
	Information		X	
Traveller' Views	-			X
Traveller Stress	Frustration	X		
	Fear of Potential Accidents	X		
	Route Uncertainty		X	

13.6.2 On balance there would be a neutral effect on vehicle travellers resulting from both Options 2 and 2A. In the year of opening (2012) it is predicted that in excess of 20,000 travellers would be using the Acle Straight each day however as the overall effect has been assessed as neutral this would not affect the significance of the effect. The effects of the proposals on travellers during the construction period are described in Chapter 14, "Disruption due to Construction".

14 Disruption due to Construction

14.1 Introduction

14.1.1 This chapter assesses the potential disruption within the study area resulting from the construction phase of the scheme. "Disruption due to construction" is a term that covers effects on people and the natural environment that can occur between the start of pre-construction works and the end of the contract maintenance period. The construction programme for the A47 Acle Straight Improvements is estimated to start in February 2010 and finish in June 2012 (Option 2) or June 2012 (Option 2A).

14.1.2 This assessment takes into account potential construction impacts to local residents, workers, vehicle and non-vehicle travellers arising from noise, vibration, dust, views and changes in journey times and amenity. The assessment also considers potential impacts on the natural environment associated with drainage, accidental spillage and dust generation. Construction impacts are defined as temporary effects associated with the construction phase of the scheme only.

14.2 Methodology

14.2.1 The methodology for the assessment of disruption due to construction has been based on guidance in the DMRB[71] and the Guidance On the Methodology for Multi-Modal Studies (GOMMMS)[72]. In accordance with this guidance, the study area for the assessment of disruption due to construction comprises a corridor 100m either side of the A47 for the length of the scheme between Acle Roundabout and the junction with the A12 at great Yarmouth. In addition, the effect of usage of possible haulage routes to and from the site is also assessed.

14.2.2 This chapter includes the following:

- An overview of construction activities and sequences
- Earthworks, including an estimation of cut and fill requirements
- Traffic management
- Environmental management provision
- An assessment of the environmental effects of construction

14.2.3 The effects on the environment resulting from the construction phase of the scheme have been assessed for the same specialist topics as those

[71] The Design Manual for Roads and Bridges, Volume 11: Environmental Assessment. Highways Agency, incorporating 2000 updates.

[72] Guidance On the Methodology for Multi-Modal Studies, DETR, 2000.

assessed for the operational phase in the preceding chapters. Where relevant the construction effects on the specialist topics have been assessed using significance criteria from GOMMMS, which are described in the methodology of the relevant proceeding chapters.

14.3 Construction Activities

14.3.1 The works in this option consist of upgrading the existing single carriageway to two-lane dual carriageway standard (D2AP) by widening the existing road, and the construction of an additional carriageway adjacent to the road.

14.3.2 Both options have minimal impact on passing traffic as the new carriageway can be built off-line. Once the new carriageway has been constructed, traffic can be diverted on to it while the existing carriageway is improveded. However, Option 2A would cause additional traffic disruption compared Option 2, due to work space clearance requirements – i.e. the safety zone would impinge on the adjacent carriageway, resulting in a 40mph speed restriction over the length of carriageway passing the work site at any given time.

14.3.3 It must be noted that the construction of the new dual carriageway embankment across the Broads would be subject to consolidation settlement loading and testing which is estimated to take 6-9 months.

14.3.4 The construction of the new carriageway would be completed before the widening commences. Each sequence has been divided into three phases, as noted below.

14.3.5 For the new carriageway:

- Phase 1A – work would begin at Acle roundabout. The Acle roundabout tie-in, Acle slough slab, Tunstall Dyke and the new Halvergate junction would be constructed first. This would be followed by construction of the new carriageway and farm access tracks on the northern side of the existing road.
- Phase 2A – the middle stages of the scheme involving construction of the new carriageway and farm access tracks on the southern side of the existing road.
- Phase 3A – comprises the construction of the new carriageway and access tracks on the southern side of the existing road at the Great Yarmouth end of the scheme. This phase would end with construction of the tie-in with the roundabout at Great Yarmouth.

14.3.6 For widening the existing carriageway:

- Phase 1B – work would begin with the tie-in at Acle roundabout followed by construction of the new Halvergate junction. The widening

of the southern side of the existing carriageway, and the construction of farm access tracks is then undertaken.

- Phase 2B – involves the middle stages of the scheme, with widening of the north side of the existing carriageway and farm access track construction.
- Phase 3B – involves the end stages of the scheme, with widening of the north side of the existing carriageway and farm access track construction, followed by the tie-in at Great Yarmouth.

Each phase would involve advanced works (including establishment on site, utility diversions etc), site clearance.

Road Works and Traffic Management

14.3.7 The A47 Acle Straight forms a strategic crossing of the Broads, with few alternative routes available. The two most obvious diversion routes are:

- The A1064 to the north from Acle via Filby, which is a somewhat tortuous route passing through several settlements. However, Norfolk County Council (NCC) has indicated that it would be opposed to this diversion.
- The A146 from a point 15kms west of Acle Roundabout south-east to Gillingham and then via the A143 north-east to Great Yarmouth would be suitable for diverting only mid- to long-distance journeys. NCC have expressed concern about safety issues along this route as the diversion would pass several schools within Great Yarmouth.

14.3.8 Use would be made of all available information systems to advise the public of the proposed works such that alternative routes can be used where possible. Local press, radio, television and the internet would be used to convey appropriate road works information. Advanced signage may be proposed on the A47, A11 and A140 to advise motorists of alternative routes to avoid the road works. NCC have also suggested that the local passenger rail service could be investigated with a view to increasing service frequency.

14.3.9 The dual carriageway option consists of constructing a new carriageway on one side of the existing road. Once this is constructed, traffic could be diverted onto the new carriageway, and would therefore only require one-way working at the locations of the tie-ins and the junctions. Construction of access tracks would have minimal impact to the mainline traffic flow.

14.3.10 Particularly disruptive stages of construction would be phased to avoid the main tourist traffic peaks in the summer months (July to September).

14.3.11 There are 84 direct farm / property accesses onto the A47 within the project area, all of which would suffer some degree of disruption due to construction work. The contractor would need to take steps to accommodate landowner requirements, including access.

Construction Materials

14.3.12 The existing road is on an embankment, and at access-track junctions and Halvergate Junction the embankment would require localised widening using imported general fill. In addition, the new carriageway would also need to be constructed on embankments, requiring a considerable quantity of general fill, as well as aggregates for concrete and surfacing. Table 14.1 details the approximate volumes of materials that would be required for construction of the scheme.

Table 14.1: Materials required for construction of the scheme

Material type	Approximate volume of materials required (m^3)	
	Option 2	Option 2A
Mainline:		
Import fill	240,000	193,000
Pavement materials	86,200	99,000
Access Tracks:		
Import fill	84,000	84,000
Pavement materials	12,600	12,600

Note: Volumes are based on conceptual design and are therefore subject to a 35% contingency

14.3.13 The surcharge method of construction would require temporary use of fill material to speed up settlement of the new embankment prior to road construction. However, to minimise the volume of materials procured for the scheme, the sucharge volumes would be provided by materials excavated on site as part of the scheme (see Table 14.3 below).

14.3.14 The nature of the site, being across an alluvial floodplain, means that the required materials cannot be sourced from borrow pits along the route. In addition, the sensitive nature of the area surrounding the route means that embankment materials would need to be made up of inert silicate materials (similar to the natural conditions) such as quartz and clay to ensure that any leachate does not have an impact on the surrounding area. Leaching tests would need to be conducted to screen any potential materials for suitability.

14.3.15 Correspondence with Norfolk County Council Minerals and Waste Disposal Planning Authority has indicated that:

- It is likely that there would be sites with planning permission within a reasonable distance which could supply the material required.
- There are also sites which can supply recycled materials and the County Council would encourage investigation of the potential contribution of those sources.

- The Broadland Flood Alleviation Project has adopted an approach of winning material for flood protection works by means of extracting clay by the widening of soke dykes and other dykes. This could be considered for the A47 as locally won clay would be relatively inert thus minimising risks of contamination of the dykes through leaching. However, this option would require planning permission.

14.3.16 NCC has also recommended that the height of the embankment should be reduced to a minimum thus minimising general fill requirement.

14.3.17 Sites that sell recycled construction wastes are registered in the Construction Recycling Sites database by CIRIA (Construction Industry Research and Information Association)[73]. Nearby sites that could supply materials for construction of the scheme are summarised below:

Table 14.2: Construction Recycling Sites

Site Name	Site Address	Materials Sold
Baileys of Norfolk	Brick Kiln Road Hevingham Norwich Norfolk NR10 5NL	Usable soil, fines Road planings
Four leaf enterprises	Carbrooke Near Wattorn Norfolk IP25 6TJ	Most segregated construction waste
Bittering Quarry	Bittering East Derekam Norfolk NR19 2QS	Asphalt Bitumen And Coated Roadstone

14.3.18 Haul routes for transporting the materials required to the site are discussed below.

Materials Disposal

14.3.19 Although the road would be built on embankment, construction of the route, such as reconstruction of drainage dykes, would result in a significant quantity of surplus materials requiring disposal after use. Although excavated materials would be used temporarily as surcharge material, they have no permanent use on site, and would therefore require disposal.

14.3.20 The majority of material would be made up of peat and poor quality fill, which could not be reused for construction purposes. The estimated

[73] www.ciria.org

volumes of surplus materials that would be produced are detailed in table 14.3 below.

Table 14.3: Surplus Materials

	Approximate volume of surplus materials (m^3)	
	Option 2	**Option 2A**
Excavation for mainline	95,500	85,500
Excavation for access tracks	97,000	97,000
Excavation for ditch construction	216,000	216,000

Note: Volumes are based on conceptual design and are therefore subject to a 35% contingency

14.3.21 The views of the Norfolk County Council Minerals and Waste Disposal Planning Authority were sought on the implications of disposal of materials. The purpose was to establish the availability of alternative licensed sites and to explore likely planning issues. Firm proposals would be subject to the necessary planning consents and appropriate consultations. Their views are summarised below:

- There are no sites near the route with permission for surplus disposal. However sites with permission for inert waste disposal exist within a reasonable distance of the A47 Acle Straight.
- There are sites dealing with materials recycling and waste transfer, for example in the Great Yarmouth area and the County Council would encourage the maximum use of such facilities and materials. Their potential to meet all or part of the scheme's requirements should be investigated.
- The reconstruction of drainage dykes would result in a significant quantity of material requiring disposal. The potential for the use of some of this material within the Broadland Flood Alleviation Project could be investigated.

14.3.22 The project would endeavour to recycle as much of the surplus material on-site as possible. Some of the material with no potential for re-use on site could be re-used elsewhere, either for land reclamation around Great Yarmouth or for strengthening works to flood defences (see NCC comments above). There may also be the potential for materials from drainage dyke construction being spread on arable land. These alternative options would depend upon local circumstances at the time of construction, and the suitability of the material (the peaty nature of the surplus material may restrict some opportunities).

14.3.23 Sites that accept construction wastes for recycling are registered in the Construction Recycling Sites database by CIRIA (Construction Industry Research and Information Association)[74]. Nearby sites that could accept

[74] www.ciria.org

and recycle some surplus materials from construction of the scheme are summarised below:

Table 14.4: Construction Recycling Sites

Site Name	Site Address	Materials Accepted
Baileys of Norfolk	Brick Kiln Road Hevingham Norwich Norfolk NR10 5NL	Cobbles And Paving Slabs Spent Railway Ballast Stone
Four leaf enterprises	Carbrooke Near Wattorn Norfolk IP25 6TJ	Graded and ungraded aggregates Usable Soil, Fines Road Planings Stone
Bittering Quarry	Bittering East Derekam Norfolk NR19 2QS	Road Planings

14.3.24 However, all of the materials listed in the above table have the potential for being reused on site, and would be where appropriate.

14.3.25 It is envisaged that surplus material unsuitable for reuse on-site, recycling, land reclamation or flood defences would be disposed of at the nearest suitably licensed facility using appropriate waste transfer documentation in accordance with the current legislation.

14.3.26 A number of suitable landfill sites in the vicinity of the study area were identified using information from the Environment Agency. However, discussions with the managers of these sites identified that none anticipated being in operation at the time of construction of the scheme. It is likely that new landfill sites would be open at the time of construction, but the environmental impacts associated with these cannot be identified at the time of this assessment.

14.3.27 Any landfill sites identified for use at the time of construction should have planning permission, meaning that the environmental effects of the use of the sites as waste disposal facilities would have been taken into account by the local planning authority.

14.3.28 It is noted that the decision on the location of the landfill sites used is ultimately one for the contractor to take, bearing in mind the relevant legal requirements. These legal requirements include strict controls to prevent illegal dumping of materials including obtaining a waste disposal license and a "duty of care" on the contractor.

Construction Traffic

14.3.29 Haulage movements would be dependent on the contractors proposed programme of works, therefore daily outputs cannot be predicted at this stage. There would also be a commitment to minimise the "haulage miles" expended by the project.

14.3.30 Haulage routes would depend on the locations of materials sources and disposal sites, which in turn would be dependent on the decisions and requirement of the contractor. Construction traffic bringing materials to the site or taking waste from the site would be routed to avoid residential areas, schools and other buildings with sensitive uses.

14.3.31 Other suggestions for materials haulage by NCC are:

- In the past, road building materials have been landed at the port of Great Yarmouth. However, the landing of large quantities of material would raise issues of impact on residents, both from the landing of the materials and their transportation through the town.
- The disused rail sidings at Great Yarmouth abut the site and would offer potential as a railhead for importation of material by rail. Although the site is not in use at present, there has been some recent freight use, and there has also been some investment in upgrading this facility.
- Disposal by barge berthed either on the River Bure or on Breydon Water is an alternative that should be examined, although there would be a need to create landing stages and temporary access routes within the sensitive Broadland landscape.

14.3.32 In addition to haulage vehicles, private vehicles transporting construction workers to and from the site would temporarily increase traffic volumes in the area.

Drainage

14.3.33 Most of the existing over the edge drainage would be retained and all roadside ditches would be regularly monitored for pollution from construction activities. A replacement roadside dyke would be required for Option 2A and an additional new roadside dyke for Option 2 and these would be created before other construction work when the existing dykes would be lost or at risk of being disturbed. These new dykes would be constructed up to 3 years in advance of the destruction of existing dykes in order to facilitate the establishment of translocated wildlife from these existing dykes.

