# A14 Study: Output 3

## Package Testing & Appraisal Report

Department for Transport

**November 2012**

Plan Design Enable

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# Table of contents

# Tables

## Figures

# Appendices (bound separately)



# Acronyms used in this report

| | |
|---|---|
| A14 HAM | A14 Highway Assignment Model |
| BCR | Benefit : Cost Ratio |
| CNB | Cambridge Northern Bypass (A14) |
| $CO_2$ | Carbon dioxide |
| CSRM | Cambridge Sub-Region Model |
| D2/3/4AP | Dual (2/3/4-lane) 'All Purpose Road' |
| DfT | The Department for Transport |
| DIADEM | Dynamic Integrated Assignment & Demand Modelling software |
| EERM | East of England Regional Model |
| EFD | (Former) Ellington to Fen Ditton Scheme |
| ERTF | English Regional Traffic Forecast |
| F2N | Felixstowe to Nuneaton (rail route) |
| GBFM | Great Britain Freight Model |
| HA | The Highways Agency |
| HGV | Heavy Goods Vehicle |
| HLOS | High Level Output Specification |
| HSB | Huntingdon Southern Bypass |
| LARs | Local (parallel) Access Roads |
| LGV | Light Goods Vehicle |
| $NO_x$ | Oxides of nitrogen |
| NPV | Net Present Value |
| NTM | National Transport Model |
| PCU | Passenger Car Unit |
| $PM_{10}$ | Particulate matter with average diameter of <10 μm |
| PV | Present Value (of costs or benefits) |
| S2AP | Single carriageway 'All Purpose Road' |
| SPZ | Site Protection Zone |
| SRFI | Strategic Rail Freight Interchange |
| SSSI | Site of Special Scientific Interest |
| TEMPRO | Trip End Model Presentation Program (DfT) |
| TUBA | Transport User Benefit Analysis software |
| WebTAG | DfT Transport Appraisal Guidance |
| WCML | West Coast Main Line |

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# 1. Introduction

## Context and background

1.1. The 2010 Comprehensive Spending Review cancelled the planned implementation of the £1.1 billion A14 Ellington – Fen Ditton scheme (the EFD scheme), as it was deemed unaffordable. As part of the Spending Review the Government set out the following position on the A14:

> *"We recognise that this corridor faces severe congestion, and that mobility along the route is critical for economic success and growth. However, the current scheme is simply unaffordable under any reasonable future funding scenario. The Department has therefore stopped the current scheme.... We will undertake a study to identify cost effective and practical proposals which bring benefits and relieve congestion – looking across modes to ensure we develop sustainable proposals. This approach will also provide an opportunity for the private sector to play its part in developing schemes to tackle existing problems in the corridor..."*

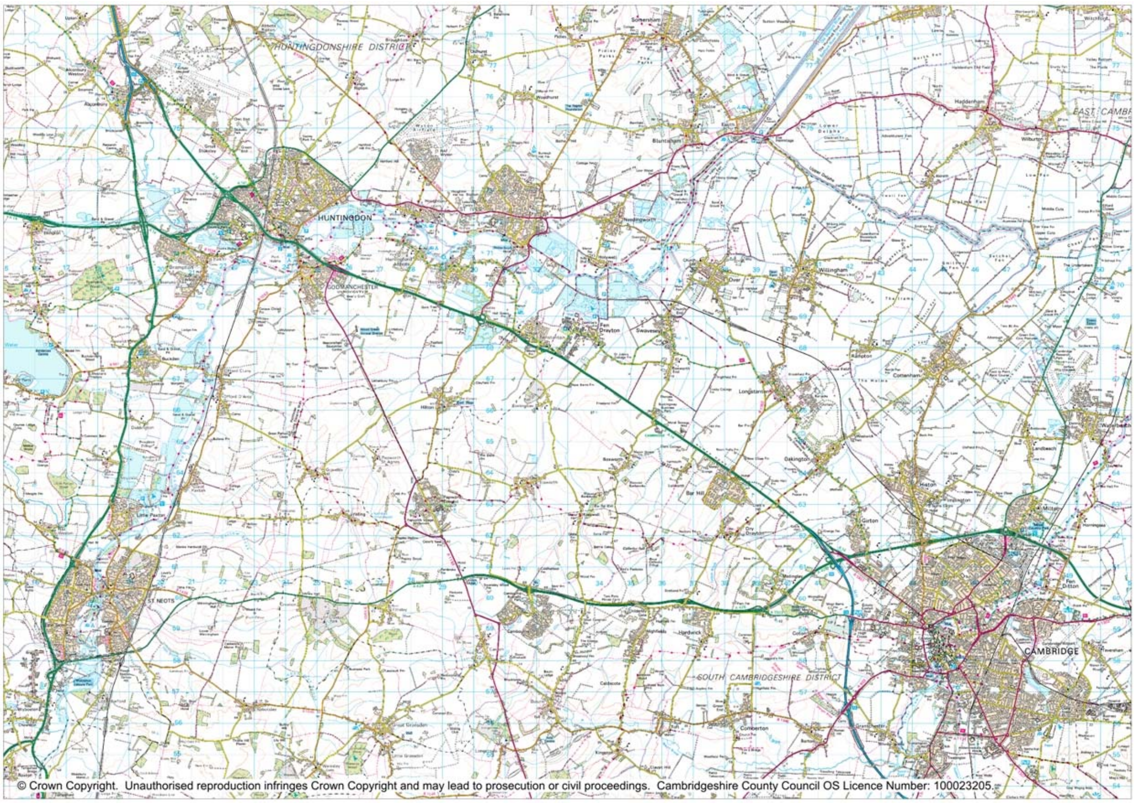
## The A14 Study

1.2. The A14 Study was undertaken in response to this commitment. The study was commissioned in three parts. The objective of each part being as follows:

- Output 1: seek to reconfirm our understanding of the nature, scale and importance of the problems affecting the A14 in the Huntingdon and Cambridge areas, developing a list of prioritised challenges (transport problems, and their consequences);
- Output 2: generate and sift potential interventions and recommend a shortlist; and
- Output 3: develop a multi-modal package of interventions to tackle the prioritised challenges, which is affordable, deliverable and value for money.

1.3. The study was concerned with a core study area and a wider study area. The core study area, as shown in Figure 1, is bounded by Ellington / Alconbury in the north west and Cambridge in the south east. The wider study area was identified to consider freight modal shift opportunities benefiting the core study area; this captures movements between the Haven Ports, London and the South East, to the Midlands and the North via the A14 corridor.

**Figure 1. Core study area**




1.4. This is the report of the A14 Study Output 3. It presents the refinement and appraisal of the public transport package, the freight package and the set of shortlisted highway packages identified in Output 2. It also recommends a preferred composite multi-modal transport package.

1.5. Output 1 reported in December 2011 [1]. It identified priority transport problems and wider challenges in the study area and beyond. The wider challenges informed the subsequent identification of core objectives for the option development and assessment work undertaken during Output 2.

1.6. Output 2 reported through three documents. Identification and initial sifting of a long list of options are presented in the Output 2A Report: Option Generation and Initial Sifting.

1.7. The Output 2B/2C report (Options Recommended for Further Assessment) describes the assessment of the initial freight, public transport and rail freight packages, and the process of identifying the best performing ones. The report recommends a sub-set of those packages for further consideration and more detailed assessment in the next part of the study (Output 3).

1.8. The Output 2D report presents the Strategic Outline Case for those modal packages which were shortlisted for further consideration. These modal packages were assessed further in Output 3 in isolation (to identify the best performing public transport, freight and highway packages) and in combination as part of a multi-modal package.

[1] *Steer Davies Gleave for the Department for Transport (December 2011) A14 Study Output 1 Report*

### Aims and objectives of Output 3

1.9. The aims and objectives of Output 3 of the A14 Study were to:

- undertake a more detailed assessment of highway packages recommended for further investigation in Output 2;
- provide an early indication of whether tolling could raise significant revenue, and what the diversionary impacts might be;
- assess the impacts of the public transport and rail freight packages; and
- assess the leading road options under tolling.

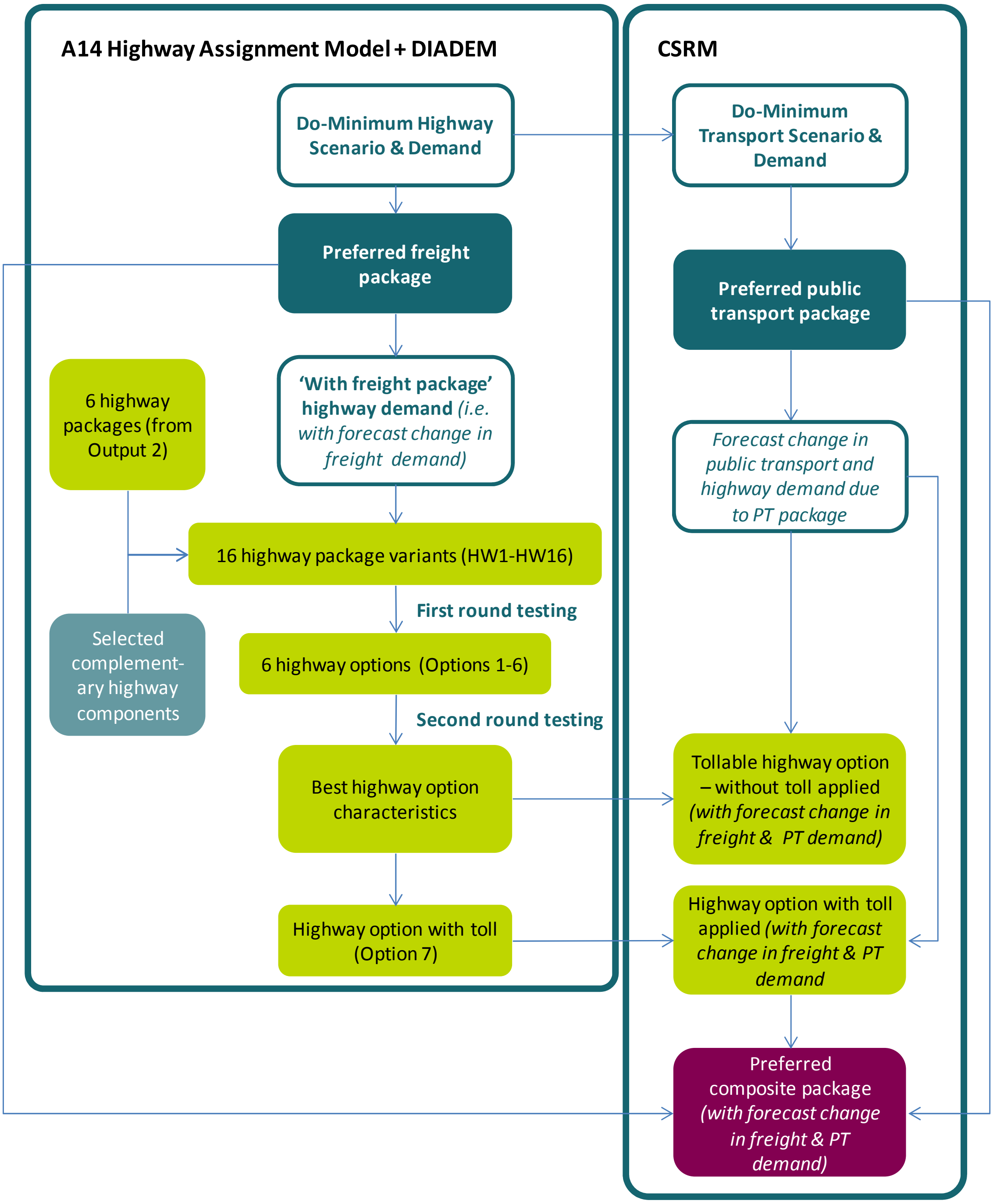
### Output 3 Summary Methodology

1.10. In summary, the approach to achieving the aims and objectives listed above required:

- establishment of an initial Do-Minimum demand scenario (see below);
- refinement of the composition of the public transport package (see Chapter 2);
- derivation of more robust forecasts of the potential demand / mode shift effects of this public transport package (see Chapter 2);
- refinement of the composition of the rail freight package, derivation of impacts and representation of resultant reduction in HGV trips in a revised Do-Minimum highway demand scenario (see Chapter 3);
- refinement of each of the six highway packages shortlisted for further investigation at the end of Output 2 (in terms of additional design detail to allow modelling and costing, and inclusion of selected supplementary components) (see Chapter 4);
- identification of the best-performing highway packages against the agreed transport objectives (see Chapters 5 to 10);
- selection and testing of a highway package with tolling (see Chapter 12);
- an assessment of how the rail freight, public transport and road packages perform together (see Chapter 13).