14.3.34 Sluices and stop logs would be constructed within existing, retaineddrainage ditches in advance of the main construction works, therefore any accidental spills during construction could be isolated.

Nightworking

14.3.35 Neither of the dual-carriageway options would require night-working.

Environmental Management

14.3.36 The contractor appointed for the scheme would have an Environmental Management System (EMS), certified to the international environmental management system standard, ISO 14001, or another recognised standard. The objectives of ISO 14001 are to be able to demonstrate that a set of environmental management procedures have been put in place and are followed, with a commitment to continual improvement. A requirement of ISO 14001 is that the EMS is verified and regularly audited by an independent checking authority.

14.3.37 An environmental manager (EM) would be appointed who would be based on the site full time throughout the construction period. The EM would be a qualified Member of the Landscape Institute, an ecologist who is a member of the Institute of Ecology and Environmental Management or an Environmental Manager who is a member of the Chartered Institute of Water and Environmental Management and have a minimum of 10 years site based, post qualification experience. The EM would be supported by site based environmental clerks of works and other environmental specialists who would visit the site on an as needed basis.

14.3.38 The EM would be responsible for producing an Environmental Management Plan (EMP) in advance of commencement of works, which would identify standard environmental management procedures (induction of site personnel, meeting all relevant environmental legislation, etc.). It would also indicate measures to be taken throughout the construction period in relation to all pertinent environmental issues identified in the Environmental Statement. Full records of the progress of environmental works would be maintained which would be held on site in a form suitable for review by the EM, such records and review would form part of the EMP.

14.3.39 These measures would assist in significantly reducing the potential disruption during the construction period.

14.4 Environmental Assessment and Mitigation

Introduction

14.4.1 This report does not include a detailed impact assessment of off-site works associated with the road improvements, such as construction and storage compounds which would be the subject of separate planning applications. At present detailed plans have not been made regarding the size or location of these areas and it is not yet known where they would be placed.

14.4.2 It is likely that some construction activities would result in disturbance and/or disruption to both the human environment and the natural environment. There are approximately 6 properties within 100m of the construction area, all situated to the north of the existing road. Three of these are residential and three are amenity properties (the Pontiac Road House Restaurant and Bar (formerly Three Feathers and Stracey Arms PH), the Stracey Arms Drainage Mill adjacent to Mill House Farm, and Vauxhall Holiday Park). The Vauxhall Holiday Park consists of approximately 430 static units of accommodation and 220 Touring caravan sites. These allow the holiday park to accommodate up to 3000 residents each week during peak seasons. Other sensitive receptors and environmental resources within 100m of the construction area are indicated in the preceding chapters.

14.4.3 The majority of the construction effects would be short term, lasting only for the duration of the construction programme. However, there is the possibility that some effects might become longer term if due care is not exercised. Therefore, a range of mitigation measures designed to reduce the scale of a particular impact and prevent a longer term problem developing have been discussed, where appropriate, below. Where significance criteria have been used they are the same as those used in assessing impacts during the operational phase.

Noise and Vibration

14.4.4 During the construction period, increased noise levels at sensitive receptors within the study area could result from plant machinery and on-site construction traffic.

14.4.5 At this stage of the planning process, details of construction plant, phasing of works and construction traffic has yet to be finalised. However, all construction noise would need to comply with the local authority's guidelines and with appropriate regard to the noise control measures outlined in BS5228.

14.4.6 Construction work involves various activities, undertaken by different types of plant, at different locations and at different times. In consequence, construction noise levels at different properties vary with time as construction noise sources move progressively closer or further away from a property, and as the activities themselves change.

14.4.7 Although the majority of the construction noise levels at nearby existing areas are likely to be within the adopted criterion (to be agreed with the local authority), noise levels of the predicted magnitude may cause noise disturbance from time to time. Therefore, the contractor, in accordance with the principle of 'best practicable means', as defined in the control of Pollution Act 1974 would need to reduce noise emissions throughout the construction period. Control measures routinely applied to minimise noise impacts include the following:

- Selecting inherently quiet plant;
- The use, where necessary and practicable, of enclosures and screens around noisy fixed plant;
- Limiting site work where possible to daytime hours; and
- Adherence to relevant British Standards.

14.4.8 Construction works that would involve piling works would be phased so that piling operations avoid undue vibration nuisance and/or building damage when assessed in accordance with BS6472 and BS7385. In any case, the contractor would be required as part of the section 61 agreement, to bring to the site the most environmentally friendly equipment to ensure compliance with BS6472 and BS7385.

Air Quality

14.4.9 Air quality effects during construction works result from both dust generation and the exhaust emissions of construction vehicles and plant. There are no formal standards or criteria for nuisance caused by dust; however, an annual deposition rate of 200 mg/m^2/day is often presented as a threshold for serious nuisance.

14.4.10 There are 3 properties within 50m of the edge of the A47 roadside. These properties may potentially suffer major impacts due to construction activities. There are also 7 properties between 50 and 100m from the road that may have moderate impacts due to construction dust. A further 27 properties are 100 to 150m from the road and construction activities may cause a minor impact. The important ecological habitat of the adjacent dykes and marshland is also located immediately adjacent to the road. Dust monitoring as part of a research programme indicates that there is negligible impact due to construction dust beyond 150m from the construction activities.

14.4.11 Construction is initially determined to have a major impact on local properties within 50m of the roadside. However, the extent of any impacts would be limited to the duration that any section of road is being constructed. In addition, a number of options are available to mitigate the impact of dust due to construction. These are described in Chapter 11: Air Quality in this report.

14.4.12 Appropriate regard to the control of dust and exhaust emissions during all construction works would be given as part of the Environmental Management Plan, which would involve liaison with the Local Authority Environmental Health Departments. The following mitigation measures should be incorporated into the Environmental Management Plan:

- the damping down of exposed soils, loose materials or unmade surfaces close to sensitive locations during dry weather;
- the sheeting of vehicles transporting friable materials to or from site;

- limiting vehicle speeds over unmade surfaces;
- controls applied to the cutting and grinding of materials;
- restrictions on the burning of materials;
- the placing of machinery with exhaust emissions as far from sensitive properties as practicable and switching off engines when not in use;
- regular maintenance of all construction equipment;
- utilisation of existing power sources (e.g. power poles) or clean fuel generators rather than temporary power generators;
- scheduling operations affecting traffic for off-peak hours whenever possible;
- minimising obstructions of through traffic lanes;
- development of a traffic plan to minimise traffic flow interference from construction activities;
- the use of cleanable hard standings and the provision of wheel washing facilities where appropriate;
- regular use of sweepers on all local roads if visible amounts of soil material are carried onto public streets;
- operation of a complaint and investigative response procedure;
- compliance with relevant legislation and British Standards described in Chapter 3.

14.4.13 Due to the limited duration at any one location and with the implementation of suitable mitigation measures, dust levels should be kept to a minimum. There are small number of residential properties within the area but the sensitive ecological habitat extends for most of the length of the scheme and it is envisaged that the residual impact of the construction works on ambient air quality would be Slight Adverse.

Landscape

14.4.14 Effects on the landscape character and quality during the construction period would result from visual intrusion of construction traffic, construction compounds, temporary signs, lighting, earthworks, additional congestion etc.

14.4.15 The adverse effects would be minimised by the construction width being limited to that of the design width, and the disturbed area being restricted to the footprint of any new embankment, ditch or access track. Any further disturbance outside this footprint, in the form of compounds and storage areas would be outside The Broads.

14.4.16 Both options would be phased in their construction, covering a period of six phases. This would minimise visual intrusion, by localising disturbance to

each phase at any one time thereby not disturbing the whole length for the duration of the works.

14.4.17 Although there would also be no haulage routes (other than the Acle Straight itself) within the Broads, adverse visual effects could be caused by haulage vehicles using adjacent roads. It is not known which roads would be used, and so no assessment has been made of these effects. However, it is advised that the contractor is restricted to major roads.

14.4.18 Construction impacts would be difficult to screen due to the open nature of the landscape. Although the area has little tall vegetation, existing mature vegetation would be retained where possible to aid screening. Most of this vegetation is on the existing road embankment slopes and protective fencing would be required between the works and the retained vegetation in order to ensure its survival.

14.4.19 Overall the construction works would result in temporary Moderate Adverse effects on the landscape.

Cultural Heritage

14.4.20 The implementation of Option 2 or 2A would disturb part of an earthworks site of possible Saxon origin and a full intrusive evaluation of the affected area would be necessary prior to the implementation of either scheme option (see Chapter 10). There is also potential for archaeological remains to be uncovered elsewhere within the scheme where ground works are undertaken. As a consequence of this there would be an archaeological watching brief maintained during all ground works. The objective of the watching brief would be to identify and record any archaeological sites/deposits and it would be undertaken in accordance with the Institute of Field Archaeologists documents *Standard and Guidance for Archaeological Watching Briefs* (1994) and the *Code of Conduct*. All archaeological works would be carried out by suitably qualified and experienced archaeological personnel. The methodology of the work would be agreed with English Heritage and the Norfolk County Archaeologist.

14.4.21 Construction of the scheme would also result in temporary visual intrusion to the settings of the following built heritage features:

Table 14.5: Impacts on Built Heritage

Site	Magnitude of Impact
Halvergate Marshes Conservation Area	Moderate adverse effect
B2. Tunstall Dyke Drainage Mill	Slight adverse effect
B3.Tunstall Dyke Smock Mill	Slight adverse effect
B4. Stracey Arms Drainage Mill	Moderate adverse effect

Table 14.5: Impacts on Built Heritage	
Site	**Magnitude of Impact**
B5. Keys Mill on Black Mill	Slight adverse effect
B9. Norfolk Railway (Norwich to Yarmouth Railway Line)	Slight adverse effect
B10. Norfolk Railway Acle Diversion	Slight adverse effect
B16. WW1 Pillbox	Moderate adverse effect
B17. WW1 Pillbox	Slight adverse effect
B20. WW2 Pillbox	Slight adverse effect
B42 Breydon Water Navigable Waterway	Slight adverse effect

Refer to Figure 10.1 for site locations

14.4.22 All other built heritage features in the study area would experience a neutral effect and the overall temporary impact on cultural heritage during construction of the proposed routes would be Slight Adverse.

Geology and Soils

14.4.23 Borrow and surplus materials, volumes and types are discussed above in clauses 14.3.12 – 14.3.28. In general there would be a net importation of material to site. All embankment fill and granular material used for the construction of the farm access track should consist of inert material so as to minimise adverse effects on adjacent wetland habitat from leachates. All such materials, together with the sub base material would comply with leachate quality thresholds to be agreed with the Environment Agency.

14.4.24 It is unlikely that significant amounts of contaminated land exist on the route of the proposed scheme. However, there is made ground at the Acle and Great Yarmouth ends of the scheme and the composition of much of this is unknown. Therefore there is a small possibility that the construction works would impinge on contaminated soils. Option 2 and 2A would also cut across an area of the railway land near Great Yarmouth where there is also a risk of contamination. Where contaminated land is present, contamination of surrounding agricultural soils may occur from construction activities.

14.4.25 Prior to construction areas at risk of contamination would be tested. If any contamination was found to be present in areas to be disturbed all earthworks,, (both excavations and excavated materials) would be carefully controlled to avoid human contact or mobilisation of pollutants into uncontaminated areas. This would be especially important where earthworks occur adjacent to sensitive areas, such as watercourses. Appropriate measures would be incorporated into the Environmental Management Plan and would include the following:

- containment of potentially contaminated excavated materials to ensure there is no human/animal contact, dust generation or runoff;

- control of dust generation and runoff from potentially contaminated excavations and suitable treatment of any contaminated run-off or groundwater;
- disposal of contaminated materials to suitably licensed sites and obtaining all appropriate waste management documentation;
- appropriate personal protective equipment and training for all site staff working in potentially contaminated areas and provision of emergency wash-down areas, as necessary;

14.4.26 Construction of the new embankment area would cause settlement of the ground in the vicinity of the embankment. At the current time trial embankment studies are underway to determine the scale of ground settlement. The settlement of the ground would cause a small amount of groundwater flow from beneath the embankment as pore water pressures are dissipated. However the amount of groundwater flow is likely to have an insignificant long term impact on surrounding groundwater levels.

14.4.27 Overall, the construction of options 2 and 2A would have a temporary Slight Adverse impact on geology and soils.

The Water Environment

14.4.28 Almost the entire length of the Acle Straight is surrounded by a complex system of ecologically sensitive dykes with a significant potential for pollution during the construction phase. Construction of the proposed scheme would involve works immediately adjacent to two existing, retained roadside dykes with Option 2 and one retained roadside dyke with Option 2A. Both options involve the construction of a new dyke alongside almost the entire length of the scheme and this would have to be connected into the existing dyke network. Both Options would also involve reinstatement of some culverts under the existing embankment and the construction of new embankment requiring culverting and bridging of the numerous dykes crossed by the route. The access tracks would also involve construction of low level bridges over the numerous dykes they would cross.

14.4.29 During construction, there are a number of pathways by which pollutants can enter surface and ground waters. The main activities that could impact on water quality are:

- Earthworks near watercourses or near a drain that leads directly into a watercourse
- Vehicles and machines near watercourses or near a drain that leads directly into a watercourse
- Storage of uncovered spoil heaps near watercourses or near a drain that leads directly into a watercourse
- Storage and use of chemicals, oils, wet concrete and cement near watercourses or near a drain that leads directly into a watercourse

- Construction, reconstruction and replacement of bridges and culverts
- Stream diversion works

14.4.30 Increases in (potentially contaminated) run-off and increased risk of spillage during construction could impact surface or ground water quality. The potential impacts on surface water quality are:

- Elevated levels of silt occurring in site drainage water resulting from earthworks in and near watercourses and near drains that discharge directly into watercourses. In addition any works in the watercourses, such as bridge and culvert works and stream diversion works, may cause disturbance to the silty bed of the watercourse. Also, spoil heaps near ditches could cause elevated levels of silt in the water by means of silty run-off. Abnormal discharges of silts can have a detrimental impact on aquatic life by damaging habitat and limiting oxygen supply. There could also be an increase in nutrient levels in the water.
- Spillage or leakage of fuel and oil from vehicles/machines and storage tanks in or near watercourses and near drains that lead directly to watercourses. Even a small oil spill could have a major visible impact on the water quality. Fuel and oil spilled on land can contaminate watercourses via run-off.
- Contamination of watercourses with chemicals, such as waterproofings and paints. These chemicals damage the aquatic environment.
- Concrete spillage while pouring wet concrete for works in and near watercourses and near drains that discharge directly into watercourses. Concrete is very alkaline and corrosive and can have a highly polluting impact on surface water. Such pollution could have a major impact on the local aquatic life.

14.4.31 Construction works could also influence flooding potential due to changes or disruption in water flows to these watercourses.

14.4.32 A number of mitigation measures would be developed in consultation with the Environment Agency, English Nature and the IDB, and would be incorporated into the Environmental Management Plan.

14.4.33 The following pollution prevention mitigation measures would be written into the Construction Environmental Management Plan (CEMP) and would be implemented to ensure that the water quality of the watercourses is protected during the construction period:

- Watercourses would not be diverted until all work on the new channels, ditches and culverts has been completed.
- Where feasible a temporary drainage system would be set up which diverts surface water runoff to a collection point where it would be treated and disposed of in an appropriate manner and with consent from the Environment Agency.

- Where considered necessary the risk of contamination to ecologically important dykes could be reduced through the use of containment ditches / plastic liners.
- Water accumulated in excavations would be collected and disposed of in an appropriate manner and with consent from the Environment Agency.
- Temporary, solid fencing would be erected on existing embankment slopes to protect downslope vegetation and to prevent materials falling into watercourses.
- The site compound would not be located in the Halvergate Marshes area or near to any other watercourses.
- All fuels, oils and chemicals associated with construction works would be stored at the site compound in suitably bunded areas.
- All refuelling would be undertaken with suitable pollution control measures. Where practically possible, electric equipment would be used, wired into distribution panels removing the requirement to have to refuel close to watercourses.
- Drip trays would be provided under all plant, as appropriate.
- Spill kits would be provided as necessary (and as a minimum at all refuelling areas).
- All construction staff would receive training regarding the protection of watercourses.
- Emergency procedures would be in place to deal with spillages and other pollution incidents. These procedures would provide clear guidelines on who to contact and what to do in case of pollution. In the event of spillage, works would be ceased immediately, containment measures implemented and the appropriate services notified. A list of contact names and numbers of services should be prepared before works commence. Organisation of a professional 24 hour call-out clean-up service should be considered.
- Reminder posters would be used on site to identify the key essential elements of the spill response procedure, and spill kits would be kept where spills may occur.
- The watercourses and protective fencing would be monitored on a daily basis by a suitably qualified environmental engineer and there would be regular liaison with the Environmental Manager.

14.4.34 The construction works would also be designed to minimise increased flood risk in the watercourses affected. Flows would be maintained normally during the majority of the construction period and a procedure would be devised in consultation with the IDB to ensure this. If temporary closure is required, water would be pumped across the works in pipes to maintain water transfer capacity.

14.4.35 Even with the above mitigation measures, adverse effects on water quality and flow of adjacent dykes are inevitable because of the close proximity of the dykes to the road and the direct effects on them in constructing bridges, culverts and connections to new dykes. These effects would be localised and the effects on the River Bure and Breydon Water would be negligible. A temporary Large Adverse effect on water courses has been identified for Options 2 and 2A

Ecology and Nature Conservation

14.4.36 The construction impacts and potential mitigation measures for biodiversity are discussed in detail in the Ecology and Nature Conservation chapter of this report (Chapter 9). In summary, construction impacts include the following:

- The location of access roads and tracks for site traffic together with site storage areas would be located outside all marshland and designated nature conservation areas. The exact location of such facilities has not been determined at this stage and effects cannot be fully determined.
- Potential for pollution and localised hydrological changes to effect roadside dykes, as a result of construction materials, silt, spillages etc. entering the water courses, exerting adverse impacts of sensitive aquatic flora and invertebrate fauna, as well as grass snake and possibly water voles and otters.
- Visual and noise disturbance during the construction process is likely to have a large adverse impact on bird populations, particularly due to the flat nature of the land along the road.
- Construction would require reprofiling of at the embankment slopes along almost the entire length of the scheme. This has potentially very serious consequences for water vole and viviparous lizard populations which are strongly dependant upon this embankment for habitat.
- The accidental discovery of roosting bats during removal of buildings, reinstatement of culverts or felling of trees along the route could cause temporary increased mortality. However, this is considered highly unlikely given the paucity of potential roosting sites and mitigation measures to be adopted during route clearance. Therefore the effect is seen as being neutral.
- The temporary effects from water pollution and hydrological change could cause a significant negative impact on Grass Snake.

14.4.37 Specific mitigation measures would include:

- An Environmental Manager (EM) and ecological clerk of works be based permanently on site for the construction period, to address any issues as they arise according to standard operating procedures for mitigation and to liaise with English Nature, as necessary.
- The CEMP would include specific measures and mitigation regimes agreed with English Nature, for miinimising disruption to protected and other rare and scarce species.

- Measures listed in 14.4 35 above would be implemented to minimise potential adverse effects on the sensitive ecological flora and invertebrate fauna interests of the roadside dykes.
- The construction work needs to occur during a period that minimises the disturbance to bird life in the area. Consideration should also be made for the time of the day and state of the tides.
- Night time working is not envisaged however during low natural light conditions any lighting required should be focused on the area of work only and hence measures taken to minimise the spread of light into the surrounding habitat.
- Nocturnal work be avoided in the areas of road closest to Breydon Water and its surrounding grazing marsh, to avoid impacts on bird populations. Night time working should be minimised in all other areas to avoid disturbance to wildlife.
- Erection at the earliest possible stage of the works of an environmental barrier to be located to the south of the road and east of Vauxhall Roundabout as mitigation against disturbance from traffic to birds on Breydon Water (see Chapter 9).
- Temporary solid fencing to be erected on existing embankment slopes to protect downslope grassland habitat and woody vegetation and aquatic habitat and prevent spillage of materials into retained roadside dykes. Additional temporary screens may also be required during the wintering and breeding season for birds in particularly sensitive locations eg Damgate Marshes and those sections of the River Bure near the route.
- Construction of new replacement dykes or additional habitat creation dykes at least 3 years in advance of the works to facilitate species translocation.
- Regular monitoring by specilist ecologists under the direction of the EM, throughout the construction period, for all key species and assemblages of species of all retained habitats and newly created / translocated habitat areas.
- Temporary exclusion fencing should be installed to prevent water voles and otters entering the construction site and also to encourage the use of reinstated culverts / otter underpasses, once constructed.
- Temporary drainage of ditches should be avoided or minimised to reduce impacts on water voles. Implementation of a specific regime of water vole conservation, including translocation from dykes to be lost or adversely affected by hydrological change. Translocation of Water Voles also needs to occur if present in ditches that need to be temporarily drained.
- Implementation of a programme of reptile mitigation works, to be agreed with English Nature, to avoid loss or injury of common lizard and grass snake. Reptile exclusion fencing to be erected to prevent straying onto the construction site.

- All tree felling should be accompanied by a detailed plan of fellings and supervision by a suitably qualified bat worker. Should any bats be discovered in trees, collapsed culverts or any other potential roost sites, then works should cease immediately until advice can be sought from the Environmental Manager or English Nature.
- Any bat translocation works would require a DEFRA licence. Workers finding roosting bats should cease work immediately and seek advice from either the Environmental Manager or English Nature.
- All retained dykes and other associated habitat to be subject to a regime of sympathetic management during the construction period. This may require implementing a cutting regime to mimic grazing.

14.4.38 Even with the above mitigation measures, adverse effects on biodiversity are likely to be significant particularly due to the close proximity of the valuable dyke habitat and the high risks of adverse effects on water quality and flow. Even though these water effects would be temporary this could result in permanent effects on the ecological habitat. In particular many of the rare species that contribute to form part of the unique invertebrate and dyke vegetation communities are likely to be highly susceptible to even small changes in their environment. Overall therefore, the construction impacts on biodiversity are likely to be Very Large Adverse for both options.

Land Use

14.4.39 Some land would be temporarily lost during the construction period for construction compounds, storage areas, temporary access routes and other associated activities. Although, the location and size of these is not known at this stage, there would be a contractual requirement for any compounds and storage areas required in addition to the footprint of the proposed road embankment, to be located outside the area administered by the Broads Authority. This restriction would also apply to any temporary access routes to such storage areas and compounds.

14.4.40 The main potential impact on land use would derive from access problems particularly to farmland. Mitigation should involve the development of a traffic management plan that ensures free access is maintaine to all land and properties at all times.

14.4.41 With mitigation the temporary effects on land use would be small and accordingly the impact is assessed as Slight Adverse.

Access and Severance

14.4.42 Pedestrians and cyclists making journeys that involve using or crossing the route could encounter disruption during certain phases of construction, both from obstructions, and reduction in amenity. However, if a Right of Way is obstructed an alternative route would be provided and overall, a very small number of people would be affected due to the lack of dwellings or

community facilities in either side of the route. The overall temporary impact is assessed as Slight Adverse.

Journey Ambience

14.4.43 Due to the open nature of the landscape, construction works, temporary compounds and construction machinery would be clearly visible to users of the road and nearby footpaths. This would have a temporary impact on traveller views, making them worse.

14.4.44 Although access to lay-bys may be temporarily disrupted, the construction phase would have negligible impacts on traveller care.

14.4.45 The imposition of temporary lane or road closures and diversion routes could increase driver stress, particularly during the peak hours when congestion is likely to occur. The presence of construction traffic on the road network may also increase frustration and the fear of accidents. Driver stress would be temporarily worse during the construction period.

14.4.46 Overall, journey ambience would be temporarily worse during the construction period.

14.5 Summary

14.5.1 The construction period would last for approximately 2 years for both options. The large volume of materials movement potentially required, the ecological and landscape sensitivity of the surroundings, and the large number of land holdings with access onto the existing A47 gives a potential for considerable disruption during the construction period. This would be offset by the appointment of an Environmental Manager as a senior member of the construction team who would be responsible for developing and implementing an EMP. The EMP would include mitigation measures to minimise the impact of the construction works on the surrounding environment and local population.

14.5.2 Taking these mitigation measures into account, the construction phase of the proposed scheme would result in the following environmental effects within the study area:

- Noise levels would be likely to be within threshold values, however, perceptible construction noise, at any level, may still comprise an annoyance to the occupants of residential and other sensitive properties within the study area.
- A Slight Adverse effect on air quality due to dust generation and the exhaust emissions of construction vehicles and plant.
- A temporary Moderate Adverse effect on the landscape resulting from visual intrusion of construction traffic, construction compounds, temporary signs, lighting, earthworks and additional congestion.

- A temporary Slight Adverse effect on listed buildings, and the disturbance of archaeology in the study area.
- A temporary Large Adverse effect on water flow and water quality.
- A Very Large Adverse effect on biodiversity.
- Temporary disruption and reduction in amenity for non-motorised users, leading to a temporarily Slight Adverse impact on access / severance.
- A Slight Adverse effect on land-use due to the temporary use of land for construction compounds, storage areas, temporary access routes and other associated activities.
- A temporary negative effect on vehicle travellers as a result of worsened views and the effects of traffic management on driver stress.

Hyder Consulting

Glossary

100 Year Flood	This describes the water level of a flood that has a 1 in a 100 chance (1%) of being exceeded at a given location in a given year. A flood with lower water levels has a greater chance of occurring, whereas a flood with higher water levels is less probable.
Alluvial deposits	Sediments deposited by the action of rivers.
AOD	Above Ordnance Datum
Aquifer	A rock formation containing water - often used as a water source
At grade	At the same ground level
Biodiversity	Biological diversity – includes all species of plants and animals, their genetic variation and the complex ecosystems of which they are part.
Biol GQA	Biological General Quality Assessment
BOD	Biological Oxygen Demand
Brownfield	An area of land formerly used for commercial or industrial activity, but now cleared and available for development
Bund	A walled area or embankment used either for secondary containment (for potentially polluting materials) or for screening
Carboniferous	A geological time period extending from 345 to 280 million years ago. Carboniferous rocks often contain coal seams.
Catchment	The area of land which drains into a river.
Chainage	Unit of measurement used on roads and other linear engineering works
COD	Chemical Oxygen Demand

Cyprinid Fishery	Fishery able to support carp type fish, which require less dissolved oxygen than salmonid fish
Desire line tracks	Tracks created by users travelling directly towards the desired destination.
Deck	The platform part of a bridge
DETR	Department of Environment, Transport and the Regions
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
Earthworks	The process of excavating soil, or an embankment etc made from earth.
EC	European Community
EIA	Environmental Impact Assessment
Fluvial-glacial deposits	Sediment deposited by the action of melt waters from glaciers.
GOMMMS	Guidance on the Methodology for Multimodal Studies
GQA	General Quality Assessment
Groundwater	Water occupying space in rocks (aquifers) or the subsoil
HA	Highways Agency
HGV	Heavy Goods Vehicle
IFA	Institute of Field Archaeologists
In situ	In its place
Leachate	Water that has dissolved or washed material out of solid

	material such as soil. Leachate can be polluted if it contains dissolved material from contaminated soil.
Listed building	Building listed by the Secretary of State as being of 'special architectural or historic interest'. Provisions relating to listed buildings are contained in the Planning (Listed Buildings and Conservation Areas) Act 1990.
Made Ground	Ground that has be disturbed or created by the activities of humans.
NAQS	National Air Quality Strategy
NATA	New Approach to Appraisal
OS	Ordnance Survey
Parapet	The walls along the sides of a bridge
Pile	A heavy beam driven vertically into the ground to support the foundations of a structure.
Piled wall	Wall made of piles.
Pipistrelle Bats-45kHz ans 55 kHz type	Pipistrelle bats are divided into 45 kilo-herz (kHz) and 55 kHz on the basis of their calling frequencies (bats emit rapid electronic pulses), i.e. 45 kHz (common) pipistrelles emit echolocation calls of frequency 45 kHz, and 55 kHz (soprano) pipistrelles emit echolocation calls of frequency 55 kHz
PPG	Planning Policy Guidance
Permeability	The capacity of a rock or soil to allow liquids (especially water) to pass through more or less freely.
Potable water	Drinking water
Puddle clay	Clay with a low water permeability - for use as a watertight covering.