1.11. This stage of the study applied a systematic process of assessing impacts and performance of the different highway packages using transport models in accordance with the DfT's WebTAG guidance. The modelling approach supporting this methodology is summarised in Figure 2. Key methodological issues are discussed in the following sections.

**Figure 2. Output 3 modelling methodology**




### Highway package selection process

1.12. Figure 2 shows the process by which 16 variants of the six highway packages shortlisted at the end of Output 2 were identified from which the best-performing highway options were identified using two rounds of testing in Output 3; and how a highway option to test with tolling was identified. This sequential process is described in detail elsewhere in this report but can be summarised as follows:

1. The six shortlisted highway packages from Output 2 were defined in more detail at a packaging workshop. This process also added selected complementary components (in particular, enhancements to the Cambridge Northern Bypass) to the package variants. In total, 16 highway package variants were defined. See Chapter 4 for further details.
2. In a first round of testing using the A14 Highway Assignment Model (A14 AM), the 16 highway package variants were assessed against a set of agreed success criteria. See Chapter 4 for further details.

3. Based on the first round testing, six highway options were selected for further testing. The intention was to identify the best performing highway options; but also to ensure that a range of highway options were carried forward which, through second-round testing, would provide an insight into the effects of the five key characteristics differentiating the 16 package variants. See Chapter 4 for further details.
4. A second round of testing of the six remaining highway options. In this round, the remaining highway options were examined in much more detail, including variable demand modelling (using DIADEM [2]) to predict demand response, full economic analysis and preparation of Benefit : Cost Ratios. See Chapters 5 to 10 for details of this report.
5. Based on the second round of testing, identification of the combination of components and characteristics that led to the best-performing highway packages. See Chapter 10 for conclusions and recommendations from the second round testing.
6. Selection of a highway option to form the basis for the tolling tests which:
    - had the potential for delivering the most benefits (i.e. one which includes Huntingdon Southern Bypass (HSB), enhancements to the A14 between the HSB and Girton, and enhancements to the Cambridge Northern Bypass);
    - offered a free alternative route for local traffic (i.e. provides Local Access Roads);
    - would attract a high proportion of through trips and those trips with an origin or destination beyond the local study area; and
    - minimised the unwanted diversionary effects of the toll (by downgrading the existing A14 between Trinity Foot and the A1(M); and provides other anti-diversionary measures on the surrounding local road network). See Chapter 12 for further details.
7. A number of tests were conducted to provide a better understanding of the potential diversionary effects of the toll and the ability of a tolled scheme to raise revenue. From this, a solution which could potentially solve the identified problems and make a financial contribution to the cost of the scheme was identified. See Chapter 12 for further details.

### Do-minimum assumptions and demand

1.13. In appraising the effects of a proposed transport scheme, it is standard practice to compare the expected outcomes in a future year with the scheme to the same future year without the scheme. The scenario without the scheme is referred to as the Do-Minimum [3]. Both scenarios include anticipated changes in land use resulting from development; revisions to transport networks elsewhere and in underlying parameters such as fuel. These changes in future years are added to a base year scenario (in the case of the A14 the base year is 2008) to form one or more future year Do-Minimum scenarios (in this case for 2016 and 2031). The details of the changes between the base year and future years are described below. It is this Do-Minimum scenario (adjusted to reflect the impacts of the freight package in the second round of testing) that was used to quantify problems along the A14 corridor and provided a means of comparing traffic conditions and environmental impacts as well as facilitating an economic assessment.

1.14. The Do-Minimum public transport network for 2031 was informed by discussions with Cambridgeshire County Council and its views on likely public transport services at that time. The public transport provision reflects prospective developments across the sub-region and the most likely services associated with the Cambridgeshire Busway and the rail network (including a new station at Cambridge Science Park from 2016). The patterns of demand for travel by public transport for the Do-Minimum were derived from an appropriate forecast year of the Cambridge Sub-Region Model (CSRM) as this model is widely used by Cambridgeshire County Council for transport assessment and scheme appraisal.

*[2] DIADEM (Dynamic integrated assignment and demand modelling) is a variable demand modelling software tool maintained and supported by Atkins Limited on behalf of the Department for Transport.*

*[3] WebTAG 3.15 advises three stages of forecasting: a reference case that includes updated demand, a without-intervention case that includes the reference case and adds changes to future year transport supply and costs and with-intervention case that adds the intervention/scheme to the without-intervention case. In this report the without-intervention case is referred to as the Do-Minimum – which is a widely used term for a vision of the future that includes all likely transport interventions and future demand but excludes the scheme being tested.*

1.15. The Do-Minimum strategic freight matrices are derived from the East of England Regional Model (EERMv2), the freight forecasts of which are constrained to the English Regional Traffic Forecast (ERTF) growth levels derived from the Department for Transport's National Transport Model (NTM). This model provides freight demand forecasts for the Cambridge Sub-Region Model. The routing of freight trips by road within EERMv2 was constrained by the capacity of the unimproved A14. There are no rail freight demand patterns stored within EERMv2.

1.16. The definition of the Do-Minimum highway network up to 2031 is also taken from Cambridgeshire County Council's sub-regional model and includes the highway infrastructure to support large development sites where appropriate. No other strategic highway infrastructure has been assumed beyond 2011. Aligned with the public transport demand, the growth assumptions are constrained to the National Trip End Model 6.2 planning assumption in the Department for Transport's WebTAG appraisal guidance (http://www.dft.gov.uk/webtag/) at a district level, with modification to take account of uncertainty of development as directed by the appropriate District Council Annual Monitoring Reports.

1.17. Future year transport growth assumptions were updated to take account of the latest National Transport Model forecasts of background growth in demand for travel contained in TEMPRO v6.2 in the Department for Transport's WebTAG appraisal guidance (http://www.dft.gov.uk/webtag/); with planning assumptions at a district level modified to take account of uncertainty of development as directed by the appropriate District Council Annual Monitoring Reports. Critical to the A14 corridor, the following sites have been included:

- Northstowe (1,500 dwellings by 2031);
- Cambridge North West;
- the National Institute of Agricultural Botany (NIAB) site; and
- some development at fringes of the operational airfield at Cambridge Airport.

1.18. However, the proposed developments at Alconbury and Waterbeach are not included in the forecasts, as at the time of reporting they were not development sites with planning permission.

### Modelling the impacts of the public transport package

1.19. During Output 2, the impacts of the public transport package were only considered at a high level with no explicit modelling conducted. For Output 3, the public transport package was more rigorously tested, in parallel to the testing of highway packages, using CSRM. The level of detail within CSRM means any public transport improvements within or close to the A14 corridor will result in a demand response. CSRM separately models each mode (rail, bus, park and ride as well as the Cambridgeshire Busway). The model represents individual services of each of those modes. This enables an accurate picture of service provision and demand patterns to be captured. The base year validation of the CSRM is 2006. A present year validation of 2011 was conducted as part of the work examining impacts of the development sites for Northstowe and Alconbury, where the developers have collected local count data, although this is restricted to count locations in close proximity to these sites.

1.20. As a consequence, the effects of an enhanced A14 on demand for public transport (and conversely the effects of enhanced public transport on demand for car travel), was undertaken using the CSRM in parallel to the highway package testing.

1.21. The impact of public transport enhancements was not included in the first and second round of highway tests, although it is likely that the enhanced capacity along the A14 would reduce public transport demand in the corridor. To ensure that this effect was reflected in the second round of tests, before the CSRM tests were available, DIADEM was used to estimate the variable demand relationship between enhanced highway supply and demand.

1.22. The CSRM test results, when they became available, provided forecasts of patronage for public transport services which established the impacts that the public transport package would have in its own right. CSRM was also used at a later stage to model the preferred highway option in conjunction with the freight package and the public transport enhancements.

### Modelling the impacts of the rail freight package

1.23. The effects of the rail freight package in terms of transfer of freight from road to rail were forecast during Output 2 using the Great Britain Freight Model (GBFM). The GBFM is the principle model in the UK for modelling the nationwide impacts of changes to freight demand as a result of transport interventions. These forecasts gave first order daily changes in freight at a fairly coarse zoning level, meaning only strategic freight impacts were captured.

1.24. In Output 3, the A14 HAM was then used to forecast the impacts of this modal transfer in terms of changes in HGV traffic on the highway network (see Chapter 3). A revised Do-Minimum demand scenario (with freight package), incorporating these HGV effects, was the basis for all highway modelling during Output 3.

### Modelling the impacts of the highway packages

1.25. The A14 HAM was used to forecast the re-routing of traffic and underlying changes in demand resulting from the highway package variants and highway options. The network coverage of the A14 HAM is adequate to capture diversionary routes within the study area and has sufficient urban and strategic junction detail to ensure local junction delays are reflected in the assignments. Forecasts were conducted for 2016 and 2031.

1.26. The first round of testing assumed a fixed level of demand for travel. The approach to the second round of testing included a forecast of changes in demand for travel by car and LGV in response to changes in travel costs (time) between the base year and forecast year resulting from traffic growth and changes in the highway network. This process used the DIADEM software suite (with HGV responses dealt with externally by the GB Freight Model).

1.27. Second round testing used the revised With Freight Package demand scenario, generated using the CSRM as the Do-Minimum input into the demand model within DIADEM. This incorporated the impacts of the freight package on HGV demand.

1.28. The main demand model used in DIADEM predicts the following demand responses to changes in travel cost (time):

- trip frequency;
- mode choice; and
- destination choice/distribution.

1.29. Time period choice for trips was excluded from the choice hierarchy.

1.30. Public transport travel times and other public transport travel costs were taken from the outputs of the CSRM assignment model. As these are tests of highway measures intended to reduce congestion in the A14 corridor, the model consistently predicted an increase in the number of trips and re-distribution of trip origins and destinations. The exact nature of these changes varies between the six highway packages tested. The outputs from the revised With Freight Package Do-Minimum scenario provide a baseline from which detailed impacts were identified and the six highway options are compared

### Modelling toll effects

1.31. The initial tests examining tolling used the DIADEM software to forecast the demand suppression effect of application of a toll on a highway enhancement package. This approach allowed for relatively quick assessment of a number of different tolling regimes. However, the analysis carried out using the CSRM model provided a more robust forecast of the effects of the toll, including the highway demand suppression effect and, additionally, the public transport demand response (i.e. a modal shift to public transport due to the toll). However, CSRM is less suited to use across a large numbers of tests. As a consequence, CSRM was used to forecast these effects at the end of Output 3 once a beneficial tolling regime had already been established using the DIADEM method.