Retaining wall	A wall supporting an earth bank
RIGS	Regionally Important Geological Sites
RPG	Regional Planning Guidance
RQO	River Quality Objective
Salmonid Fishery	Fishery able to support salmon/trout type fish, which require more dissolved oxygen than cyprinid fish
Standpipe	A tube placed in side a borehole that allows the monitoring of gas or groundwater.
SBAP	Staffordshire Biodiversity Action Plan - designates species which at a national or regional scale are exhibiting a significant decline in numbers
Scheduled Ancient Monument	Monument scheduled by the Secretary of State as appearing to be, by reason of period, rarity, fragility, potential etc. of national importance. Provisions relating to Scheduled Ancient Monuments are contained in the Ancient Monuments and Archaeological Areas Act 1979 and the National Heritage Act 1983
SMR	Sites and Monuments Record
Source Protection Zone	Protection zones around certain sources of groundwater used for public water supply. Within these zones, certain activities and processes are prohibited or restricted.
Special waste	A waste containing substances or having characteristics that are hazardous, making it difficult or dangerous to dispose. Substances and characteristics are listed under the Special Waste Regulations 1996.
SSSI	Site of Special Scientific Interest
Strata	Rock layers.

Superstructure	The part of a bridge or building above its foundations
Surface water	Water features present above ground including lakes, ponds and rivers.
Remediation	Treating, containing or removing contaminated land so that it no longer poses a hazard.
Townscape	The visual appearance of a town or towns.
TPH	Total Petroleum Hydrocarbons.
Transverse slurry walls	Watertight wall made using bentonite (substance with low water permeability).
Visual envelope	The extent of visibility to and from a point on a site.
Wildlife corridor	A linear habitat along which animals can move from one area to another.

Hyder Consulting

Appendix 1 Introduction

Appendix 1.1 Environmental Specialist Reports

Norfolk Archaeological Unit (2003) An Archaeological Evaluation at A47 Acle Straight, Norfolk

Norfolk Wildlife Service (2003) Survey and assessment of Dyke Vegetation in A47 Corridor

Norfolk Wildlife Service (2003) Survey and Assessment of Otter and Water Vole Populations in A47 Acle Straight

Norfolk Wildlife Service (2003) Survey and Assessment of Reptiles and Amphibians on A47 Acle Straight

Norfolk Wildlife Service (2003) Survey and Assessment of the Invertebrates on the A47 Acle Straight

Norfolk Wildlife Service (2003) Survey and Assessment of Bats on A47 Acle Straight

Reading Agricultural Consultants (2003) Agricultural Assessment

RPS Ecoscope Applied Ecologists (2002) Scoping Study of Winter Bird Survey Methods for the A47 Acle Straight Road Improvement Scheme

RPS Ecoscope Applied Ecologists (2003) Winter Bird Survey 2002/3 for the A47 Acle Straight

RPS Ecoscope Applied Ecologists (2003) Breeding Bird Survey Report for the A47 Acle Straight Road Improvement Scheme

RPS Ecoscope Applied Ecologists (2003) Impact assessment of the A47 Acle Straight Road Improvement Scheme on Wintering Birds

Susan Deakin (2003) Phase 1 Habitat Survey

Susan Deakin (2003) Badger Survey Report

Hyder Consulting

Appendix 5 Pedestrians, Cyclists, Equestrians and Community Effects

Appendix 5.1 Letter received from Sustrans

Sustrans
routes for people

Environment & Energy Centre,
33a Westgate,
Peterborough PE1 1PZ
tel. 01733 319981
fax. 01733 346932
nigelb@sustrans.org.uk
www.sustrans.org.uk

HYDER CONSULTING LTD
GUILDFORD

PASS TO	A/	COPY	DEADLINE
AM	-	-	24/1/03
GT	1	-	

DATE REC'D 23 JAN 2003
INCOMING No HR32749
FILE REF

Adrian Manning
Hyder Consulting
Medawar Road
Surrey Research Park
Guildford, GU2 7AR

20th January 2003

Dear Adrian

National Cycle Network – Acle Straight

Further to our recent telephone conversation I attach a marked up plan showing options for the National Cycle Network between Norwich and Great Yarmouth. This route would form part of National Cycle Network Route 1 and the North Sea Cycle Route, part of the Eurovelo network. As you can see there are a number of options that we have looked at and none of them are simple, due to the major difficulties of trying to find a safe, convenient, attractive route to avoid the Acle Straight. The Network is aimed at inexperienced cyclists as we try to encourage people to start cycling to try and meet Government targets of quadrupling cycling by 2012 and I am sure that you will agree that the Acle Straight is a real barrier to cycling in the area. I attach information about our work.

We have been liaising with the local authorities for a number of years over this route. The Highways Agency have been supportive of our work and are currently looking into options at the Yare viaduct, near Postwick for the route to continue to Whitlingham Country Park and Norwich. I would be very grateful if you could look at options that might arise as part of your work and let us know if you have any queries or suggestions as to how to improve matters for vulnerable road users along this very difficult corridor. We were consulted briefly during the previous Norwich-Great Yarmouth study. At that time there was opposition to a route that we were considering using rights of way across Halvergate Marshes. This was one of many options, which has now been dropped, but it seems to have clouded matters as far as cycling was concerned and the report did not come out with any clear recommendations for cycling. We consider that this was a lost opportunity and hope it can be redressed.

The main routes that we have considered are shown on the attached plan:

1. This mainly follows the Breydon Water and the Yare using minor roads between Blunham and Reedham and is the favoured route at present. It is an attractive route and ties in with a number of points of interest, making good use of the minor road network. It is not yet agreed with landowners and planners.
2. This is a variation on Option 1 using the Fleet Path via Halvergate, but missing Berney Arms and Reedham. It is not agreed with landowners and planners.

Cont/page 2

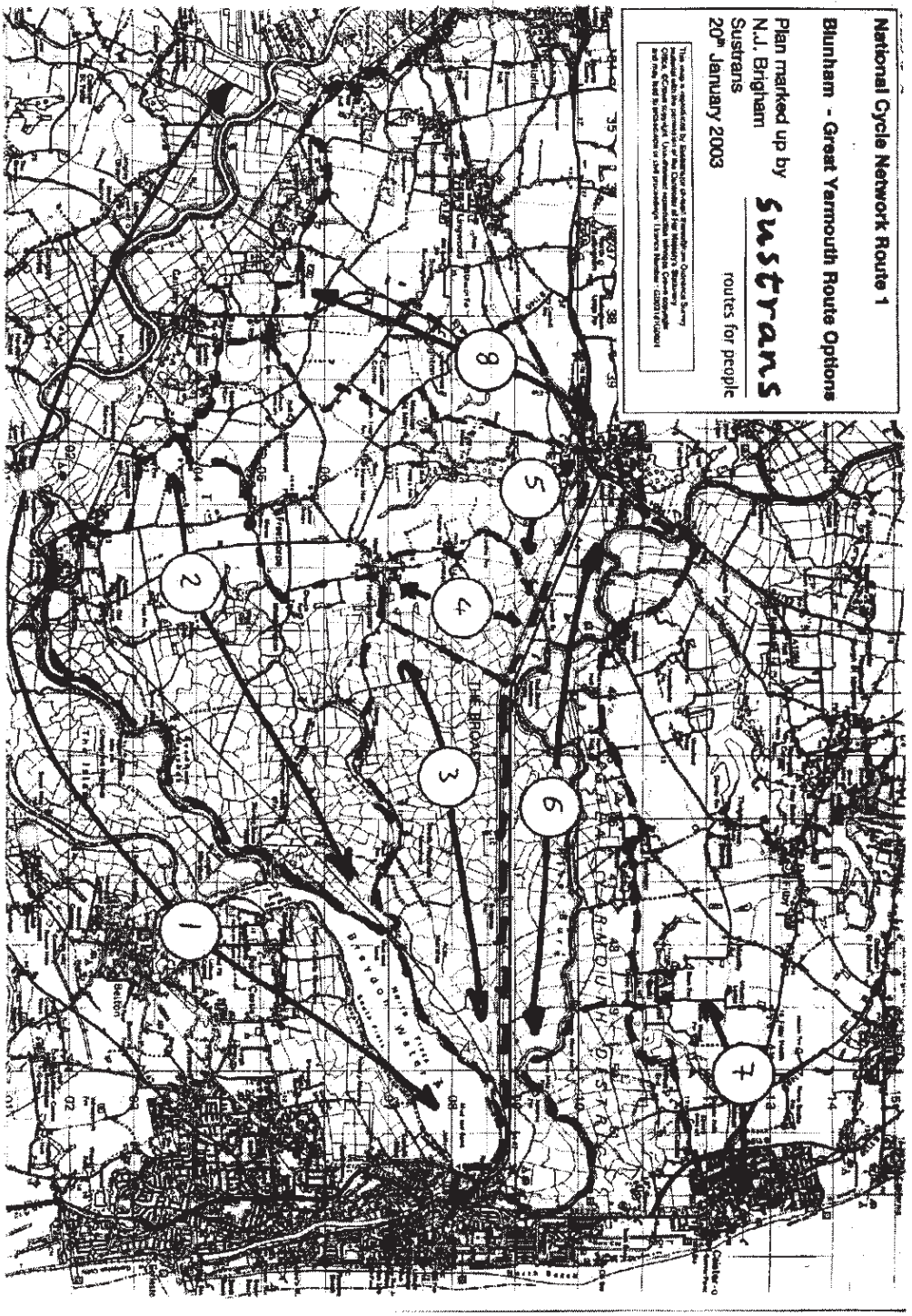
3. This would use a new path following the A47 and the railway as far from the road as possible to give as attractive an environment as possible. The minor road between Halvergate and the A 47 is a cause for concern and would benefit from traffic calming to reduce speeds. Sustrans has not investigated this option in terms of land and technical issues, but understands that this is something that could come out of the A 47 highways agency MMS.
4. A variation on Option 3 avoiding the minor road between Halvergate and the A47, however the link between Staithe Farm and an A 47 path may be difficult to achieve. Sustrans has not investigated this option in terms of land and technical issues, but understands that this is something that could come out of the A 47 highways agency MMS.
5. A variation on Options 3 and 4 but continuing to Acle besides the A 47. How the route would link into Acle is uncertain and is likely to be technically difficult ; it may need a new bridge over the A 47 or the railway. Sustrans has not investigated this option in terms of land and technical issues, but understands that this is something that could come out of the A 47 highways agency MMS.
6. A new route following the Bure and minor roads via Runham. There are technical and land problems with the link into Acle and land issues to be resolved near the Bure at the Yarmouth end.
7. A variation on Option 6 linking with Caister rather than Yarmouth. Work would be needed between Caister and Great Yarmouth and this would need an improvement to the A 149 crossing (Ramps instead of steps at an existing bridge). There are land issues to be resolved between West End and Decoy Farm.
8. Any route via Acle is more difficult than a route via Reedham in that there is not such a good network of minor roads. A detailed survey is needed to determine the best route and works needed.

I would welcome the opportunity to discuss this further with you and do hope that you will consider carefully the possibilities for this important part of the National Cycle Network.

Yours sincerely

Nigel Brigham
Regional Manager

enc plan
Network News


National Cycle Network Route 1
Blunham - Great Yarmouth Route Options
Plan marked up by
N.J. Bingham
Sustrans
20th January 2003
Sustrans
routes for people
1
2
3
4
5
6
7
8

Hyder Consulting

Appendix 7 Water Quality and Drainage

Hyder Consulting

Table 1: List I and List II substances as defined by EC Groundwater Directive (80/68/EEC)

LIST I OF FAMILIES AND GROUPS OF SUBSTANCES

These substances should be prevented from being discharged into groundwater.

List I contains the individual substances which belong to the families and groups of substances specified below, with the exception of those which are considered inappropriate to List I on the basis of a low risk toxicity persistence and bioaccumulation.

Such substances which with regard to toxicity, persistence and bioaccumulation are appropriate to List II are to be classed in List II.

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment.
2. Organophosphorous compounds.
3. Organotin compounds.
4. Substances which possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment (Note 1).
5. Mercury and its compounds.
6. Cadmium and its compounds.
7. Mineral oils and hydrocarbons.
8. Cyanides

LIST II OF FAMILIES AND GROUPS OF SUBSTANCES

Discharges of these substances into groundwater should be minimised.

List II contains the individual substances and the categories of substances belonging to the families and groups of substances listed below which could have a harmful effect on groundwater.

1. The following metalloids and metals and their compounds:

1	Zinc	11	Tin
2	Copper	12	Barium
3	Nickel	13	Beryllium
4	Chrome	14	Boron
5.	Lead	15	Uranium
6	Selenium	16	Vanadium
7	Arsenic	17	Cobalt
8	Antimony	18	Thallium
9	Molybdenum	19	Tellurium
10	Titanium	20	Silver

2. Biocides and their derivatives not appearing in List I.
3. Substances which have a deleterious effect on the taste and/or odour of groundwater and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption.
4. Toxic or persistent organic compounds of silicon and substances which may cause the formation of such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances.
5. Inorganic compounds of phosphorus and elemental phosphorus.
6. Fluorides.
7. Ammonia and nitrites.

Note 1 – when certain substances in List II are carcinogenic, mutagenic or teratogenic they are included in category 4 of List I.

Assessment for Surface Water

General Water Quality Assessment

The Environment Agency uses the General Quality Assessment (GQA) shown in the Table 2. All rivers are sub-divided up into stretches (or reaches), each characterised by a single water quality monitoring site. Routine water quality samples are collected over a three year period and the results used to establish the GCA class. A limited number of parameters are included in the analysis, though these are more appropriate to detecting organic pollution (such as sewage effluent) than the effects of largely inorganic discharges such as those contained in road runoff.

Table 2: General Quality Assessment chemical grading for rivers and canals

Water Quality	Grade	Chemical Parameters		
		Dissolved Oxygen % Sat 10 %ile	Biochemical Oxygen Demand mg/l 90%ile	Ammonia mgN/l 90%ile
Good	A	80	2.5	0.25
	B	70	4	0.60
Fair	C	60	6	1.3
	D	50	8	2.5
Poor	E	20	15	9.0
Bad	F	<20	>15	>9.0

Setting Targets and Water Quality Objectives

Water Quality Objectives (WQOs) will be used to plan future improvements in water quality and are important in considering the acceptability of any proposed discharge. With knowledge of the present and future uses which a stretch of water needs to support, the water quality requirements can be derived.