### Modelling effects of the composite package

1.32. The final round of testing of the composite package (of public transport enhancements, the highway option and rail freight measures) was undertaken using the CSRM. This model includes not only the elements considered by DIADEM but also the interaction between land use and transport and thus determines:

- relocation of population (residents) and jobs (workers) to fill development sites;
- the total number of trips produced and attracted (from National Travel Survey trip rates);
- the mode of travel for trips – based on travel costs to/from sites; and
- the distribution of trip origins and destinations.

## The A14 Challenge

1.33. Alongside the A14 Study, the Department for Transport (DfT) initiated the A14 Challenge [4]. The A14 Challenge comprised two components, the first of which was a web-based survey inviting people who "use the A14, live in the area, or can help with delivery" identify what they think would work best in terms of solutions for the corridor [5]. Views were invited on the scope for improvements to both the national and local road networks, to public transport and to road and rail freight facilities.

1.34. The second component, considered alongside the outputs from the web-based survey, was feedback from a series of engagement events led by Cambridgeshire, Suffolk and Northamptonshire County Councils to gather views on the same issues from key stakeholders.

1.35. The findings of the A14 Challenge informed the A14 Study at a number of stages, in particular in the identification of potential solutions, including value engineering of highway options, and opportunities for innovative funding mechanisms. Examples of ideas suggested by respondents to the A14 Challenge which were included in the packages tested include:

- upgrading the rail network for heavy goods from Felixstowe to the North and West:
- strategic road/rail interchange depots in the region, serving freight movement from the Thames ports and the Channel Tunnel as well as Felixstowe;
- fast direct buses from Huntingdon to employment centres in Cambridge with a possible new Park and Ride site at Godmanchester;
- additional bus services, including on the Busway, increasing the bus network scope;
- better connections between local villages, Park & Ride sites and railway stations;
- upgrading the existing A14 to a modern/higher standard, with free-flow junctions;
- improving Cambridge Northern Bypass using collector/distributor lanes to resolve merging/exiting traffic issues;
- strategic route options via A428 near Caxton Gibbet, connecting with the A1;
- new routes for local traffic on settlements parallel near to the A14; and
- re-modelling Spittals and Girton interchanges and providing grade separation at Brampton Hut.

[4] *http://www.dft.gov.uk/consultations/dft-20111212*

[5] *The web-based survey closed on 31st January 2012*

## Structure of this report

1.36. The remainder of this report is structured as follows:

- The public transport package and its potential impacts are described in Chapter 2.
- Similarly, the rail freight package and its potential impacts are described in Chapter 3.
- The process by which the highway package variants from Output 2 were refined and reduced to six highway options for further testing is described in Chapter 4.
- Chapters 5 to 9 describe the forecast impacts of the six highway options in terms of traffic flow and demand (5), journey times and delays (6), accidents (7), environment (8) and total monetised benefits (9).
- The costs of the six highway options are described in Chapter 10.
- A summary of the impacts of the six highway options, and recommendations for further short-listing, are provided in Chapter 11.
- Forecasts of the effects of tolling an enhanced A14 are provided in Chapter 12.
- Chapter 13 provides conclusions and final recommendations of the A14 Study.

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# 2. The public transport package

## Description of the package

### Initial proposals from Output 2

2.1. Two provisional public transport packages were developed in Output 2 of the study which comprised one or both of:

- a new Park and Ride site(s) and/or expansion of existing Park and Ride sites in the corridor, intended to encourage modal shift of people away from car travel for those journeys that could be served partly by public transport, particularly in the peak period; and
- new or enhanced conventional bus or Busway services intended to encourage modal shift of people away from car travel, particularly in the peak period.

2.2. A combination of the two elements above has the potential to make a greater contribution to removing traffic from the A14 than either element has individually. As a result, the public transport package tested in Output 3 incorporated both elements.

2.3. Having reviewed available information on the trip patterns in the corridor, Output 2 tentatively proposed that the preferred location for a new Park & Ride site was in the Bar Hill area. A site in this area would offer relatively short bus journey times, and therefore lower bus operating costs than a site further from Cambridge, and would have the highest potential to intercept passing traffic; up to 30% of morning peak vehicles at this point are heading for the Cambridge urban area [6] although most of this traffic will also have chosen not to use the existing Park & Ride site at St. Ives.

2.4. However, Output 2 also noted that a site further west, such as at Alconbury or Brampton, could potentially be more beneficial in terms of reducing traffic along a longer section of the A14 through supporting local development aspirations and linking the Enterprise Zone to Huntingdon station, and beyond to Cambridge.

2.5. Output 2 also proposed that:

- the existing Citi 5 bus service (three buses per hour per direction between Cambridge city centre and Bar Hill, with one bus per hour continuing to Swavesey or Fenstanton) was retained, possibly with an enhanced frequency, but running between Cambridge and Bar Hill only; and
- a new service was established between Bar Hill and Longstanton using the current Citi 5 route, then either proceeding on the Busway directly to Cambridge or connecting with existing Busway services.

2.6. This route was thought to offer the best potential to remove traffic from the A14 by improving the connectivity of the villages between St. Ives and Cambridge to the Busway.

### Revised definition of package

2.7. In April 2012, representatives of the DfT, Cambridgeshire County Council, the Highways Agency and Atkins met to define the public transport, freight and highway packages in more detail. As the local transport authority, Cambridgeshire County Council was particularly instrumental in defining the nature of the public transport package.

2.8. The outcome of this work was a revised package as follows:

- A new Park & Ride site, assumed for modelling purposes to be located in the area of Alconbury (of undefined capacity) linked to the Enterprise Zone and Cambridge by a dedicated bus service making use of the Busway to run express to a number of stops in central Cambridge (or served by the recently-introduced Stagecoach

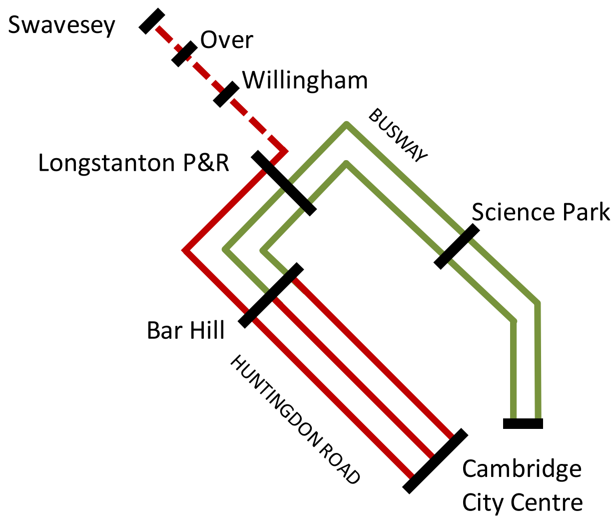
[6] *Defined by the model zoning system as the City of Cambridge, plus Cambridge Science Park and the settlements of Fen Ditton and Teversham.*

express bus service between Peterborough and Cambridge, although the former is assumed in the demand forecasting). This location was selected in preference to one closer to Cambridge because:

- it has the potential to positively effect a longer section of the A14 and support longer-distance bus services (as observed during Output 2 and supported by responses to the A14 Challenge);
- the area closer to Cambridge as a whole is already well-served by Park & Ride (at St. Ives and Longstanton); and
- the completion of the Busway opens up new commercial service possibilities; and
- the emergence of longer distance express services such as the recently-operational Stagecoach service between Cambridge to Peterborough as potential ways to serve Park & Ride sites.

- A new local bus service operating in a bi-directional loop between Bar Hill and Cambridge City Centre. Following discussions with Cambridgeshire County Council, this route was thought to offer a greater enhancement to public transport connectivity north of Cambridge than the route proposed in Output 2 as it would provide a direct link between Bar Hill, Cambridge Science Park and the new Cambridge Science Park station, which otherwise requires a change of service in Cambridge City Centre. The service would run from Bar Hill to the Busway at Longstanton Park & Ride, Cambridge Science Park, the proposed new Cambridge Science Park station, Cambridge City Centre and return to Bar Hill via Huntingdon Road. A service frequency of two buses per hour in each direction has been assumed with a journey time between Bar Hill and Cambridge of 21 minutes via Huntingdon Road or 27 minutes via the Science Park on the opposite side of the loop. This service is assumed to replace the two of the current three buses per hour along Huntingdon Road provided by the current Citi 5 service which terminate in Bar Hill. As a result, these changes would not result in a decrease in service for existing passengers). Service frequencies are shown in Figure 3.

**Figure 3. Bus service frequencies of 'Citi 5' and proposed new service**

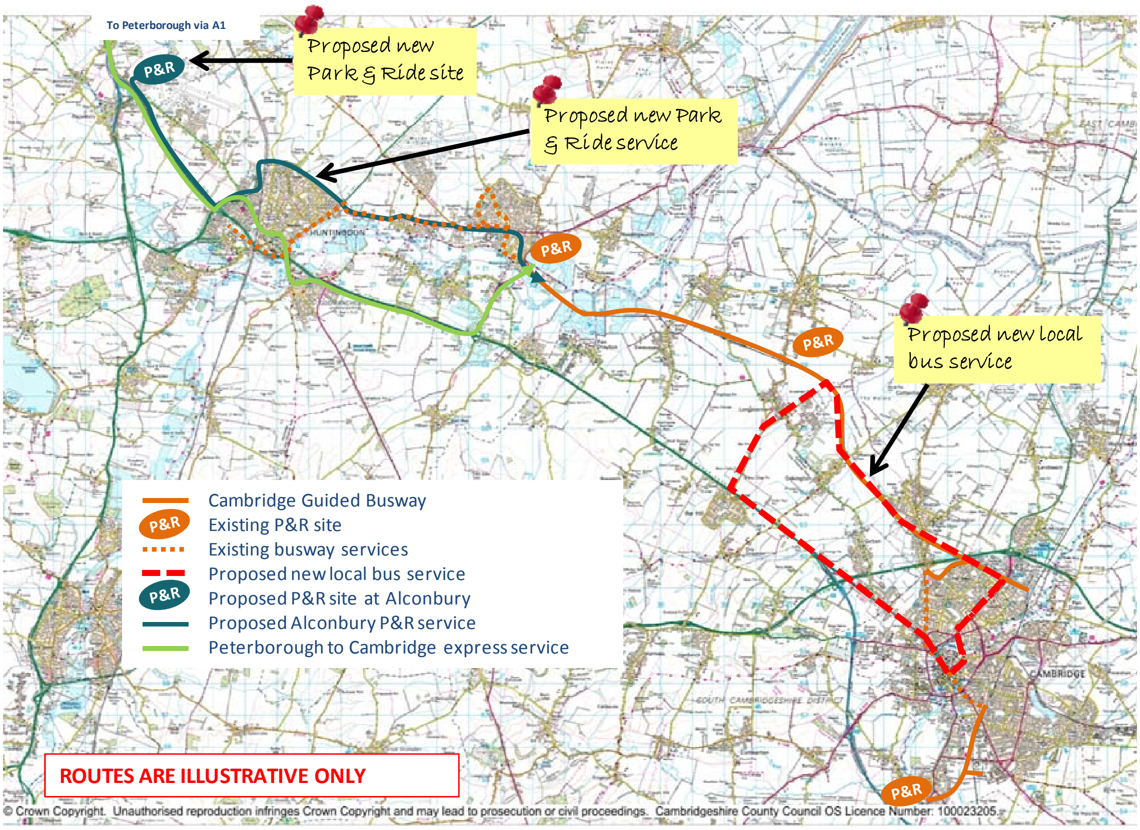



| Section | Buses per hour (per direction) | |
|---|---|---|
| | Current | Proposed |
| Cambridge City Centre - Bar Hill (via Huntingdon Road) | 3 | 3 |
| Bar Hill – Longstanton P&R (via Longstanton) | 1 | 3 |
| Longstanton P&R – Swavesey (via Willingham and Over) | 0.5 | 0.5 |
| Fenstanton – Cambridge City Centre (via Science Park) | - | 2 |

2.9. During the period of this study, a commercial operator has introduced an express bus service between Peterborough and Cambridge. Whilst this is not part of the package, a service similar to this one has been included in the list of interventions tested to forecast the possible effects of the public transport package as a whole. The service tested was assumed to run twice an hour in each direction (peak) or once an hour (inter-peak) between Peterborough Queensway Bus Station and Cambridge Bus station, stopping at Huntingdon Bus station (with a journey time of 80 minutes). The service would run via the A1(M), Ermine Street and Brampton Road (Huntingdon) and then to the Busway via the A1123.

2.10. Indicative service routings and possible location of a new Park & Ride site are shown in Figure 4.

**Figure 4. Illustrative public transport service routings and Park & Ride site locations**




2.11. At the Study Steering Group in April 2012, Atkins was asked to examine the potential to enhance rail services between Peterborough and Cambridge (a journey which currently takes a minimum of 50 minutes and includes an interchange at Ely). In consultation with Cambridgeshire County Council and the DfT, it was judged that improved bus provision is better suited to the potential new development pressures in the corridor (such as at Alconbury and Northstowe) than enhanced rail services. Bus services can potentially offer lower fares and more varied set of destinations linking locations where people live and work than a city centre to city centre rail service which will inevitably require longer connections to ultimate origins and destinations. Enhanced bus services were therefore expected to be more likely than increased rail service frequency to be a solution to the issues on the A14, and as a result, more frequent passenger rail services were not modelled. Improvements to passenger rail were not therefore included in the public transport package.

## Forecast impacts of the public transport package

2.12. The public transport package tested would provide:

- significantly improved public transport connectivity between Bar Hill, Cambridge Science Park and planned new Science Park station;
- a Park & Ride service which negates the need to drive on the A14 south of Spittals interchange to places served by public transport; and
- direct connections to Alconbury Enterprise Zone, central Huntingdon (and three Park & Ride sites) from central Peterborough and central Cambridge

2.13. Forecasts of changes to public transport patronage due to the public transport package were undertaken using Cambridgeshire County Council's CSRM model. CSRM predicts the change in overall demand for public transport as a result of changes in public transport provision. Changes in demand for public transport due to enhancements to the highway network were not modelled at this stage, but to do so would result in a modest reduction in the forecast public transport patronage.

2.14. CSRM forecast that the public transport package (plus the now-operational Peterborough - Cambridge service) would result in only a modest increase in net public transport demand in the study area of 150 passengers in the morning peak period (three hours) in 2031. This equates to a 1-2% increase in public transport trips in the study area. As these are net figures, they include some abstraction of passengers from existing rail and bus services and Park & Ride sites.

2.15. The nature of the existing transport networks, and disparate trip patterns in the study area, suggest that the measures tested offer the best scope for shifting demand from road to public transport and that there are no other affordable options which would result in a much larger shift, particularly of local demand. In comparison, there appears to be much greater scope to transfer freight from road to rail, as is discussed in the following chapter.

2.16. The number of passengers using the new bus services is shown in Table 1.

**Table 1. Passenger loadings on new bus services (period totals, 2031)**

| Service (direction) | Section | Total loading (all buses in period) | | |
|---|---|---|---|---|
| | | AM peak (3 hrs) | Inter-peak (6 hrs) | PM peak (3 hrs) |
| Peterborough - Cambridge Express (southbound) | Peterborough Bus Station to Huntingdon Bus Station | 96 | 25 | 25 |
| | Huntingdon Bus Station to Cambridge Bus Station. | 75 | 13 | 13 |
| Cambridge – Peterborough Express (northbound) | Cambridge Bus Station to Huntingdon Bus Station | 10 | 18 | 55 |
| | Huntingdon Bus Station to Peterborough Bus Station | 28 | 48 | 90 |
| Local 5 (clockwise) | Cambridge City Centre to Bar Hill (via Huntingdon Road) | 25 | 44 | 47 |
| | Bar Hill to Cambridge City Centre (via Busway) | 29 | 26 | 29 |
| Local 5 (anti-clockwise) | Cambridge City Centre to Bar Hill (via Busway) | 12 | 12 | 12 |
| | Bar Hill to Cambridge City Centre (via Huntingdon Road) | 37 | 37 | 37 |

2.17. The proposed Park & Ride site at Alconbury is forecast to attract 60 vehicles in the morning peak (three hour period) in 2031. This assumes a dedicated bus service between the site and central Cambridge.

2.18. The net increase in demand for public transport described above reflects generation of new public transport trips as a result of the new services, and modal shift from car to public transport. However, the modest patronage forecasts mean that the public transport package will have only a small impact in terms of removing traffic from the A14 (a modal shift of 150 passengers from road to public transport is equivalent to removal of approximately 120 vehicles in the morning peak three hour period). As this equates to less than 1% of traffic in this period, the public transport package in isolation will not resolve the problems on the A14 identified in Output 1 of this study. However, this is not to say that the individual elements of the public transport package do not necessarily have merit in themselves, for example in improving public transport accessibility, although the modest additional patronage forecast suggests that these benefits are limited.

## Delivery and funding

2.19. Responsibility for delivery and funding of the public transport package is assumed to lie with the relevant local transport authorities and private operators. The A14 Study has not sought to examine delivery or funding in any detail but anticipates that:

- The Peterborough – Cambridge Express bus service is already being operated commercially;
- The Local 5 service would be provided by a private operator. However it may require operational subsidy initially if introduced;
- The capital costs of the Alconbury Park & Ride site could be funded through devolved Local Authority Major Scheme funding and/or contributions from local partners, including the Local Enterprise Partnership and developers; and
- Ongoing support may be required to cover any net operating costs associated with the Park & Ride site and bus service (after parking receipts).

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# 3. The rail freight package

## The Do-Minimum scenario

3.1. The following assumptions were made in defining the Do-Minimum scenario for 2020 and 2030 against which the impacts of the rail freight package were compared:

- All known port schemes are fully developed, including London Gateway, Felixstowe South and Bathside Bay [7].
- Freight train capacity on the Felixstowe Branch Line limited to 30 trains per day (the existing level), meaning that no additional capacity is assumed from the Port of Felixstowe either via the London or cross-country routes, and train productivity is limited to current levels i.e. train lengths limited to circa 500 metres and five-day working.
- An increase in the loading gauge of the Felixstowe to Nuneaton (F2N) line to W10 to allow high cube containers to be moved by rail (complete).
- Clearance to loading gauge W12 between Syston and Stoke-on-Trent to enable container traffic to/from the North West and Scotland to bypass Leicester and the West Coast Main Line (WCML) between Nuneaton and Crewe.
- Kennett re-signalling (new signalling, including shorter signal block sections to provide additional capacity between Kennett and Bury St Edmunds) (complete).
- Nuneaton North Chord (to allow freight trains to cross the West Coast Main Line without affecting WCML services, thereby increasing freight capacity and capability).
- Ely Loops (to be delivered as part of Network Rail's F2N Phase 1. Two loops east of Ely station at Ely Dock Junction will facilitate better regulation of trains through the junctions at Ely.
- Re-modelling track layout in the Leicester area to provide additional capacity for freight trains between Syston and Wigston North (in combination with planned re-signalling).
- No new rail-linked warehousing schemes (Strategic Rail Freight Interchanges – SRFIs) are developed.

## Description of the rail freight package

3.2. During Output 2 of this study, two broad packages of rail-freight measures were drawn up which incorporated a number of discreet rail infrastructure enhancement schemes. The two packages were:

- O(D): Implementation of new/expanded Strategic Rail Freight Infrastructure to encourage freight to travel by rail rather than by road through the study area plus measures to shift haulage of road freight away from the peak periods.
- O(ABCD): As package O(D) plus rail freight infrastructure enhancements to the F2N line to provide additional operational capacity for rail freight movements.

3.3. Both packages were brought forward for further consideration in Output 3. However, an assessment of the two packages in Output 2 showed that O(ABCD) had a much greater potential to reduce freight traffic on the A14 and, as a consequence, this combined package was adopted as the preferred freight package for assessment.

[7] *The Felixstowe South development requires partial double-tracking of the Felixstowe Branch line which forms part of the Do-Something Freight Package.*

3.4. The purpose of the package is to reduce HGV demand along the A14 corridor by encouraging a transfer of freight from road to rail. Given the nature of freight movements in the core study area, the focus was on modal shift of traffic moving from the Haven Ports to the Midlands and North; and encouraging re-routing of some Haven Ports traffic away from London. As such, the majority of measures proposed relate to the F2N route. These build on the significant raft of measures already committed (see below).

3.5. Modal shift can be encouraged by improving the financial attractiveness of movement of freight by rail to the ports compared to road haulage. This in turn is achieved by enhancing the capacity and capability of the F2N route to enable quicker journey times, operation of longer trains and by providing additional freight paths. The infrastructure schemes described below were considered to be the most feasible and affordable ways of enabling this, noting that the benefits of this improved network performance is dependent on the decisions of private rail freight operators.

3.6. The rail freight schemes included in the modelled Do-Something package, are listed below. Since the modelling of the rail freight package, a number of schemes have progressed to the point that they should now be considered to form part of the Do-Minimum scenario. However, the modelling has not been repeated. As a consequence, the forecast impacts of the rail freight package (see below) represent the impacts of a number of committed schemes.