Statutory WQOs will be progressively introduced by the Secretary of State. The Surface Water (Rivers Ecosystem)(Classification) Regulations 1994 are the first step towards this. Five river use classes are envisaged:

i. River Ecosystem (RE)
ii. Special Ecosystem (SE)
iii. Abstraction for Potable Supply
iv. Agricultural/Industrial Abstraction
v. Water Sports

In the case of the surface the River Bure and River Yare the River Ecosystem (RE) classification is of relevance. The RE classification puts water courses into five classes based on their water quality. Table 3 below shows these classes and the parameters that define them.

Table 3: River Ecosystem Classification								
Class	**Dissolved Oxygen** **% saturation** **10 percentile**	**BOD (ATU)** **mg/l** **90 percentile**	**Total Ammonia** **mg N/l** **90 percentile**	**Un-ionised Ammonia** **mg N/l** **95 percentile**	**pH** **Lower limit as 5 percentile;** **upper limit as 95 percentile**	**Hardness** **mg/l $CaCO_3$**	**Dissolved Copper** **µg/l** **95 percentile**	**Total Zinc** **µg/l** **95 percentile**
RE1	80	2.5	0.25	0.021	6.0-9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	30 200 300 500
RE2	70	4.0	0.6	0.021	6.0-9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	30 200 300 500
RE3	60	6.0	1.3	0.021	6.0-9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	300 700 1000 2000
RE4	50	8.0	2.5	-	6.0-9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	300 700 1000 2000
RE5	20	15.0	9.0	-	-	-	-	-

Water Quality Prediction for Discharges to Surface Waters

The water quality impact of road runoff to surface water is assessed using water quality prediction calculation outlined in the DMRB Volume 11 Section 3 Part 10. The assessment in the DMRB focuses on two pollutants from road runoff, soluble copper and total zinc concentration. These pollutants are of interest because copper and zinc pose a particular threat to aquatic life.

In the general the assessment calculates the mass of pollutant that is laid down on the road surface and which is then dissolved in a volume of road runoff from rainfall. The resultant pollutant concentration from the road is added to the concentration of the pollutant entering the reach of river in question. If this total concentration exceeds an environmental quality standard (EQS) concentration specified by the Environment Agency, then mitigation measures will be required.

The concentration of a parameter downstream, C_r, is given by:

$$C_r = [(C_b \times Q_5) + (1000 \times M)] / (Q_5 + V)$$

Where

C_b = existing water quality data for water entering the reach in question.

M = 5 day pollutant build-up

Q_5 = 5 percentile flow (flow equalled or exceeded 95% of the time)

V = total runoff volume

Parameters

The pollutant concentration entering the reach of river in question (C_b) is calculated from Environment Agency water quality data from a monitoring point directly upstream.

However it should be noted that the A47 Acle Straight is an unusual case. Although the 'over the side' drainage is to the surface water of the roadside ditches these ditches have little or no flow in them. Therefore the parameters C_b and Q_5 would effectively zero. A more appropriate water quality prediction

assessment would to treat the ditches like that of an aquifer assuming no dilution. This calculated as follows below.

Annual Average pollutant runoff concentration = Annual Pollutant Build-up rate

Runoff Coefficient x annual average rainfall

The runoff coefficient is assumed to be 0.5 and the annual pollutant build-up rates for soluble copper and total zinc are presented in Table 4 below.

Table 4: Typical pollutant Build-up Rates (kg/ha/a)

	Traffic Flow Two Way AADT	Soluble Copper	Soluble Copper	Total Zinc	Total Zinc
	No. vehicles	kg/ha/a	kg/m2/a	kg/ha/a	kg/ha/a
2000 Base Model	15,000 - 30,000	0.2	0.00002	0.4	0.00004
Existing - High Growth	> 30,000	1.2	0.00012	5.0	0.0005
Option 2 & 2A - Wide single C'Way High Growth	> 30,000	1.2	0.00012	5.0	0.0005

Spillage Assessment Methodology

The DMRB Volume 11 Section 3 Part 10 stipulates that the probability of a serious accident spillage should be calculated as part of the water quality assessment of a new road scheme. This figure is then used to calculate the probability of a serious pollution occurring. The acceptable risk should normally be 1 in 100 years for discharges to aquifers and to reaches of sensitive watercourses such as those on the Acle Straight.

Probability of a serious accidental spillage

The probability of a serious accidental spillage (P_{acc}) is given by:

$$P_{acc} = RL \times SS \times (AADT \times 365 \times 10^{-6}) \times (\%HGV \div 100)$$

where,

RL = road length (km)

SS = serious accidental spillage rate (spillage / million HGV km / yr)

AADT = annual average daily traffic (both sides of the road)

%HGV = percentage of heavy goods vehicles

The equation can be simplified to:

$$P_{acc} = RL \times SS \times AADT \times \%HGV \times 365 \times 10^{-8}$$

Probability of a pollution incident occurring

The probability that a spillage will cause a pollution incident ($P_{pol/year}$) is given by:

$$P_{pol/year} = P_{acc} \times P_{pol}$$

P_{pol} = risk reduction factor, dependent on the emergency services response times, which determines whether a serious spillage will cause a serious pollution incident.

Parameters for calculations

Serious accidental spillage per million HGV km/year

Values for serious accidental spillage rates taken from the DMRB for "all purpose urban and rural" roads (i.e. not motorway) were used for the calculations. The values (spillages / million HGV km / year) used for the parameter SS are given below:

Rural No junction 0.0017

Rural Roundabout 0.0119

Urban Roundabout 0.0296

For side roads and roundabouts, the risk factor applies within 100m of the junction type in all directions.

Probability of a serious spillage leading to a serious pollution incident

The probability of serious accidental spillage leading to a serious pollution incident is dependent on two factors:

1) The emergency services response time to the site of spillage.

2) The quality of the receiving watercourse.

In the case of the A47 Acle Straight the emergency response time is within 20 minutes. The receiving water courses, in this case the roadside ditches are classified as RE1 or RE2 (high quality). Using the DMRB methodology, these factors lead to a risk reduction factor P_{pol} of 0.45.

Traffic flow figures

The calculations for the existing situation were based on the measured Annual Average Daily Traffic (AADT) flow figures for 2000. The traffic flow data are available in the Traffic Forecasting Study report carried out by Hyder Consulting (UK) Ltd in May 2003. Projected traffic flows for the year 2020 of the proposed scheme and existing scheme were also calculated by Hyder Consulting (UK) Ltd.

Heavy Goods Vehicles

The spillage assessment is directly dependent on the number of Heavy Goods Vehicles (HGVs) that use the road. The average percentage of HGVs as a part of total traffic flow for the existing main carriageway of the road is 10.7% for the A47 Acle Straight. This value of 10.7% is also assumed for the proposed and existing schemes in the year 2020.

Assessment scenarios

Three spillage assessment calculations were carried out for:

1) The existing road configuration in the year 2000.
2) The existing road with high traffic flows in the year 2020.
3) The proposed road with high traffic flows in the year 2020.

The results of these calculations are presented in Section 6 of the environmental assessment report.

Appendix 8 Landscape Effects

APPENDIX 8.1: VISUAL IMPACT SCHEDULE – Options 2 & 2a

Properties

(High sensitivity, except where stated) Date of Survey Work: September 2003

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
3,5,7,11,15, 17 & 25 Mardling Run, Acle	2 storey, brick terraced starter houses	54 to 124	2: 44 to 114 2A: 47 to 117	Front, first floor	Views of adjacent houses and edge of Acle. Well established vegetation along the A1064 largely contains views in summer.	New roundabout, loss of vegetation along Acle Straight, & a new carriageway would make traffic more clearly evident and increase the intrusiveness of the A47. The establishment of the adjacent woodland would screen the traffic on this road from the view.	Moderate Adverse	Slight Beneficial
10, 12,14,29,31 & 33 Mardling Run, Acle	2 storey, brick terraced starter houses	29 to 43	2: 19 to 33 2A: 22 to 36	Front, ground & first floor	Views of adjacent houses and edge of Acle. Well established vegetation along the A1064 partially contains views in summer.	New roundabout would have a dominant effect on views, particularly if this leads to the loss of the adjacent vegetation next to the roundabout. Replanted vegetation near to houses would reduce adverse effect	Substantial Adverse	Moderate Adverse
27 Mardling Run, Acle (low sensitivity)	2 storey, brick terraced starter houses	50	2: 40 2A: 43	Rear, first floor	Well established vegetation along the A1064 largely contains views in summer. Some views over vegetation to marsh & planted fringe.	New roundabout, loss of vegetation along Acle Straight would make traffic more clearly evident and increase the intrusiveness of the A47.	Moderate Adverse	Neutral
Little Chef, Acle	1 storey, brick café	59	2: 69 2A: 66	Front and east elevation	Predominantly views from main café window on eastern elevation, but also front. View mainly of A47 to Norwich, with carr beyond and roundabout.	Changes to the roundabout would be perceptible, without being prominent. Roundabout would be further away and adverse effects neutralised when replacement planting established.	Slight Adverse	Neutral
Site of Palmers Mill	Formers site of hollow post drainage mill.	21	2: 31 2A:28	Setting	The south-bound carriageway of the A47 to Norwich currently occupies the site and dominates the setting.	No perceptible difference.	Neutral	Neutral
61 Old	2 storey, brick	355	2: 343	Front, first	Views over Old Road and A1604 to	Loss of vegetation adjacent to Acle	Slight Adverse	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Road, Acle	detached house		2A: 348	floor	traffic on Acle Straight.	Straight and perception of an increase in traffic flow and movement would become a notable feature in views. The establishment of the adjacent woodland would screen the traffic on this road from the view.		
63 Old Road, Acle	2 storey, brick detached house	367	2: 357 2A: 360	Front, first floor	Leylandii hedge contains views at ground floor. First floor views over Old Road and A1604 to traffic on Acle Straight.	Loss of vegetation adjacent to Acle Straight and perception of an increase in traffic flow and movement would become a notable feature in views. The establishment of the adjacent woodland would screen the traffic on this road from the view.	Slight Adverse	Neutral
Wayside, Acle	2 storey, brick and rendered semi-detached house	383	2: 373 2A:376	Front, first floor	Semi-rural views over the edge of Acle, A1604, and marsh fringe to traffic on Acle Straight, with carr beyond.	Loss of vegetation adjacent to Acle Straight and perception of an increase in traffic flow and movement would become a notable feature in views. The establishment of the adjacent woodland would screen the traffic on this road from the view.	Moderate Adverse	Neutral
Willowland, Acle	2 storey, brick and rendered semi-detached house	388	2: 378 2A: 381	Front, first floor	Semi-rural views over the edge of Acle, A1604, and marsh fringe to traffic on Acle Straight, with carr beyond.	Loss of vegetation adjacent to Acle Straight and perception of an increase in traffic flow and movement would become a notable feature in views. The establishment of the adjacent woodland would screen traffic from the view.	Moderate Adverse	Neutral
Rowan House, Acle	2 storey, white rendered house	410	2: 400 2A: 403	Front, first floor	Small tree in front garden partially restricts views. Semi-rural views over the edge of Acle, A1604, marsh fringe and oblique views of traffic on Acle Straight, with carr beyond.	Due to obliqueness of the views, changes resulting from the proposed scheme would only be perceptible, except for the screening of traffic from the views when the adjacent woodland has established.	Slight Adverse	Neutral
Hermitage	2 storey, white	428	2: 418	1 side	Semi-rural views over the edge of Acle,	New carriageway initially perceptible,	Moderate	Slight Adverse

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Restaurant and Public House, Acle	rendered pub & house		2A: 421	window, first floor	marsh fringe, with recently planted wood and views of traffic on Acle Straight, with carr beyond.	with increased traffic notable in views. Adjacent woodland planting would reduce views of traffic during summer.	Adverse	
The Willows, Acle	Low 2 storey, white washed brick, detached house	428	2: 418 2A: 421	Rear, ground & first floor	Boundary vegetation and hedgerow largely contain views in summer. In winter views become more open or filtered, exposing a rural view where the traffic on the Acle Straight is prominent.	Removal of vegetation and increased presence and movement of traffic flow becomes notable in views.	Moderate Adverse	Moderate Adverse
Meadow Holme, Acle	1 storey, brick detached house	466	2: 456 2A: 459	Rear, ground floor	Hedge on all sides largely contains views. Filtered rural views occur in winter.	No perceptible difference.	Neutral	Neutral
Boat House, Acle	1 storey, detached house	546	2: 536 2A:539	Front, ground floor	Attractive views over Acle Dike, with broken views over marsh beyond to traffic on Acle Straight and carr.	Removal of vegetation and increased presence and movement of traffic flow becomes notable in views.	Moderate Adverse	Moderate Adverse
Broad Farm House, Acle	1 & 2 storey, split level, brick detached house	519	2: 509 2A: 512	Rear, ground and first floor	Attractive views over Acle Dike, with broken views over marsh beyond to traffic on Acle Straight and carr.	Removal of vegetation and increased presence and movement of traffic flow becomes notable in views.	Moderate Adverse	Moderate Adverse
Mill House Farm & Charlie Water Mill, Nr Acle	2 storey, brick detached house & stump of brick tower – SMR listed feature.	852	2: 842 2A: 845	Rear, first floor & setting of tower	Attractive, open, rural views over River Bure and marsh. Traffic on Acle Straight seen as a distant feature in a narrow section of the view.	No perceptible difference, possible improved screening of traffic from views once planting along Acle Straight has established.	Neutral	Neutral
Chimneys, Stokesby	2 storey, brick, dormer bungalow	1291	2:1281 2A: 1284	Front, first floor	Attractive rural views over marsh to woodland carr. Lorries on Acle Straight seen in small sector of view.	Levees of River Bure restrict views of the traffic on the Acle Straight. No perceptible difference.	Neutral	Neutral
Hedgleys, Stokesby	2 storey, brick, dormer bungalow	1281	2: 1271 2A:1274	Front, first floor	Attractive rural views over grazing marsh to woodland carr. Lorries on Acle Straight seen in small sector of view.	Levees of River Bure restrict views of the traffic on the Acle Straight. No perceptible difference.	Neutral	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Fieldview, Stokesby		1322	2: 1312 2A:1315	Rear, first floor	Attractive rural views. Oblique & occasional, views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	No perceptible difference.	Neutral	Neutral
One High House, Stokesby	1-3 storey, stepped rear – front, brick, thatched detached house	1187	2: 1177 2A: 1180	Rear, first floor dormer window	Very attractive open, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Anchor House, Stokesby	2 storey, brick detached house	1169	2: 1159 2A:1162	Rear, ground & first floor	House orientated to obtain the most from the very attractive open rear views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic..	Slight Adverse	Slight Adverse
Millreach, Stokesby	2 storey, brick detached house	1160	2: 1150 2A:1153	Rear, ground & first floor	House orientated to obtain the most from the very attractive open rear views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Riverside House, Stokesby	2 storey, brick detached house	1164	2: 1154 2A:1157	Rear, ground & first floor	House orientated to obtain the most from the very attractive open rear views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Commission Drainage Mill	Brick wind pump, without roof or sail. Grade II listed building.	739	2: 729 2A: 732	Setting	Attractive, open, rural setting overlooking the River Bure and marsh. Traffic on Acle Straight creates an intrusive feature within the setting.	Loss of roadside vegetation and closer proximity of faster moving traffic would make the traffic, initially, more evident as well as there being an increased perception of numbers of vehicles. Establishment of new planting along	Slight Adverse	Slight Adverse