- **Ipswich North Chord** which forms part of Network Rail's F2N Phase 1 enhancement programme. The scheme will enable trains to run from the Felixstowe branch line directly onto the eastbound Great Eastern Main Line (i.e. towards Ely) without the need to reverse in Ipswich Yard, thereby increasing in freight capacity and capability. Funding has been set aside in Control Period 4, and in September 2012 development consent for this scheme was granted.
- Installation of second track between **Ely and Soham**, in order to provide additional freight capacity. The scheme forms part of Network Rail's F2N Phase 2 enhancement programme and funding was set-aside in the Autumn statement (National Infrastructure Plan). As such, this could also now be considered to be in the Do-Minimum scenario.
- Double-tracking sections of **Felixstowe branch line** to provide increased freight capacity. The scheme has subsequently been funded by Hutchison Ports UK through a Section 106 agreement and would also now be considered part of the Do-Minimum.
- **Freight loop enhancements at March** to increase freight capacity and permit longer freight trains. The scheme is currently un-resourced but could be funded during Control Period 5.
- Re-modelling of **Ely North Junction**. The need for junction re-modelling may be triggered by increased passenger services to/from Kings Lynn. The scheme is in Network Rail's F2N Phase 2 but is currently un-resourced.
- Increased rail-serviced warehousing floor space at **Strategic Rail Freight Interchange** developments (see Table 2). Based on trends over the last 15 to 20 years, on average around one million $m^2$ of new warehouse floor space is built in Great Britain per year. However, much of this is replacing existing stock which is life expired. On that basis, the assumed market response is that there is a continual need for new warehousing and, consequently, a continual demand from the logistics market for new warehouse floor space. New warehousing is normally built by commercial property developers and then leased to retailers, their suppliers or contracted logistics specialists. Recent experience suggests that major distributors are seeking to develop the new warehouse capacity on rail-served sites for commercial reasons. The assumptions in Table 2 are consistent with the most recent national rail freight demand forecasts which assume an additional 7.2 million $m^2$ of warehousing will be developed on rail-linked sites (or approximately 35% of the warehousing likely to be built in Great Britain over the next 20 years).

3.7. After the agreement of the rail freight package to be tested in April 2012, the DfT published in July 2012 the High Level Output Specification for Control Period 5 (April 2014 – March 2019). It is not the purpose of the HLOS to set the detail of particular schemes to be delivered (other than those already committed), but rather to set out what the government wishes to see achieved in the Control Period. However, the HLOS does establish a number of strategic outputs of relevance, notably in connection with providing sufficient capacity for east-west freight traffic to cross radial passenger routes to/from London at Leicester, Peterborough and Ely. This announcement is therefore fully supportive of the freight package set out above and indeed may bring forward a number of the schemes in the package.

**Table 2. Assumed expansion of rail-linked warehousing (000s m$^2$)**

| Site | Current | 2020 | 2030 |
|---|---|---|---|
| Alconbury (Cambridgeshire) | 0 | 140 | 200 |
| Barking (London) | 0 | 100 | 100 |
| Bicester | 0 | 133 | 400 |
| Birch Coppice (Warwickshire) | 60 | 120 | 120 |
| Burnaston / Etwall (Derbyshire) | 0 | 205 | 614 |
| Castle Donington (Leicestershire) | 0 | 67 | 200 |
| Corby | 100 | 250 | 400 |
| Coventry | 150 | 150 | 150 |
| DIRFT (Daventry) | 400 | 867 | 1,400 |
| Ditton (Cheshire) | 0 | 300 | 300 |
| Doncaster | 0 | 17 | 50 |
| Exeter | 0 | 20 | 20 |
| Four Ashes (Staffordshire) | 0 | 133 | 400 |
| Gartcosh (Strathclyde) | 0 | 67 | 200 |
| Grangemouth (Falkirk) | 50 | 83 | 150 |
| Hams Hall (Birmingham) | 300 | 400 | 500 |
| Howbury Park (Dartford) | 0 | 200 | 200 |
| Luton | 0 | 67 | 200 |
| Mossend (Strathclyde) | 100 | 167 | 300 |
| Port Salford (Greater Manchester) | 0 | 183 | 250 |
| Port Warrington (Cheshire) | 0 | 25 | 75 |
| Rossington (South Yorkshire) | 0 | 125 | 500 |
| Seaforth (Merseyside) | 0 | 67 | 200 |
| Selby (West Yorkshire) | 15 | 15 | 15 |
| Shellhaven (Essex) | 0 | 450 | 900 |
| Sheffield | 0 | 33 | 100 |
| SIFE (Slough) | 0 | 190 | 190 |
| Swindon | 0 | 33 | 100 |
| Tees (Cleveland) | 120 | 150 | 210 |
| Telford | 0 | 13 | 40 |
| Wakefield | 350 | 350 | 350 |
| Wentloog (Newport, South Wales) | 0 | 17 | 50 |
| **Total** | **1,645** | **5,136** | **8,884** |

*Note: Following production of these forecasts, the Alconbury Enterprise Zone Masterplan has been modified to exclude rail-linked warehousing. This will have a small impact on the forecast modal shift from road to rail.*

3.8. In combination, the rail freight measures in the Do-Minimum would reduce journey times and facilitate an increase in train length from 23 to 30 wagons (500 to 640 metre trailing length) compared to the Do-Minimum, thereby delivering efficiency gains and opening up additional capacity. The number of additional paths which the package would enable is dependent on timetable decisions and therefore has not been estimated at this stage – for the purposes of forecasting, demand for rail freight is assumed not to be constrained by the number of freight paths available.

3.9. The inclusion or otherwise of improvements to Haughley Junction was raised at a study Steering Group. The junction connects the Great Eastern Main Line north of Stowmarket to the cross country route to Ely and Peterborough. It is a single lead junction, meaning that only one train at a time can pass through the junction.

3.10. Network Rail's view, sought during this study, is that, given capacity enhancement schemes recently completed or planned for implementation over the next few years, there is no requirement on capacity grounds to double-track the line through the junction (in other words, the enhancement is not required to deliver the capacity required to meet expected future demand). However, in the longer term, there may be benefits on reliability and resilience grounds of double-tracking the junction, as it would better enable network recovery following disruption. It is therefore not viewed as a current priority and not included in the freight package.

3.11. The key rail freight package components are shown in Figure 5.

**Figure 5. Locations of Do-Minimum and rail freight package schemes**

## Forecast impacts of rail freight package

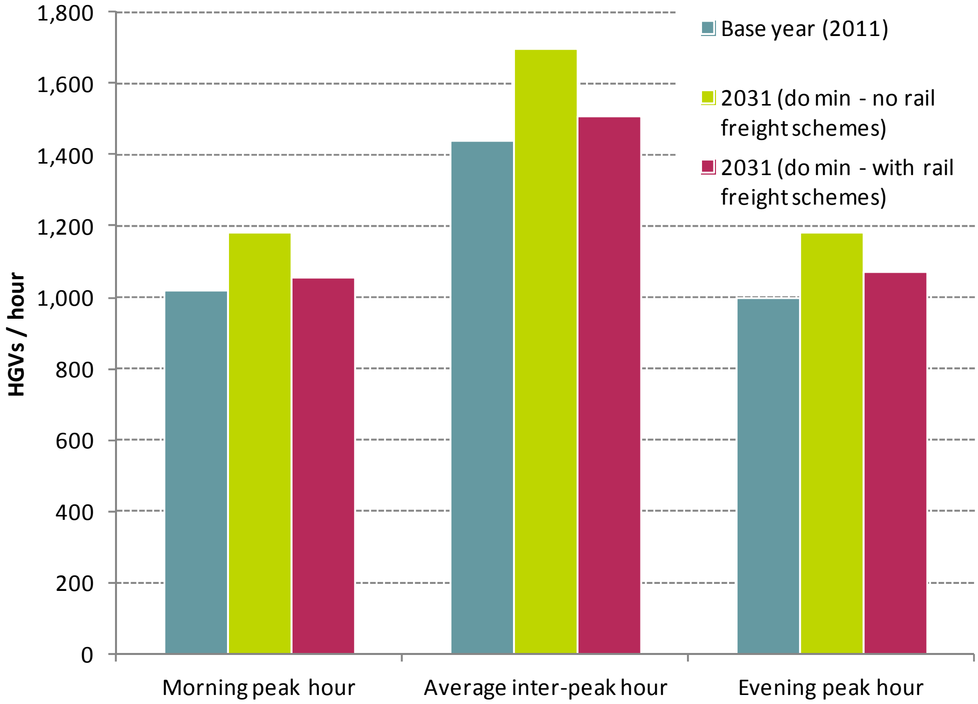
3.12. The nature of the rail freight interventions mean that the benefits of this modal shift will be felt over a wide area, in particular eastern England. The forecasting suggests that, by 2031, the freight package (all committed and uncommitted components) would remove approximately 1,300 HGVs from the road network travelling to/from the Haven Ports area during an average 24 hour period compared to the Do-Minimum.

3.13. As shown in Table 3 and Figure 6, the rail freight package is forecast to reduce HGV traffic on the A14 in the core study area by up to 11% compared to a Do-Minimum scenario without the A14 freight package [8]. These reductions would offset 60 to 80% of the forecast growth in HGV traffic which would otherwise have occurred between 2011 and 2031.

**Table 3. Forecast HGV flow (combined direction, weekday, A14 east of Trinity Foot)**

| Time period | Base year (2011) | Initial Do-Minimum (2031) | With Freight Package Do-Minimum (2031) | Effect of freight package (2031) | |
|---|---|---|---|---|---|
| Morning peak hour | 1,020 | 1,180 | 1,060 | -120 | -11% |
| Inter-peak (average hour) | 1,440 | 1,700 | 1,510 | -190 | -11% |
| Evening peak hour | 1,000 | 1,180 | 1,070 | -110 | -9% |

**Figure 6. Forecast HGV flow (combined direction, weekday, A14 east of Trinity Foot)**




3.14. This modal shift of freight from road to rail forecast by the Great Britain Freight Model is represented in testing of the highway packages as reported in Chapters 5 to 10.

[8] *The modelling assumes that the additional capacity offered by additional train paths and longer trains is taken up by rail freight operators.*

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# 4. Selection and description of six highway options for testing

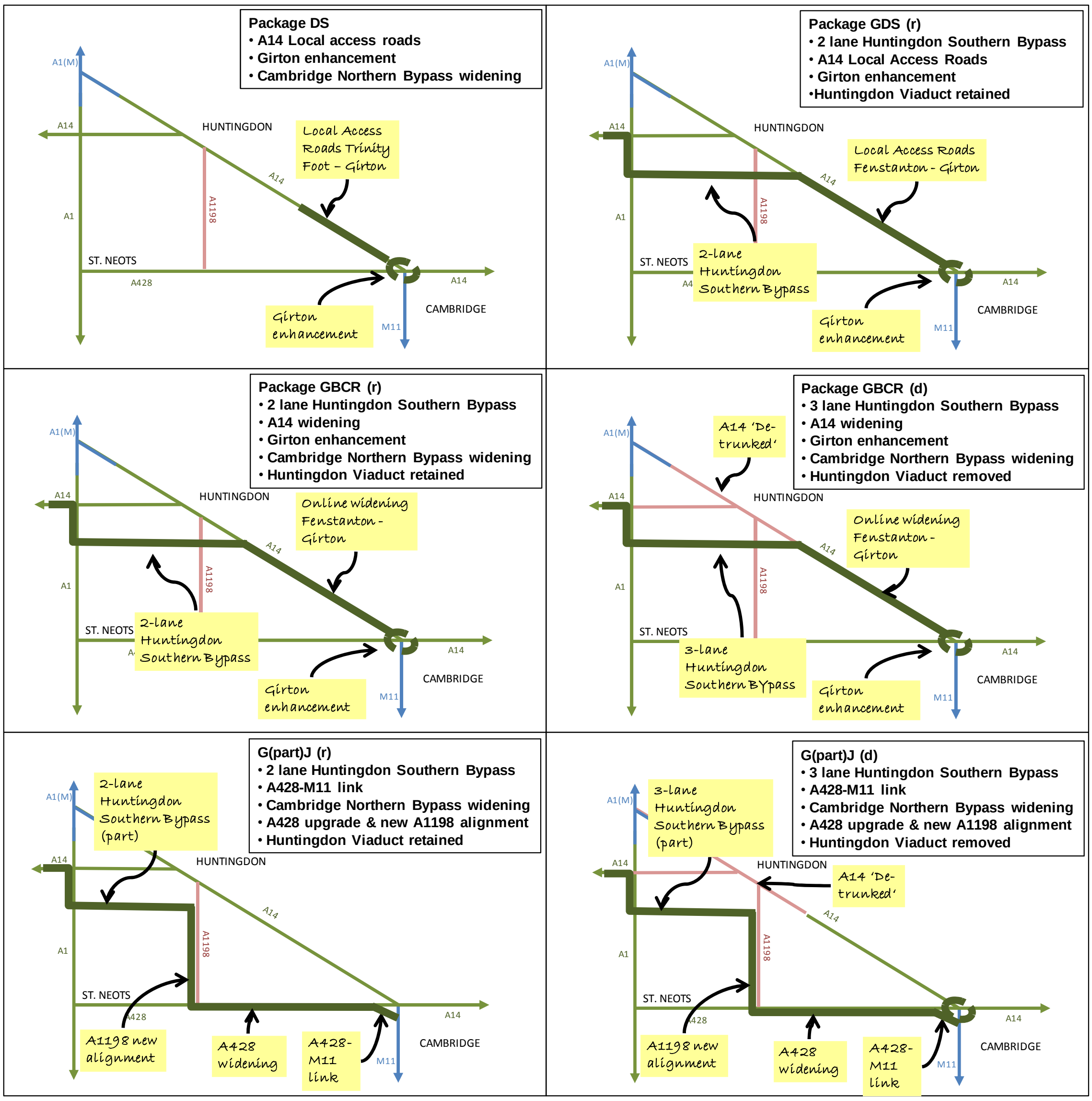
## Introduction

4.1. In Output 2, a total of 21 highway packages were assessed in terms of their ability to overcome the known challenges in the study area (as identified in Output 1). These were then narrowed-down to a shortlist of just six (for further details of this process see the A14 Study Output 2B/2C Report [9]). The six shortlisted packages, as shown in Figure 7, were:

- DS: two-lane local access roads between Trinity Foot and Girton plus full Girton enhancement;
- GDS (r): as DS plus a two-lane Huntingdon Southern bypass with a tie in south east of Fenstanton;
- GBCR (r): a two-lane Huntingdon Southern bypass with a tie in south east of Fenstanton, plus online widening from the HSB to Girton and scaled-back Girton enhancement, Huntingdon viaduct retained;
- GBCR (d): a three-lane Huntingdon Southern bypass with a tie in south east of Fenstanton, plus online widening from the HSB to Girton and scaled-back Girton enhancement, Huntingdon Viaduct removed and existing A14 alignment downgraded;
- G(part)J (r): a two-lane Huntingdon Southern bypass (western section) plus upgraded A428 / A1198 corridor, Huntingdon Viaduct retained; and
- G(part)J (d): a three-lane Huntingdon Southern bypass (western section) plus upgraded A428 / A1198 corridor, Huntingdon Viaduct removed and existing A14 alignment downgraded.

[9] *Atkins for the Department for Transport (May 2012)*

**Figure 7. Shortlisted highway packages from Output 2**




4.2. During Output 2, the highway packages had only been defined by their general route and form. In order to properly test and appraise the package variants, it was first necessary to refine the design of each to a level which would allow the packages to be represented in the A14 Highway Assignment Model (A14 HAM) network and allow preparation of more accurate construction costs.

4.3. These six highway packages were assessed further in Output 3 to identify which performed best in transport terms. This process involved:

- identification and first-round testing of 16 different variants of the six packages and, from those, selection of six variants for further testing (as described in this chapter);
- second-round testing of the six shortlisted highway options and identification of the best highway option characteristics in transport terms (as described in Chapters 5 to 10);
- further testing of one highway option to understand the potential effects of tolling the enhanced route (as described in Chapter 12).

## Selection of 16 variants for first-round testing

4.4. The identification of the 16 variants (of the six packages) to be tested was undertaken at a workshop on 2nd May 2012 attended by representatives of the Department for Transport, Cambridgeshire County Council, the Highways Agency and Atkins. The rationale for selection was as follows:

- all four of the shortlisted packages with the Huntingdon Viaduct retained to be tested;
- both of the highway packages with the Huntingdon Southern Bypass (HSB) and the existing A14 downgraded in the vicinity of Huntingdon (i.e. the (d) derivatives) to be tested with two alternative sets of assumptions about physical measures relating to a downgrade, making a further four variants:
    - the Huntingdon Railway Viaduct retained (and the Spittals to Godmanchester section reduced to one lane with a 30 mph speed limit); and
    - the viaduct removed and the local road network in Huntingdon improved as per the design of the cancelled A14 EFD scheme [10].
- each of the eight highway packages defined above to be tested with and without Cambridge Northern Bypass (CNB) improvements as a sensitivity test in order to understand whether the CNB improvements were required to deliver the full benefits of the scheme as a whole (thus doubling the number of variants to 16).

4.5. In devising these variants, no new packages were created.

4.6. The 16 resultant variants are summarised in Table 4. Definitions relating to this table are as follows:

- D2AP / D3AP / D4AP: dual carriageway “All Purpose road” (available to all road users, therefore excluding motorways for example) with two, three or four lanes respectively in each direction;
- S2AP: single carriageway “All Purpose road” with one lane in each direction;
- 1 m strip: a one metre wide hard-surfaced strip between the road and the verge (not the same standard as a hard shoulder);
- LARs: parallel Local Access Roads;
- W-facing slips: west-facing slips, i.e. providing access only to/from the west;
- EFD: Ellington to Fen Ditton scheme (refers to the cancelled A14 Ellington to Fen Ditton detailed scheme design);
- HSB: Huntingdon Southern Bypass;
- All mvmnts: a junction where all turning directions are possible;
- No jn: no junctions on the section of road indicated; and
- As is: no changes to current/planned configuration.

4.7. For modelling purposes, where indicated, junctions were modelled according to the assumptions for the cancelled A14 EFD scheme.

[10] *Note there is a question as to whether physically retaining the Huntingdon Viaduct with low capacity for motor vehicles and a low speed limit would function well with the surrounding road network as it has not previously been subject to detailed design.*

### Table 4. Summary of 16 package variants for first-round testing

| Test No. | Highway package | A14 carriageway | | | | | | Other carriageway | | | Key interchanges | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ellington-Brampton (HSB) | Brampton-Trinity Foot (HSB) | Trinity Foot-Bar Hill | Bar Hill-Girton | Cambridge Northern Bypass (Girton-Milton) | Spittals-Trinity Foot (incl. viaduct) | A1 B'mptn Hut - Brampton | HSB / A1198 Brampton - Caxton Gibbet | A428 Caxton Gibbet - Girton | A1 Bramp-ton | HSB / A1198 | Trinity Foot | Bar Hill & Dry Drayton | Caxton Gibbet | Girton |
| HW1 | DS | N/A | N/A | D2 (main) + D2 (LARs) * | D2 (main) + D2 (LARs) | As is (D2) | As is (D2) | As is (D2) | As is (A1198) | As is (D2) | N/A | N/A | All mvmnts | As EFD | As is | As EFD |
| HW2 | | N/A | N/A | D2 (main) + D2 (LARs) * | D2 (main) + D2 (LARs) | D3 + longer slips at Histon & Milton | As is (D2) | As is (D2) | As is (A1198) | As is (D2) | N/A | N/A | All mvmnts | As EFD | As is | As EFD |
| HW3 | GBCR (d) | D2 + 1m strip | D3 + 1m strip | D3 + metre strip | D4 + metre strip | As is (D2) | As EFD (viaduct removed) | As EFD | As is (A1198) | As is (D2) | As EFD | As EFD | All mvmnts | All mvmnts | As is | Scaled back EFD |
| HW4 | | D2 + 1m strip | D3 + 1m strip | D3 + metre strip | D4 + metre strip | As is (D2) | S2AP 30mph (viaduct retained) | As EFD | As is (A1198) | As is (D2) | As EFD | No jn | All mvmnts | All mvmnts | As is | Scaled back EFD |
| HW5 | | D2 + 1m strip | D3 + 1m strip | D3 + metre strip | D4 + metre strip | D3 + longer slips at Histon & Milton | As EFD (viaduct removed) | As EFD | As is (A1198) | As is (D2) | As EFD | As EFD | All mvmnts | All mvmnts | As is | Scaled back EFD |
| HW6 | | D2 + 1m strip | D3 + 1m strip | D3 + metre strip | D4 + metre strip | D3 + longer slips at Histon & Milton | S2AP 30mph (viaduct retained) | As EFD | As is (A1198) | As is (D2) | As EFD | No jn | All mvmnts | All mvmnts | As is | Scaled back EFD |
| HW7 | GBCR (r) | D2 + 1m strip | D2 + 1m strip | D3 + metre strip | D4 + metre strip | As is (D2) | As is (D2) | As is (D2) | As is (A1198) | As is (D2) | No jn | No jn | All mvmnts | All mvmnts | As is | Scaled back EFD |
| HW8 | | D2 + 1m strip | D2 + 1m strip | D3 + metre strip | D4 + metre strip | D3 + longer slips at Histon & Milton | As is (D2) | As is (D2) | As is (A1198) | As is (D2) | No jn | No jn | All mvmnts | All mvmnts | As is | Scaled back EFD |
| HW9 | GDS (r) | D2 + 1m strip | D2 + 1m strip | D2 (main) + D2 (LARs) * | D2 (main) + D2 (LARs) * | As is (D2) | As is (D2) | As is (D2) | As is (A1198) | As is (D2) | No jn | No jn | All mvmnts | As EFD | As is | As EFD |
| HW10 | | D2 + 1m strip | D2 + 1m strip | D2 (main) + D2 (LARs) * | D2 (main) + D2 (LARs) * | D3 + longer slips at Histon & Milton | As is (D2) | As is (D2) | As is (A1198) | As is (D2) | No jn | No jn | All mvmnts | As EFD | As is | As EFD |
| HW11 | G(part)J (d) | N/A | N/A | As is - D2 (main) | As is – D3 (main) | As is (D2) | As EFD (viaduct removed) | As EFD | D3 + 1m strip | D4 + 1m strip | As EFD | All mvmnts | As is | As is | W-facing slips | 2 lanes M11-A14 |
| HW12 | | N/A | N/A | As is - D2 (main) | As is – D3 (main) | As is – D2 | S2AP 30mph (viaduct retained) | As EFD | D3 + 1m strip | D4 + 1m strip | As EFD | No jn | As is | As is | W-facing slips | 2 lanes M11-A14 |
| HW13 | | N/A | N/A | As is - D2 (main) | As is – D3 (main) | D3 + longer slips at Histon & Milton | As EFD (viaduct removed) | As EFD | D3 + 1m strip | D4 + 1m strip | As EFD | All mvmnts | As is | As is | W-facing slips | 2 lanes M11-A14 |
| HW14 | | N/A | N/A | As is - D2 (main) | As is – D3 (main) | D3 + longer slips at Histon & Milton | S2AP 30mph (viaduct retained) | As EFD | D3 + 1m strip | D4 + 1m strip | As EFD | No jn | As is | As is | W-facing slips | 2 lanes M11-A14 |
| HW15 | G(part)J (r) | N/A | N/A | As is - D2 (main) | As is – D3 (main) | As is (D2) | As is (D2) | As is – D2 | D3 + 1m strip | D3 + 1m strip | No jn | No jn | As is | As is | W-facing slips | 1 lane M11, 2 lanes A14 |
| HW16 | | N/A | N/A | As is - D2 (main) | As is – D3 (main) | D3 + longer slips at Histon & Milton | As is (D2) | As is – D2 | D3 + 1m strip | D3 + 1m strip | No jn | No jn | As is | As is | W-facing slips | 1 lane M11, 2 lanes A14 |

[*] *Four lanes of capacity between Trinity Foot and Girton has been assumed as the basis of testing these options, split equally between the main carriageway and LARs. Further design work will determine the amount of capacity needed for the main carriageway and LARs.*

4.8. Sketch drawings of the components of the 16 package variants are provided in Appendix A. Note that, during the modelling process, an additional (to the sketch drawing) dedicated free-flow left turn lane was added to the design of the northern roundabout of the Bar Hill junction (southbound from the B1050). This affects package variants HW2 and HW10 (and subsequently the tolled Option 7).