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
						Acle Straight would slightly reduce views of traffic in summer but insufficiently to screen it.		
Commission Drainage Mill house	2 storey, white painted brick house	730	2: 720 2A: 723	Side, 1 first floor window	Attractive, open, rural setting overlooking the River Bure and marsh. Traffic on Acle Straight creates an intrusive feature within the setting.	Loss of roadside vegetation and closer proximity of faster moving traffic would make the traffic, initially, more evident as well as there being an increased perception of numbers of vehicles. Establishment of new planting along Acle Straight would slightly reduce views of traffic in summer but insufficiently to screen it.	Slight Adverse	Slight Adverse
The Candle Maker, Stokesby	2 storey, white rendered detached business and house	1176	2: 1166 2A: 1169	Rear, first floor & possible ground floor	Very attractive open, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Millstone, Stokesby	Brick bungalow	1207	2: 1197 2A: 1200	Front, ground floor	View includes village street scene, with "window" within view allowing more extensive views over marsh.	No perceptible difference.	Neutral	Neutral
Saithe House, Stokesby	2 storey, brick detached house. Grade II listed building.	1159	2: 1149 2A: 1152	Front, ground & first floor	Very attractive open, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
The Camber, Stokesby	1 1/2 storey semi-detached, white-washed brick cottage	1147	2: 1137 2A: 1140	Front, ground & first floor	Very attractive open, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Ferry Cottage,	1 1/2 storey semi-	1145	2: 1135	Front, ground &	Very attractive open, rural views over River Bure and marsh. Traffic on Acle	Barely perceptible effect on views due to the open, rural nature of the existing	Slight Adverse	Slight Adverse

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Stokesby	detached, white-washed brick cottage		2A: 1138	first floor	Straight seen in the mid-distance, as small to moderate scaled features.	view and increase in moving traffic.		
Ferry Inn, Stokesby	2 storey rendered brick, detached public house	1131	2: 1121 2A: 1124	Rear, ground & first floor + pub garden	Very attractive open, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
The Old Carpenters, Stokesby	2 storey, brick detached house	1253	2: 1243 2A: 1246	Rear, first floor	Attractive partial, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	No perceptible difference.	Neutral	Neutral
House with no name, Stokesby	2 storey, brick detached house	1247	2: 1237 2A: 1240	Rear, first floor	Attractive relatively open, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Cead Mile Fajlte, Stokesby	2 storey, brick detached house	1256	2: 1246 2A: 1249	Rear, first floor	Attractive relatively open, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic..	Slight Adverse	Slight Adverse
Stokesby Village Hall (lower sensitivity)	1 storey, brick detached hall	1244	2: 1234 2A: 1237	Rear, ground floor	Attractive, rural views over River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	No perceptible difference.	Neutral	Neutral
Stokesby House, Stokesby	Large 2 storey brick manor house	1402	2: 1392 2A:1395	South elevation first floor	Views largely contained within garden setting by boundary vegetation, but also with views of rural countryside. Traffic on Acle Straight evident in limited views.	No perceptible difference.	Neutral	Neutral
Church of St Andrews Stokesby	Flint & thatched church. Grade II* listed building.	1365	2: 1355 2A: 1358	Southern views – garden/ grave yard	Attractive rural views on the edge of Stokesby. Traffic on Acle Straight evident just beyond & above boundary hedge.	No perceptible difference.	Neutral	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Glebe Farm & Barn, Stokesby	2 storey, brick thatched, detached house & barn. Grade II listed buildings.	1159	2: 1149 2A:1152	Rear, first floor & setting	Vegetation to rear of property largely contains views. Filtered rural views in winter.	No perceptible difference.	Neutral	Neutral
Pumping station, end of Tunstall Dyke	Bungalow with dormer windows/ skylights.	316	2: 306 2A: 309	Front, ground, possibly dormer/ skylights	Main views to the north over River Bure and marsh with boundary vegetation containing views to the south and traffic on Acle Straight – however a lot more apparent in winter.	Increased volume, slightly closer proximity and, faster speed of traffic would be perceptible. Less evident in summer.	Slight Adverse	Slight Adverse
Stokesby Hall & two barns to N & NW.	2 storey brick detached house & 2 barns. All grade II listed buildings.	1143	2: 1133 2A: 1136	Side–SW elevation first floor & setting	Views largely contained to garden setting by mature woody vegetation on boundary. Oblique views to SW over out buildings to marsh and Acle Straight	No perceptible difference.	Neutral	Neutral
Old Hall Drainage Mill	Brick wind pump, timber elements gone & overgrown with ivy. SMR built heritage.	353	2: 343 2A:346	Setting	Attractive setting overlooking River Bure and marsh, but heavily influenced by traffic on the Acle Straight.	New carriageway, and increased traffic flow/speed would become more prominent in view. Partially offset by reduced night-time effects due to new road lighting with reduced sky glow and light spill. Effects slightly reduced in summer when planting matures but insufficient to screen traffic.	Moderate Adverse	Moderate Adverse
Bure Cottage	Unoccupied, dilapidated, $1^1/_2$ storey, brick detached house	397	2: 387 2A: 390	Setting	Views essentially contained in summer by boundary vegetation. Filtered, rural views incorporating traffic on Acle Straight, in winter.	New carriageway and increased traffic flow evident in winter. Unchanged in summer.	Slight Adverse	Neutral
Herringby Hall	2 storey, grey brick detached house	1431	2: 1438 2A: 1438	Rear, first & possibly ground floor	Rural views restricted by boundary vegetation.	No perceptible difference.	Neutral	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
The Cottage	2 storey, brick detached house	1527	2: 1534 2A: 1534	Front, first floor	Largely open, rural views over marsh. Traffic on Acle Straight forms a prominent feature within the view.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Herringby Cottages	2 storey, brick semi-detached houses	1592	2: 1599 2A: 1599	Front, first floor	Largely open, rural views over marsh. Traffic on Acle Straight forms a prominent feature within the view.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Dove House Farm	2 storey, brick detached house	1308	2: 1315 2A: 1315	Rear, ground & first floor	Largely open, rural views over marsh. Traffic on Acle Straight forms a prominent feature within the view.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Parkers Cottage	2 storey, brick detached house	1601	2: 1608 2A: 1608	Rear, first floor	Largely open, rural views over marsh. Traffic on Acle Straight forms a prominent feature within the view.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Marshwall Cottage, Runham	2 storey, brick & flint, semi-detached house	1733	2: 1740 2A: 1740	Rear, first floor in winter	Rural views. Vegetation along the rear boundary restricts most views in summer & filters in winter.	No perceptible difference.	Neutral	Neutral
No. 2, Runham (adj. to Marshwall Cottage)	2 storey, brick & flint, semi-detached house	1730	2: 1737 2A: 1737	Rear, first floor in winter	Rural views. Vegetation along the rear boundary restricts most views in summer & filters in winter.	No perceptible difference.	Neutral	Neutral
Marsh House, Runham	Low 2 storey, brick & white rendered detached house	1712	2: 1719 2A: 1719	Rear, first floor in winter	Rural views. Vegetation along the rear boundary restricts most views in summer & filters in winter.	No perceptible difference.	Neutral	Neutral
6 Mile House	2 storey, brick detached house. Built heritage site	972	2: 979 2A: 979	Front, first floor	Boundary vegetation largely contains views, but more open in winter, when the traffic on Acle Straight becomes prominent in views.	Little noticeable difference in view to south during summer. Increased traffic flow on Acle Straight would become more apparent during winter.	Slight Adverse	Neutral
6 Mile	Brick wind	923	2: 930	Setting	Open, expansive, rural views over River	Barely perceptible effect on views due	Slight Adverse	Slight Adverse

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
House Drainage Mill	pump – no roof or sails. Grade II listed building.		2A: 930		Bure and marsh. Traffic on Acle Straight is a prominent feature in views.	to the open, rural nature of the existing view and increase in moving traffic.		
Manor Farm House, Runham	Large, 2 storey, brick detached house	1827	2: 1834 2A: 1834	Side –south elevation first floor	Views largely contained by trees and scrub on the garden boundary. Filtered and oblique views of Acle Straight in winter.	No change.	Neutral	Neutral
Runham Drainage Mill	Black painted brick wind pump, timber elements in place – no sails. Grade II listed building.	1061	2: 1068 2A: 1068	Setting	Wide, expansive, open rural views over River Bure and marsh. Traffic on Acle Straight forms prominent elements in the setting.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Runham Swim Drainage Mill	Black painted brick wind pump – no sails. Grade II listed building.	952	2: 959 2A: 959	Setting	Wide, expansive, open rural views over River Bure and marsh. Traffic on Acle Straight forms prominent elements in the setting.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Five Mile House	1 storey house and built heritage site	914	2: 921 2A: 921	Rear views - ground floor & setting	Wide, expansive, open rural views over River Bure and marsh. Traffic on Acle Straight forms prominent elements in the setting.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Five Mile House Drainage Mill	Black painted brick wind pump – no sails. Listed building.	924	2: 931 2A: 931	Setting	Wide, expansive, open rural views over River Bure and marsh. Traffic on Acle Straight forms prominent elements in the setting.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Marsh Farm,	2 storey,	1601	2: 1608	Rear, first	Rear view partially contained by conifer	No perceptible difference.	Neutral	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Runham	rendered detached house		2A: 1608	floor	hedge – oblique views to SW.			
The Old Chapel, Runham	Brick chapel converted to a 2 storey detached house	1905	2: 1912 2A: 1912	Front, first floor	Broken rural view over marsh. Traffic on the Acle Straight perceptible within the view.	No perceptible difference.	Neutral	Neutral
Hilton House, Runham	2 storey, brick detached house	1908	2: 1915 2A: 1915	Rear, first floor	Adjacent vegetation partially restricts rural views over the marsh. Traffic on the Acle Straight perceptible within view.	No perceptible difference.	Neutral	Neutral
No. One, Runham	2 storey, brick detached house	1897	2: 1904 2A: 1904	Front, ground & first floor	Adjacent vegetation moderately restricts, rural views over the marsh. Traffic on the Acle Straight perceptible within the view	No perceptible difference.	Neutral	Neutral
Whitegate House, Runham	2 storey, brick detached house	1807	2: 1814 2A: 1814	Front, first floor	Filtered views through adjacent hedge and trees of rural views over the marsh, during winter.	No perceptible difference.	Neutral	Neutral
Pink house, Runham	2 storey semi-detached, rendered house	1794	2: 1801 2A: 1801	Front, first floor	Open, rural views over the marsh. Traffic on the Acle Straight perceptible within the view.	No perceptible difference.	Neutral	Neutral
White house, Runham	2 storey semi-detached, rendered house	1790	2: 1797 2A: 1797	Front, first floor	Open, rural views over the marsh. Traffic on the Acle Straight perceptible within the view.	No perceptible difference.	Neutral	Neutral
Rookery Farm, Runham	2 storey brick detached house	1798	2: 1805 2A: 1805	Side – south elevation first floor	Open, rural views over the marsh. Traffic on the Acle Straight perceptible within the view.	No perceptible difference.	Neutral	Neutral
Rookery Cottage, Runham	2 storey, white rendered detached	1797	2: 1804 2A: 1804	Front, first floor	Broken, rural views over the marsh, partially contained by adjacent trees/hedge. Traffic on the Acle Straight	No perceptible difference.	Neutral	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
	house				perceptible.			
Decoy Farm	Large, 2 storey brick detached house	1961	2: 1968 2A: 1968	Rear, first & probably ground floor	Open, expansive rural views over the marsh. Traffic on the Acle Straight forms a perceptible feature in the view.	No perceptible difference.	Neutral	Neutral
Mautby Windmill or Mautby Marsh Drainage Mill	Restored, brick wind pump + white rendered $1^1/_2$ storey extension. Grade II listed building.	1000	2: 1007 2A: 1007	One, front first storey view & setting	Views largely contained by the River Bure levees, with limited view of marsh and traffic on the Acle Straight, beyond.	No perceptible difference.	Neutral	Neutral
Ashtree Farm Drainage Mill	Grade II listed building	582	2: 589 2A: 589	Setting	Open, expansive views over the River Bure, adjacent grazing marsh, but also with clear views of the Acle Straight and traffic.	Perceptible increase in awareness of traffic and new carriageway.	Slight Adverse	Slight Adverse
111 Caister Road, Great Yarmouth	2 storey, white rendered detached house	978	2: 985 2A: 985	Rear, first floor	Views over the River Bure and marsh beyond. Traffic on the Acle Straight forms a perceptible feature in the view.	No perceptible difference.	Neutral	Neutral
115 Caister Road, Great Yarmouth	$1^1/_2$ storey, white & green rendered detached house	1005	2: 1012 2A: 1012	Rear, dormer windows, first floor	Views over the River Bure and marsh beyond. Traffic on the Acle Straight forms a perceptible feature in the view.	No perceptible difference.	Neutral	Neutral
117, 119, 121, 123 & 125 Caister Road, Great Yarmouth	2 storey, brick detached house	1021 to 1070	2: 1028 to 1077 2A: 1028 to 1077	Rear, first floor	Views over the River Bure and marsh beyond. Traffic on the Acle Straight forms a perceptible feature in the view.	No perceptible difference.	Neutral	Neutral
6,12,13,14, 15,16, 17 &	2 storey, brick and false	1069 to 1151	2: 1076 to 1158	Rear, first floor	Views over the River Bure and marsh beyond. Traffic on the Acle Straight	No perceptible difference.	Neutral	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
18 River Walk, Great Yarmouth	Tudor detached house		2A: 1076 to 1158		forms a perceptible feature in the view.			
Vauxhall Caravan Park, Great Yarmouth	Caravan Park with a number of 2 storey chalets and 1 storey caravans + facility buildings & play area	9	2: 16 2A: 16	Views mainly from one chalet and play area	Views largely internal, but also include peripheral areas, such as the Euro-Centre Industrial Estate, grazing marsh and the Acle Straight. The latter is a dominant feature only to one of chalets & play area, otherwise little change.	Perceptible increase in awareness of traffic from one chalet and play area offset by decrease in visibility for chalets/caravans at eastern end of site due to environmental barrier.	Slight Adverse	Slight Adverse
World War 1 Pillbox (1)	SMR listed feature	92	2: 99 2A: 99	Views to west, south and east	Views of grazing marsh and Great Yarmouth, but heavily dominated by Acle Straight and its traffic.	Due to the very close proximity of the pillbox, the new access track would become a prominent feature, as well as there being an increased awareness of traffic.	Substantial Adverse	Substantial Adverse
World War 1 Pillbox (2)	SMR listed feature	17	2: 10 2A: 10	Views to west, south and east	Views of grazing marsh and Great Yarmouth, but heavily dominated by Acle Straight and its traffic.	The pillbox is in the line of the new carriageway with both Options and would have to be demolished or relocated.	Property in line of route	Property in line of route
Falklands Farm (low sensitivity)	Corrugated barns	202	2: 195 2A: 195	Views to the north	Collection of barns with views over Acle Line, grazing marsh, and the Acle Straight and its traffic.	Perceptible awareness in the increase in traffic flow and additional carriageway.	Slight Adverse	Slight Adverse
Scaregap Cottages, No.1	2 storey, brick, semi-detached houses	41	2: 48 2A: 48	Front, ground & first floor views	Situated immediately adjacent to Acle Straight, to which it and its traffic dominate views from the front of the house.	Due to the very close proximity of the road to the house, the new carriageway, new access track & nearby access track junction would become a prominent feature, as well as there being an increased awareness of the speed and volume of traffic.	Substantial Adverse	Substantial Adverse