## Approach to first-round testing

4.9. As the work programme required rationalisation of the packages in a short period of time, the approach to first-round testing made use of an existing A14 HAM (with a fixed overall level of travel demand) rather than using a more complex model which represented changes in demand. First-round testing was undertaken using a revised With Freight Package Do-Minimum demand scenario for 2031 (a forecast year which was readily available and after the anticipated scheme opening year). Following DfT guidance, the same travel demand forecast is used for both the Do-Minimum and package tests.

4.10. Future year transport growth assumptions were updated to take account of the latest National Transport Model forecasts of background growth in demand for travel contained in TEMPRO v6.2 in the Department for Transport's WebTAG appraisal guidance (http://www.dft.gov.uk/webtag/); with planning assumptions at a district level modified to take account development uncertainty as directed by the appropriate District Council Annual Monitoring Reports. Critical to the A14 corridor the following sites have been included:

- Northstowe (1,500 dwellings by 2031);
- Cambridge North West;
- the National Institute of Agricultural Botany (NIAB) site; and
- partial development at fringes of Cambridge Airport.

4.11. The revised Do-Minimum for 2031 also reflects reductions in HGV demand via road resulting from the rail freight package.

4.12. In this round of testing, demand is fixed, in other words the total level of demand for travel in the study area does not vary between the Do-Minimum and package tests, or within the package tests themselves, but traffic can re-route. In addition, the impacts of the freight package on HGV demand were represented (i.e. the reduction in HGV demand resulting from a higher share of freight being carried by rail, as described in Chapter 3).

4.13. The outputs from this modelling task were intended to quantify, using available metrics, performance against the study objectives (the success measures, as shown in Table 5). The outputs from the revised With Freight Package Do-Minimum scenario (incorporating freight impacts) provide a baseline against which the 16 variants are compared.

**Table 5. Success measures**

| Objective | Success measure | Specific Metric |
|---|---|---|
| Reducing lost productive time | Change in travel time for all employers' business trips and HGV trips in the corridor. | Network travel time in A14 corridor by user class |
| Supporting growth of the wider UK economy | Change in travel time for employer's business trips and HGV trips through the corridor. | Travel time through A14 corridor by user class |
| Supporting the economic growth of greater Cambridge | Change in travel time for employer's business trips and commuting trips with an origin or destination in Cambridgeshire.<br>Estimate housing development unlocked.<br>Estimate employment development unlocked. | Travel time by user class for journeys with an origin or destination in Cambridgeshire |
| Improving access to labour markets | Change in proportion of population within 30, 45 and 60 minutes commuting time of Cambridge, Huntingdon and Alconbury. | Change in proportion of population within 30, 45 and 60 minutes commuting time of Cambridge, Huntingdon and Alconbury in the morning peak |
| Improving quality of life and welfare | Change in average speed for trips with an origin or destination within Cambridgeshire during the morning peak. | Average speed for journeys with an origin or destination in study area |
| Reducing the number of accidents on the A14 in the core study area | Change in the number of accidents in the A14 corridor. | Estimate of change in accidents in A14 corridor |
| Reducing air quality and noise impacts | Change in air quality and noise impacts in the Huntingdon AQMA and elsewhere in the A14 corridor. | Estimate of change in air quality in A14 corridor based on fuel consumed |

## First-round test results

4.14. Each of the 16 highway package variants was modelled and compared to the revised With Freight Package Do-Minimum scenario assuming a fixed level of demand. Table 6 summarises the relative performance of the variants against the measures of success metrics shown in Table 5. Those variants with top third (best 6 or 7 tests) performance are indicated with a tick.

**Table 6. First-round test results – summary**

| Highway package | Test | CNB | HV | Metric | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Travel time in corridor - cars | Travel time in corridor - HGVs | Travel time thru corridor – cars | Travel time thru corridor - HGVs | Travel time in Cambs – EB | Travel time in Cambs - comm | Access to labour markets | Core network avg. speed | Accidents | Air quality & noise |
| DS | HW1 | No | Retained | | | | | | | | | ✓ | ✓ |
| | HW2 | Yes | Retained | | | | | | | | | ✓ | |
| GBCR (d) | HW3 | No | Removed | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| | HW4 | No | 30mph | | | | | | | | | ✓ | |
| | HW5 | Yes | Removed | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | HW6 | Yes | 30mph | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | | |
| GBCR (r) | HW7 | No | Retained | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| | HW8 | Yes | Retained | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| GDS (r) | HW9 | No | Retained | | ✓ | | ✓ | | | ✓ | | ✓ | ✓ |
| | HW10 | Yes | Retained | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| G(part)J (d) | HW11 | No | Removed | | | | | | | | | | |
| | HW12 | No | 30mph | | | | | | | | | | |
| | HW13 | Yes | Removed | ✓ | | | | ✓ | ✓ | | ✓ | | |
| | HW14 | Yes | 30mph | | | | | | | | ✓ | | |
| G(part)J (r) | HW15 | No | Retained | | | | | | | | | | ✓ |
| | HW16 | Yes | Retained | | ✓ | | ✓ | | | ✓ | ✓ | | |

4.15. Full details of the test results can be found in Appendix B.

## Selection of highway options for further testing

4.16. The selection was based on seeking to choose the best performing package variants; but also to ensure that a range of package variants were carried forward which, through second-round testing, would provide an insight into the impacts of the five key differentiating characteristics (as set out in Chapter 1).

4.17. On the basis of the results summarised above, six package variants were selected for further testing. In particular, the results of the first round testing indicated that:

- HW1 and HW2 (package DS) performed poorly, but that it could be delivered as the first stage of a larger project and was therefore worth further consideration;
- the tests with widening as opposed to Local Access Roads appeared to perform better but that there remained significant uncertainty over the relative merits of the two approaches;
- in overall performance there wasn't a clear winner between those variants which retained the Huntingdon Viaduct as is, and those which remove it, meaning that both should be considered further, but that the tests with a retained but downgraded Huntingdon Viaduct (HW4, 6, 12 and 14) performed relatively poorly and could be dismissed;
- the variants with enhancements to the A1198/A428 corridor performed less well than the other larger variants although there was merit in retaining one variant of this type for future comparison against those options enhancing the A14;
- the tests with Cambridge Northern Bypass enhancements consistently performed better than those without (although there was merit in retaining one variant without these improvements for comparative purposes).

4.18. The six package variants selected for further testing were:

1. HW2: Package DS (local access roads between Trinity Foot and Girton plus full Girton enhancement) with enhancement of Cambridge Northern Bypass and Huntingdon Viaduct retained as is for strategic traffic to/from the A1(M).
2. HW3: Package GBCR(d) (D3AP Huntingdon Southern bypass with a tie in south east of Fenstanton, plus online widening from the HSB to Girton and scaled-back Girton enhancement) with no enhancement of Cambridge Northern Bypass but Huntingdon Viaduct removed and replaced with a local road network as per the former ECI scheme.
3. HW5: Package GBCR(d) (D3AP Huntingdon Southern bypass with a tie in south east of Fenstanton, plus online widening from the HSB to Girton and scaled-back Girton enhancement) with enhancement of Cambridge Northern Bypass but Huntingdon Viaduct removed and replaced with a local road network as per the former ECI scheme.
4. HW8: Package GBCR(r) (D2AP Huntingdon Southern bypass with a tie in south east of Fenstanton, plus online widening from the HSB to Girton and scaled-back Girton enhancement) with enhancement of Cambridge Northern Bypass and Huntingdon Viaduct retained as is for strategic traffic to/from the A1(M).
5. HW10: Package GDS(r) (D2AP Huntingdon Southern bypass with a tie in south east of Fenstanton, local access roads between Trinity Foot and Girton plus full Girton enhancement) with enhancement of Cambridge Northern Bypass and Huntingdon Viaduct retained as is for strategic traffic to/from the A1(M).
6. HW13: Package G(part)J(d) (D2AP Huntingdon Southern bypass (western section) plus upgraded A428 / A1198 corridor) with enhancement of Cambridge Northern Bypass but Huntingdon Viaduct removed and replaced with a local road network as per the former ECI scheme.

4.19. These options are shown diagrammatically in Figure 8 to Figure 13 at the end of this chapter.

4.20. **From this point forward in this report, these package variants are referred to as Options 1 to 6.**

4.21. Those options with a D3AP Huntingdon Southern Bypass and a down-graded A14 alignment past Huntingdon (Options 2, 3 and 6) also included additional junctions on the bypass with the A1198 and A1. Other options have junctions on the Huntingdon Southern Bypass at Ellington and Trinity Foot only.

4.22. The insight gained from second-round testing was subsequently used to choose a highway option for testing with a toll; noting that the findings of the second-round testing may suggest that the best combination of characteristics may not have been modelled up to that point. The options as chosen allowed the effects of the following five differentiating characteristics of the packages to be assessed:

- a relatively small scheme (Option 1) or a larger scheme which includes a Huntingdon Southern Bypass (Options 2 to 6);
- Huntingdon Southern Bypass with enhancements on the existing A14 alignment (Options 2 to 5) or the A428/A1198 corridor (Option 6);
- Huntingdon Southern Bypass with widening of the A14 (Options 2 to 4) or local access roads (Option 5) – Option 4 versus Option 5 is a particularly good comparison;
- retention as a strategic link (Options 4 and 5) or removal (Options 2 and 3) of the Huntingdon Railway Viaduct – Option 3 versus Option 4 is a particularly good comparison; and
- no enhancement (Option 2) or enhancement of Cambridge Northern Bypass (Options 3 to 6) – Option 2 versus Option 3 is a particularly good comparison.

## Approach to second-round testing

4.23. The second round of testing used the same revised Do-Minimum demand scenario as the first round of tests, which includes the impacts of the freight package on reducing HGV demand, as the input to the variable demand model. This means that the impacts of the freight package on reducing HGV demand is incorporated into the forecasts.

4.24. However, whilst the first round of testing undertaken assumed a fixed level of demand for travel, the second round of testing included a forecast of changes in demand for travel by car, LGV and HGV between the base year and forecast year. This change occurs in response to changes in travel costs (time) between the base year and forecast year, caused, for example, by changes in traffic congestion or changes in the highway network.

4.25. The testing used the DIADEM software to predict the following types of changes in travel behaviour which would result in a change in demand for travel (a demand response):

- trip frequency – changes in the number of trips;
- mode choice – changes in car trips relative to public transport trips; and
- destination choice/distribution – changes in trip destination.