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Scaregap Cottages, No. 2	2 storey, brick, semi-detached houses	41	2: 48 2A: 48	Front, ground & first floor views	Situated immediately adjacent to Acle Straight, to which it and its traffic dominate views from the front of the house.	Due to the very close proximity of the road to the house, the new carriageway, new access track & nearby access track junction would become a prominent feature, as well as there being an increased awareness of the speed and volume of traffic.	Substantial Adverse	Substantial Adverse
Scaregap Farm (low sensitivity)	Corrugated barns	517	2: 524 2A: 524	Views to the south	Collection of barns with views over Acle Line, grazing marsh, and the Acle Straight and its traffic.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
Britannia Farm (low sensitivity)	Corrugated barns	193	2: 186 2A: 186	Views to the north	Collection of barns with views over grazing marsh. Filtered views through boundary vegetation of Acle Line and the Acle Straight and its traffic.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic. Vegetation screens views in summer.	Slight Adverse	Neutral
Kerrisons Level (Keys Mill) Drainage Mil	Restored wind pump, tarred brick tower & weather board cap. Grade II listed building	394	2: 387 2A: 387	Setting	Views over grazing marsh, Acle Line and Acle Straight and its traffic, the latter two being partially obstructed by Kerrisons Level.	Perceptible effect on views to the north due the increase in flow and speed of traffic.	Slight Adverse	Slight Adverse
Sracey Arms Mill House/ Farm (Mill Shop)	1 storey, pink rendered shop/house	36	2: 43 2A: 43	Views to the south	Attractive views to the north, overlooking River Bure and grazing marsh. In contrast, views to the south have been heavily disturbed and dominated by the Acle Straight and its traffic, Acle Line, and the Branch Road bridge crossing of the Acle Line.	Due to the very close proximity of the proposals to the house, the new carriageway and access tracks would become prominent features, as well as there being an increased awareness of flow and speed of traffic.	Substantial Adverse	Substantial Adverse
Stacey Arms Drainage Mill	Brick towered windpump with weather board cap & sails.	43	2: 50 2A: 50	Setting	Attractive views to the north, overlooking River Bure and grazing marsh. In contrast, views to the south have been heavily disturbed and	Due to the very close proximity of the proposals to the house, the new carriageway and access tracks would become prominent features, as well as	Substantial Adverse	Substantial Adverse

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
	Grade II listed building				dominated by the Acle Straight and its traffic, Acle Line, and the Branch Road bridge crossing of the Acle Line.	there being an increased awareness of flow and speed of traffic.		
The Pontiac Public House	1 storey building. Site of Seven Mile House – built heritage site	27	2: 34 2A: 34	& setting	Attractive views to the north, overlooking River Bure and grazing marsh. In contrast, the main views are to the south have been heavily disturbed and dominated by the Acle Straight and its traffic, Acle Line, and the Branch Road bridge crossing of the Acle Line.	Due to the very close proximity of the proposals to the house, the new carriageway and access tracks would become prominent features, as well as there being an increased awareness of flow and speed of traffic. New planting would help filter views during the summer once established	Substantial Adverse	Substantial Adverse
Tunstall Dyke Drainage Mill	Brick towered windpump, tar painted with roof. Grade II listed building	383	2: 393 2A: 390	Setting	Attractive setting of the Tunstall Dyke, grazing marsh, but also including views of the Acle Line and Acle Straight and traffic.	Perceptible effect on views to the north due the increase in flow and speed of traffic. The proposed planting along the Acle Straight would provide a minor benefit by filtering views of traffic in summer but insufficient to alter scale of impact.	Slight Adverse	Slight Adverse
Tunstall Dyke Smock Mill	White timber smock type windpump. Corrugated iron shack-type extension. Grade II listed building.	351	2: 361 2A: 359	Setting	Attractive setting of the Tunstall Dyke, grazing marsh, but also including views of the Acle Line and Acle Straight and traffic.	Perceptible effect on views to the north due the increase in flow and speed of traffic. The proposed planting along the Acle Straight would provide a minor benefit by filtering views of traffic in summer but insufficient to alter scale of impact.	Slight Adverse	Slight Adverse
Lockgate Drainage Mill		1784	2: 1777 2A: 1777	Setting	Attractive setting incorporating Breydon Water and grazing marsh. Traffic on Acle Straight is a distant but perceptible feature within views.	No perceptible difference.	Neutral	Neutral

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Howard's Drainage Mill	Brick towered windpump. Listed building	1677	2: 1670 2A: 1670	Setting	Attractive setting incorporating Breydon Water and grazing marsh. Traffic on Acle Straight is a distant but perceptible feature within views.	No perceptible difference.	Neutral	Neutral
High's Drainage Mill	Tower mill. Listed building	1761	2: 1754 2A: 1754	Setting	Attractive setting incorporating Breydon Water and grazing marsh. Traffic on Acle Straight is a distant but perceptible feature within views.	No perceptible difference.	Neutral	Neutral
1 Staithe Road, Tunstall	2 storey, brick and white rendered, semi-detached house	1572	2: 1582 2A: 1579	Front, first floor views	Attractive views overlooking grazing marsh to north-east. Traffic on Acle Straight is a distant but perceptible feature within views.	No perceptible difference.	Neutral	Neutral
3 Staithe Road, Tunstall	2 storey, brick and white rendered, semi-detached house	1618	2: 1628 2A: 1625	Front, first floor views	Attractive views overlooking grazing marsh to north-east. Traffic on Acle Straight is a distant but perceptible feature within views.	No perceptible difference.	Neutral	Neutral
Lower Farm, Tunstall	Barns and farmyard	1258	2: 1268 2A: 1265	Views to the north	Collection of barns with views to the north over grazing marsh, including traffic on Acle Straight.	No perceptible difference.	Neutral	Neutral
1, 2, 3 & 4 Lower Farm Road, Tunstall	2 storey, brick, semi-detached houses	1448 to 1474	2: 1458 to 1484 2A: 1455 to 1481	Front, first floor views	Attractive views overlooking grazing marsh to north-west. Traffic on Acle Straight at times is a notable feature within views.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
1 Marsh Road, Tunstall	2 storey, brick, terraced house	1542	2: 1552 2A: 1549	Rear, first floor views	Attractive views overlooking grazing marsh to north-east. Traffic on Acle Straight at times is a notable feature within views.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse
2 Marsh Road,	2 storey, brick, terraced house	1547	2: 1557	Rear, first floor views	Attractive views overlooking grazing marsh to north-west. Traffic on Acle	Barely perceptible effect on views due to the open, rural nature of the existing	Slight Adverse	Slight Adverse

Property	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter	Visual Effect of Road After 15 Years (Summer)
Tunstall			2A: 1554		Straight at times is a notable feature within views.	view and increase in moving traffic.		
3 Marsh Road, Tunstall	2 storey, brick, terraced house	1551	2: 1561 2A: 1558	Rear, first floor views	Attractive views overlooking grazing marsh to north-west. Traffic on Acle Straight at times is a notable feature within views.	Barely perceptible effect on views due to the open, rural nature of the existing view and increase in moving traffic.	Slight Adverse	Slight Adverse

Public Recreation/Linear Routes
(High sensitivity, except where stated)

Public Open Space/ Linear Route	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter)	Visual Effect of Road After 15 Years (Summer)
Stokesby Village Green		1143	2: 1133 2A: 1136	Views to the S, particularly near R. Bure	Very attractive setting within this pretty village with excellent views over the River Bure and marsh. Traffic on Acle Straight seen in the mid-distance, as small to moderate scaled features.	Little perceptible difference, however due to the open, rural nature of the existing view, the increase in traffic and movement, would increase the adverse effect.	Slight Adverse	Slight Adverse
Footpath to the Church of St Andrew, Stokesby	Public footpath	1186 - 1351	2: 1176 – 1341 2A: 1170 - 1344	Views to the south	Views largely contained by hedge along Runham Road, except near the church, where there are views over the rural countryside, including the marshes. Traffic on Acle Straight is perceptible.	No perceptible difference.	Neutral	Neutral
River Bure levees & Acle Dyke	Public footpath	73 – 1304	2: 80 – 1294 2A: 80 - 1297	Views to SE, S & SW	Two footpaths, either side of the river, on the levees, follow the meandering route, essential E-W + a small length of footpath along the Acle Dike. Very	There would be little perceptible difference in views, except where the footpaths come close to the Acle Straight at Halvergate Junction and	Neutral to Substantial Adverse	Neutral to Substantial Adverse

Public Open Space/ Linear Route	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter)	Visual Effect of Road After 15 Years (Summer)
					attractive views along the river & adjacent marshes. The traffic on the Acle Straight is usually visible, varying in prominence depending on proximity of the footpaths to the road.	Scaregap Cottages, where the new carriageway, new access tracks and junction improvements would become prominent. Also due to an increased awareness of traffic due to increased flow and speed. Adverse effects partly offset by reduced night-time intrusion due to new road lighting with reduced sky glow and light spillage. In summer limited screening near Halvergate Junction and Scaregap provided by new planting once established would filter some views of traffic.		
River Bure & Acle Dike	Boat traffic on river (almost entirely recreational)	103 – 1187	2: 110 – 1177 2A: 110 - 1180	Views to SE, S & SW	The river follows a meandering route, essential E-W, with a short arm to Acle along the Acle Dike. Boats often float below the height of the adjacent levees, restricting views to river corridor. However, on more elevated boats and when standing, very attractive views are available over the adjacent marshes. The traffic on the Acle Straight is usually visible, varying in prominence depending on proximity of the footpaths to the road.	There would be little perceptible difference in views, except where the river comes close to the Acle Straight at Halvergate Junction and Scaregap Cottages, where the new carriageway, new access tracks and junction improvements would become prominent. Also due to an increased awareness of traffic due to increased flow and speed. Adverse effects partly offset by reduced night-time intrusion due to new road lighting with reduced sky glow and light spillage. In summer limited screening near Halvergate Junction and Scaregap provided by new planting once established would filter some views of traffic.	Neutral to Substantial Adverse	Neutral to Substantial Adverse
River Yare	Boat traffic on river (almost	520 - 2000	2: 527 – 2000	Views to N & NW	Views are predominantly of the river corridor and Breydon Water, with Great	Nearest part of scheme to river is elevated section at approach to	Neutral	Neutral

Public Open Space/ Linear Route	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter)	Visual Effect of Road After 15 Years (Summer)
	entirely recreational) + feature of historic interest		2A: 527 - 2000		Yarmouth becoming a greater influence in views on approaching travelling from the south-west. The Acle Straight and its traffic also become more apparent in views.	Vauxhall roundabout. This would be screened by new environmental barrier. Elsewhere barely perceptible effect on views due to increase in moving traffic.		
Recreation Ground, Great Yarmouth	Public open space	1180 – 1728	2: 1187 – 1735 2A: 1187 - 1194		Views are mainly focused within the recreation area, although views are afforded to the south-west over the River Bure and grazing marsh, with the Acle Straight and its traffic beyond.	Barely perceptible effect on some views due to increase in moving traffic.	Slight Adverse	Slight Adverse
Paddys Loke	Public footpath	11 – 380	2: 18– 387 2A: 18 - 387	Views to SE, S & SW	Set on the edge of Great Yarmouth, views are dominated by the urban fringe elements, as well as the Acle Straight and its traffic. The River Bure and grazing marsh are also prominent features.	Construction of access tracks and new carriageway would create a prominent feature close to, as well as there being awareness of an increase in traffic. The proposed planting would provide minmal benefits.	Moderate to Substantial Adverse	Moderate to Substantial Adverse
Weaver's Way	Public footpath	8 – 2000	2: 9 – 2000 2A: 9 - 2000	Various	A long distance footpath, which enters the VEM to the NW following the River Bure, travelling south across Acle Straight to follow the grazing marsh fringe, and then cross the marshes to follow the margins of Breydon Water. A variety of very attractive views are afforded over much of the wide expansive Broads and its fringes.	Over much of the Way, there would be a barely perceptible difference, due to the increased traffic flow and movement within this expansive & open landscape. However, the changes become far more prominent, where the Way approaches and crosses the Acle Straight, near Acle. The new carriageway, access tracks and increased traffic flow would become prominent and even dominant features. Proposed planting at the Acle end would provide a noticeable benefit in reducing the visibility of traffic.	Largely Slight Adverse, becoming or Moderate Adverse near to Acle Straight	Largely Slight Adverse, becoming or Moderate Adverse near to Acle Straight
Tunstall Dyke levees	Public footpath	0 – 1157	2: 9 – 1167	Various	The footpaths follow the Tunstall Dyke, which lies close to and crosses the Acle	New carriagway and access tracks would create a prominent feature close	Moderate to Substantial	Slight to Substantial

Public Open Space/ Linear Route	Type	Distance to Existing Road (m)	Distance to Proposed Road (m)	View Affected	Nature of Existing View	Nature of Proposed View	Visual Effect of Road After First Year (Winter)	Visual Effect of Road After 15 Years (Summer)
			2A: 9 - 1164		Line and Acle Straight and traffic, and thus is dominated by them in views, particularly the latter.	to paths. Also there would be an increased awareness of traffic. The proposed planting would provide minimal benefits in summer, by filtering views of the traffic to west.	Adverse (section of Neutral to south)	Adverse (section of Neutral to south)
Norwich – Great Yarmouth Railway (Via Acle) (Low sensitivity)	Railway & linear historic feature	33 - 180	2: 26 – 190 2A: 26 - 187	Views to NW, N, NE & setting	Views over the extensive, open grazing marsh, but dominated to the north by the Acle Straight and its traffic.	The introduction of a new carriageway, particularly from Halvergate Junction to Great Yarmouth would be a prominent feature in views, combined with new access tracks, access track junctions, and the roundabout at Halvergate junction and a greater awareness of an increase in traffic flow.	Moderate Adverse	Moderate Adverse
Norwich – Great Yarmouth Railway (Via Runham) (Low sensitivity)	Railway & linear historic feature	143 – 2000	2: 136 – 2000 2A: 136 - 2000	Views to NW & N & setting	Views over the extensive open grazing marshes and on approaching Great Yarmouth, views to the east and south over Breydon Water. The traffic on Acle Straight only becomes noticeable on approaching and joining the line via Acle.	Little perceptible difference over much of line, but new carriageway and increased awareness of traffic flows, would be more perceptible close to the intersection of lines.	Neutral to Slight Adverse	Neutral to Slight Adverse

Hyder Consulting

Appendix 10 Cultural Heritage

Appendix 10.1 List of Documents Consulted

Norfolk Archaeological Unit (1993) Report of an evaluation at A47 Acle Straight

Norfolk Archaeological Unit (2000) A47 Multi Modal Study Desk Top Archaeological Survey

Unpublished Historic Landscape Character Assessment (Broads Authority)

Williamson (1997) The Norfolk Broads: A Landscape History. Manchester University Press

Hyder Consulting

Appendix 11 Air Quality

Appendix 11.1 References

1 Highways Agency, 1994, Design Manual for Roads and Bridges, Volume 11, Part 3, Section 1 Air Quality (February 2003).

2 Defra, 2000, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, HMSO

3 Defra, 2003, LAQM PG(03): Policy guidance: Local air quality management .

4 Defra, 2003, LAQM TG(03): Technical Guidance: Local air quality management

5 NETCEN, 2003, Local Air Quality Management Website, http://www.airquality.co.uk/archive/laqm/laqm.php

6 Great Yarmouth Borough Council, 2000, Stage 2 Local Air Quality Review and Assessment.

7 Highways Agency, 1994, Design Manual for Roads and Bridges, Volume 11, Part 3, Section 3 Disruption due to Construction

8 NSCA, 2002, Clean Air and Environmental Protection; *Measurements of PM_{10} Emissions from a Construction Site – A Case Study, Upton, S and Kikadia, V*, Vol 32, No.3, Autumn 2002

9 CIRIA, 1999, CIRIA C 502 Environmental Good Practice on Site, CIRIA.

10 Broadlands District Council, Personal Contact.

Appendix 11.2 Pollutants and their Effects

This Section describes the main traffic related pollutants as identified in the NAQS and their main impacts on humans and ecosystems.

Benzene

The main source of benzene in ambient air is from vehicle exhaust fumes. Its industrial sources include stack emissions during its production, and it is also used in the manufacture of other chemicals used in foams, fibres, coatings, detergents solvents and pesticides.

Benzene is a proven carcinogen, and has a causal association with acute non-lymphocytic leukaemia in humans. The main toxic effects of benzene occur in bone marrow, with toxic exposures reducing bone marrow and the production of red and white blood cells and platelets.

It is suggested that a lifetime exposure to 1µg/m^3 of benzene would cause an extra 3-30 cases of acute non-lymphocytic leukaemia per million population. It is therefore considered that the risk of leukaemia from ambient benzene exposure is so small as to be immeasurable.

1,3-Butadiene

1,3-Butadiene is mainly derived from road transport, and forms during combustion. Emissions also arise as stack and fugitive emissions from its manufacture and in the chemical industry.

Research is consistent in showing 1,3-butadiene to be a carcinogen, and has been linked with lymphomas and leukaemia through long-term exposure. 1,3-butadiene has also been shown to act indirectly through derived chemicals in the body on the genetic material of cells and react with haemoglobin.

Carbon Monoxide

Carbon Monoxide (CO) is a colourless, odourless gas formed by the incomplete combustion of carbon based fuels and is an indirect greenhouse gas. Road transport is responsible for a significant proportion of total emissions of CO. Other sources include gas domestic appliances and cigarette smoke.

Carbon monoxide is rapidly absorbed by the blood and thereby reduces the ability of red blood cells to transport oxygen around the body and blocks

essential biochemical reactions in cells. In very high doses it is fatal due to cerebral and cardiac hypoxia, and poisoning can lead to brain damage in people who recover. At low doses CO may affect higher cerebral function, heart function and exercise capacity, which are all sensitive to blood oxygen content.

It is a relatively stable compound that takes part only slowly in atmospheric chemical reactions. It contributes indirectly to the greenhouse effect by depleting atmospheric levels of hydroxyl radicals and thus slowing the destruction of methane, which is a powerful greenhouse gas. It also has an impact on vegetation, is observed to be phytotoxic and causes discolouration of plant leaves.

Nitrogen Dioxide

All combustion processes in air produce oxides of nitrogen. Nitrogen dioxide (NO_2) and nitric oxide (NO) are both oxides of nitrogen and together are referred to as NO_x. It is NO_2 which is associated with adverse effects on human health. Almost half of all NO_2 emissions are from road vehicles, with other sources including power stations and combustion processes.

The oxidising properties of NO_2 mean that it has the potential to damage lung tissue. At high doses, it can cause acute inflammation of the airways and might predispose people to respiratory infections. Animal studies have also linked NO_2 to impaired immunity, although this was at levels far exceeding ambient concentrations.

Long-term exposure may increase susceptibility to allergens and may affect lung function. NO_2 may have long-term effects in people with asthma, though the lowest level at which NO_2 has been consistently shown to affect people with asthma is 564µg/m³; well above the average ambient levels of 38µg/m³ in the UK. Furthermore, animal studies suggest that high concentrations may lead to lung fibrosis and emphysema.

NO_2 also has a climatic impact, and can combine with SO_2 and O_3 to form acid rain.

Particulate Matter

Particulate matter is composed of a wide range of materials arising from a variety of sources. Particulate matter is typically assessed as total suspended particulates or as a mass size fraction. The Air Quality (England)(amendment) Regulations (2002) has adopted the PM_{10} standard for the assessment of fine particulate matter. This expresses particulate

levels as the total mass size fraction at or below an aerodynamic diameter of 10 μm.

There are two main groups of particulate matter: primary and secondary. Road vehicles emit about a quarter of the primary particle air pollution in the UK. Primary particles can also be derived naturally, for example through soil and rock erosion, pollen, fungal spores or by anthropogenic activities like stack emissions and solid fuel combustion as well as vehicle exhaust fumes. Secondary particles are formed in the atmosphere, primarily by gas to particle conversion within cloud droplets.

PM_{10} have a diameter of less than 10 μm and are more likely to be deposited in the lung, whereas larger particles rest in the nose, throat or airways of the lung. Particulate air pollution can be associated with a range of effects on health including effects on the respiratory and cardiovascular systems, asthma and increase in mortality. Although the precise mechanism by which particles damage health remains unclear studies have shown relationships between various indices of ill health and measurements of particle concentrations. However, there remains considerable uncertainty about the precise nature of these effects.

The abrasive qualities of airborne particulates can also degrade painted surfaces, and block ventilation systems of buildings and vehicles.

Appendix 11.3 Construction Dust

Summary

Dust is defined in BS6069 as particulate matter in the size range 1 - 75 µm in diameter. Dust is dispersed by the wind, smaller particles remaining airborne for longer and dispersing more widely. Stronger winds may support larger particles, but these would normally be returned to the surface at faster rates. Research undertaken to date is not conclusive in regard to the distances travelled by dust.

A study undertaken to determine the impacts of construction dust found that no increases in PM_{10} concentrations attributable to activities at the (construction) site could be detected at the downwind monitoring station (about 150m away).

The dust emissions can be considered in terms of nuisance, or as a health risk.

Dust is of principal concern during demolition and construction activities. The severity of dust impacts is weather dependent, with increased emissions during dry and windy conditions. The type of topsoil, construction activity, transport modes, storage location, number and movements of the material also affect dust.

Dust emissions are significant as a result of their potential health impacts. Airborne particulate matter may pose a health risk if respired, although the chemical composition would determine the potential risk. Fine particles have been linked with a number of respiratory conditions, cardiac conditions and increases in mortality. Coarse particles deposit onto buildings and other surfaces could be a source of nuisance.

Nuisance

Problems with the implementation of any deposited dust nuisance standards in the UK arise from inherent differences in the efficiency of dust collection devices, a lack of survey information on the perception of dust nuisance, the level of dust at which an impact can occur, the limited consistent data on UK dust deposition, the wide variability in dust emissions which may be found, and the subjective nature of the perception of dust nuisance. There are no agreed standards or guidelines for the nuisance impact of deposited dusts in the UK.

Dust deposition and/or ambient dust concentrations are extremely variable and will depend not only on the location and emissions concentrations at source, but also on receptor location and meteorological conditions. Dust nuisance is often characterised by a few or occasional dusting events (relatively high concentrations of dust deposition potentially caused by particular emissions sources and particular combinations of wind and rainfall conditions).

Dust deposition will be dependent on local sources, in terms of activities and distance from monitoring locations, and prevailing meteorological conditions. For this reason dust collection over short periods has the potential to over or underestimate impact, dependent on both those potential dust generating activities and weather conditions during the monitoring period. Consequently, long term dust monitoring in terms of total deposition and directionality is recommended to fully describe background levels and deposition patterns.

Health

Particulate matter is typically assessed as total suspended particulates or as a mass size fraction. The National Air Quality Strategy has adopted the PM_{10} standard for the assessment of fine particulate matter. This expresses particulate levels as the total mass size fraction at or below an aerodynamic diameter of 10 µm. Particles of this size and below have the greatest likelihood of penetrating deep into the lungs.

Health effects of PM_{10} are largely linked with the worsening of pre-existing conditions. For instance, there is no evidence that PM_{10} exposure can cause asthma but its effects can lead to periods of increased morbidity during periods of high particulate concentrations. Increases in mortality rates from heart and lung disease on exposure to different levels of PM_{10} have been measured to be 1.4% and 3.4% per 10 µg/m^3 respectively, although the impact on heart disease-related fatalities has a greater impact on the population as heart disease accounts for 45% of deaths while lung disorders cause only 5% of deaths.

Hyder Consulting

Appendix 12 Traffic Noise and Vibration

Appendix 12.1 Terminology

ACOUSTIC TERMINOLOGY

A Weighting

Sound pressure levels recorded on a sound level meter incorporating an 'A' weighting network of filters are denoted L_{PA} and are measured in dBA. 'A' weighting filters have a reduced response to low and very high frequency sound in order to simulate the non-linear response of the human ear.

Decibel (dB)

A unit of level derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 μPa, the threshold of normal hearing is in the region of 0 dB, and 140 dB is the threshold of pain. A change of 1 dB is only perceptible under controlled conditions.

dBA

Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of a different frequency (pitch) in a similar way to the human ear. Measurements in dBA broadly agree with people's assessment of loudness. A change of 2-3 dBA is the minimum perceptible under normal conditions, and a change of 10 dBA corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30-40 dBA; normal conversation about 60 dBA at 1 metre; heavy road traffic about 80 dBA at 10 metres; the level near a pneumatic drill about 100 dBA.

Free Field

A sound field which is free from reflecting surfaces.

$L_{A10(T)}$

The A weighted level of noise exceeded for 10 per cent of the specified measurement period (T). It gives an indication of the upper limit of fluctuating noise such as that from road traffic. $L_{A10,\ 18\ hr}$ is the arithmetic average of the 18 hourly L_{A10} hourly values from 0600 to 2400.

$L_{A90(T)}$

The A weighted level of noise exceeded for 90 per cent of the specified measurement period (T). It is often referred to as a measure of the background noise level and is specified by BS4142.

$L_{Aeq(T)}$

The equivalent continuous sound level, L_{eq}, is the notional steady sound level which over the measurement period T would deliver the same amount of sound energy as the actual fluctuating level. Hence fluctuating levels can be described in terms of a single sound level over the same exposure period. The L_{eq} is normally expressed in dBA, hence L_{Aeq} over the period T giving $L_{Aeq(T)}$.

Noise

Sound that is undesired by the recipient.

Sound Exposure Level (SEL)

The SEL is a measure of the total sound energy from a single event or activity. It is the level which if maintained constant for a period of 1 second, would cause the same sound energy to be received as is actually received from the single event or activity.

Sound Power Level (L_W or L_{WA})

The sound power level of a source is the quantity of sound energy emitted by the source per second in Watts to a reference level of 1 pW. If the sound power of the source is determined using the 'A' weighting filter, then it is denoted L_{WA} (dB). The sound power level of a source is a single figure definition of the sound generating ability of that source.

Sound Pressure

A fluctuating pressure superimposed on the static pressure by the presence of sound.

Sound Pressure Level

The sound pressure level of a sound, in decibels, is equal to 20 times the logarithm to the base 10 of the ratio of the RMS (root mean square) sound pressure to the reference sound pressure (20μPa).

Sound Propagation

The wave process whereby sound is transferred from one part of a medium to another.

Sound Transmission

The transfer of sound energy from one medium to another. The sound transmission loss is commonly referred to as the difference in airborne sound power incident on a partition, or element of a building envelope, and transmitted by the partition and radiated on the other. This quantity is expressed in decibels (dB).