4.26. The modelling did not allow trips to change time of travel (for example switching from a peak to off-peak period).

4.27. As would be expected, because these tests reflect measures intended to reduce congestion in the A14 corridor, the model consistently predicted an increase in the number of trips and re-distribution of trip origins and destinations. The exact nature of these changes varies between the six packages tested. The outputs from the revised With Freight Package Do-Minimum scenario provide a baseline against which the six highway options are compared.

4.28. The study adopted a proportionate approach to modelling and appraisal relative to the timetable for the study and level of scheme design using available tools. As such:

- economic analysis was undertaken using the TUBA software [11], providing an estimate of monetised benefits in 2002 prices;

[11] *Transport User Benefit Analysis (TUBA) recommended by the Department for Transport for the calculation of benefits at www.webtag.org.uk*

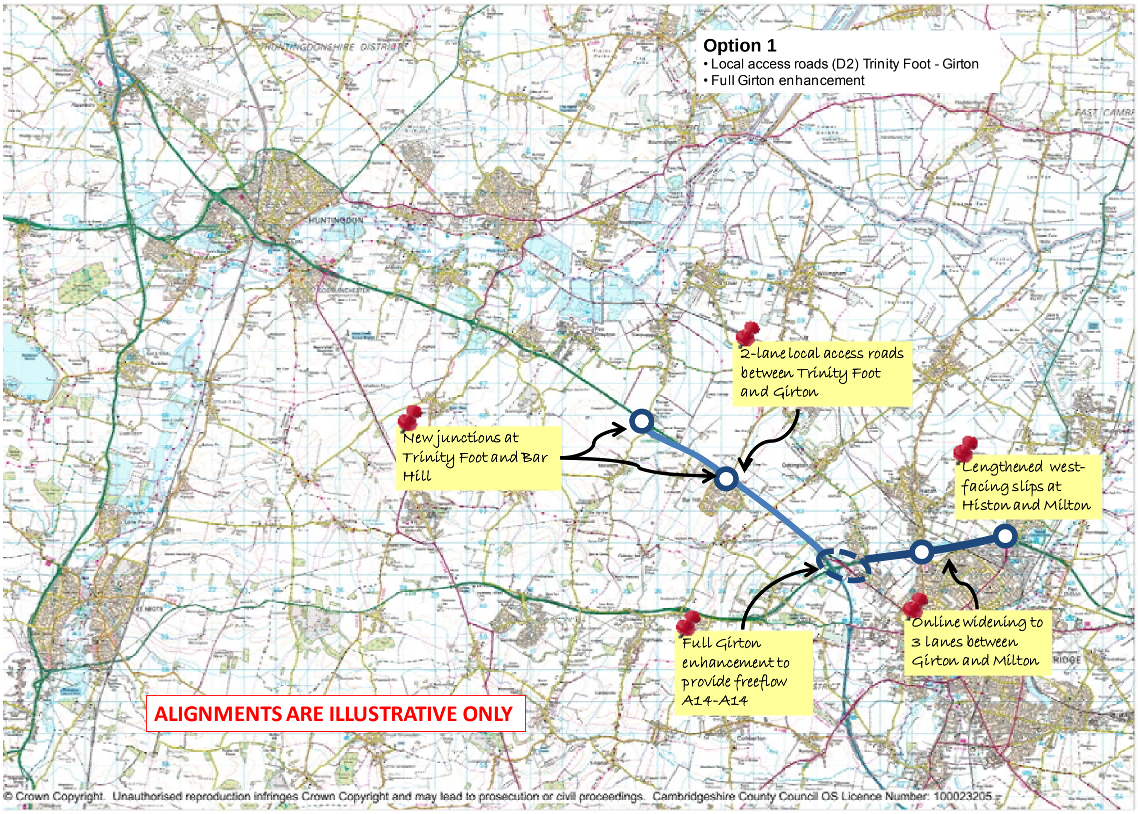
- accident analysis was undertaken using a bespoke Atkins spreadsheet (the ability of this approach to replicate the more traditional approach using COBA software has been demonstrated to the DfT during Major Scheme Bid submissions);
- carbon emissions were assessed in line with DfT guidance (WebTAG Unit 3.3.5);
- $PM_{10}$ [12] and $NO_x$ [13] emissions forecasts follow the Regional Assessment Methodology from Design Manual for Roads & Bridges §11.3.1 as recommended for Strategic Assessments in WebTAG Unit 3.3.3 (and is therefore consistent with the Highways Agency's Emissions Factor Toolkit);
- principles to develop forecasts of changes in $NO_x$ and $PM_{10}$ (changes to absolute concentration levels were not established at this stage as this is more complex); and
- noise was assessed using a bespoke Atkins spreadsheet that follows DfT's guidance (WebTAG Unit 3.3.2) to develop forecasts of changes in (rather than absolute values of) noise which is plotted on the network and qualitative descriptions regarding the proximity of settlements to roads and changes in traffic noise are made.

4.29. Other environmental and social effects were assessed as part of a desktop study using available information derived from the data provided above, and from the previous A14 EFD Scheme work.

*[12] Particulate matter with an average diameter of less than 10 µm.*

*[13] Oxides of nitrogen.*

### Figure 8. Highway Option 1




### Figure 9. Highway Option 2

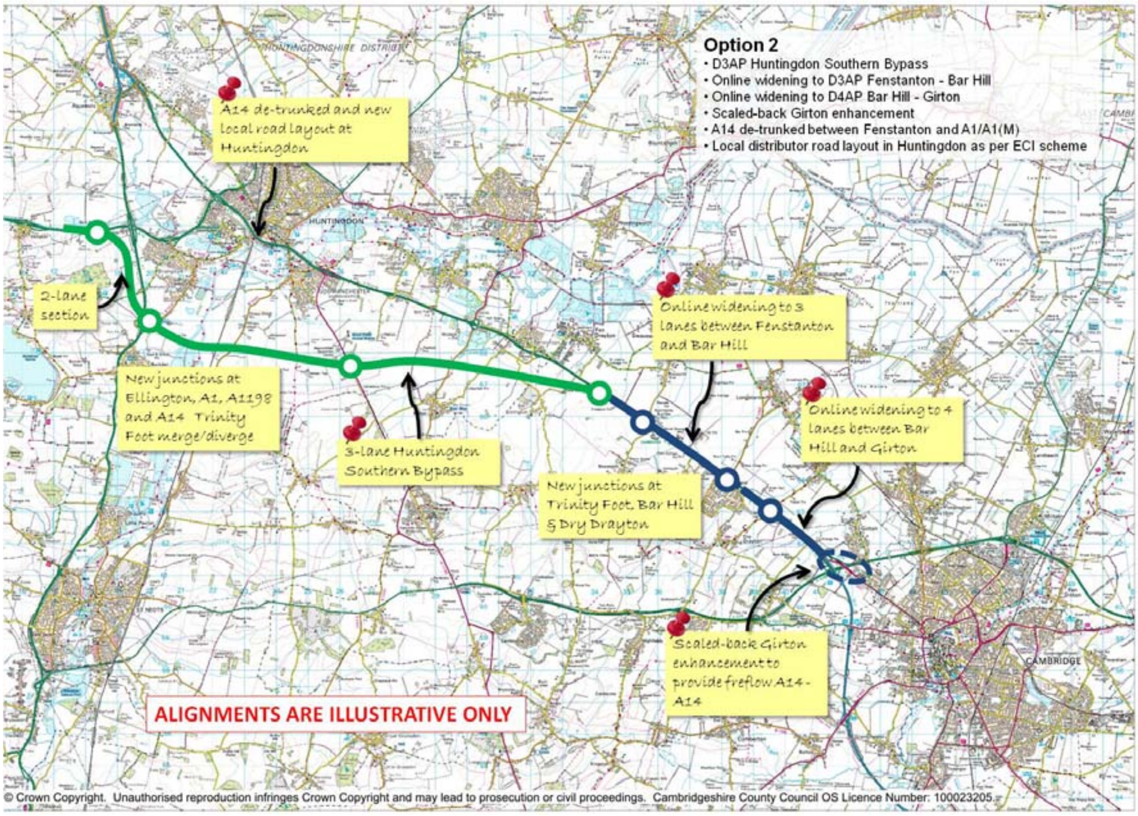


**Figure 10. Highway Option 3**

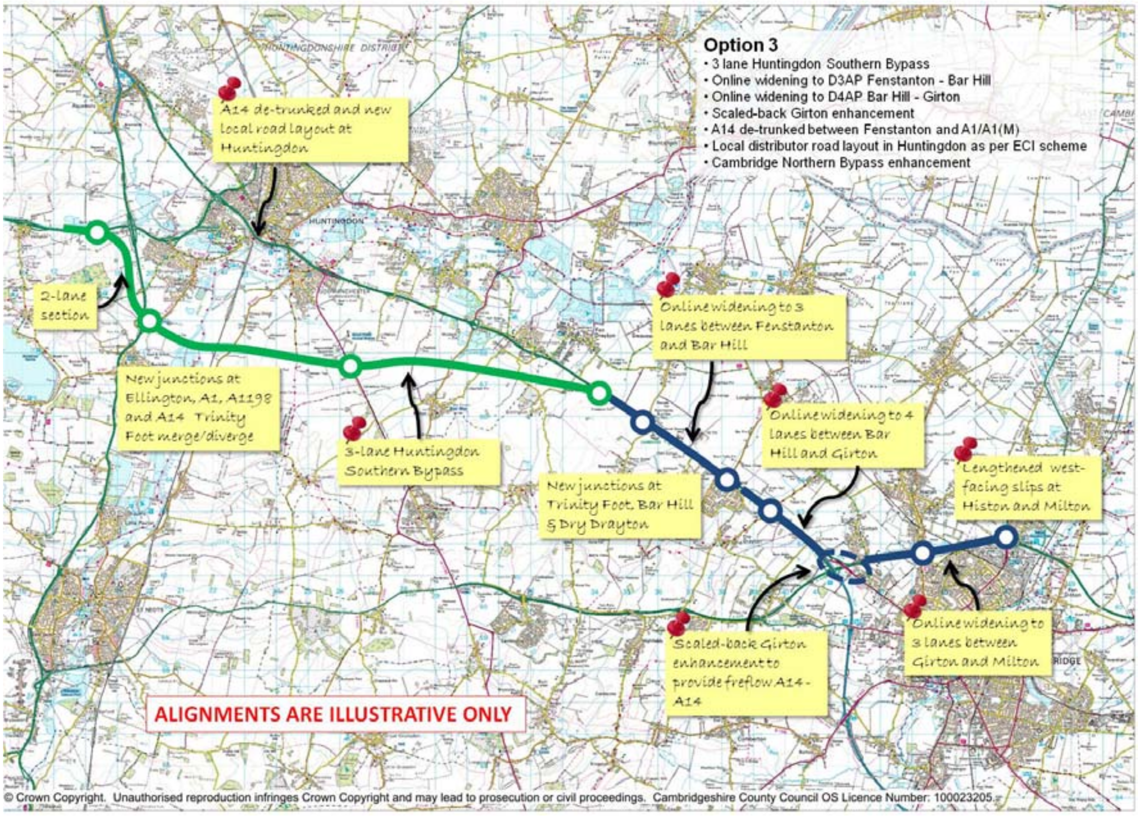



**Figure 11. Highway Option 4**

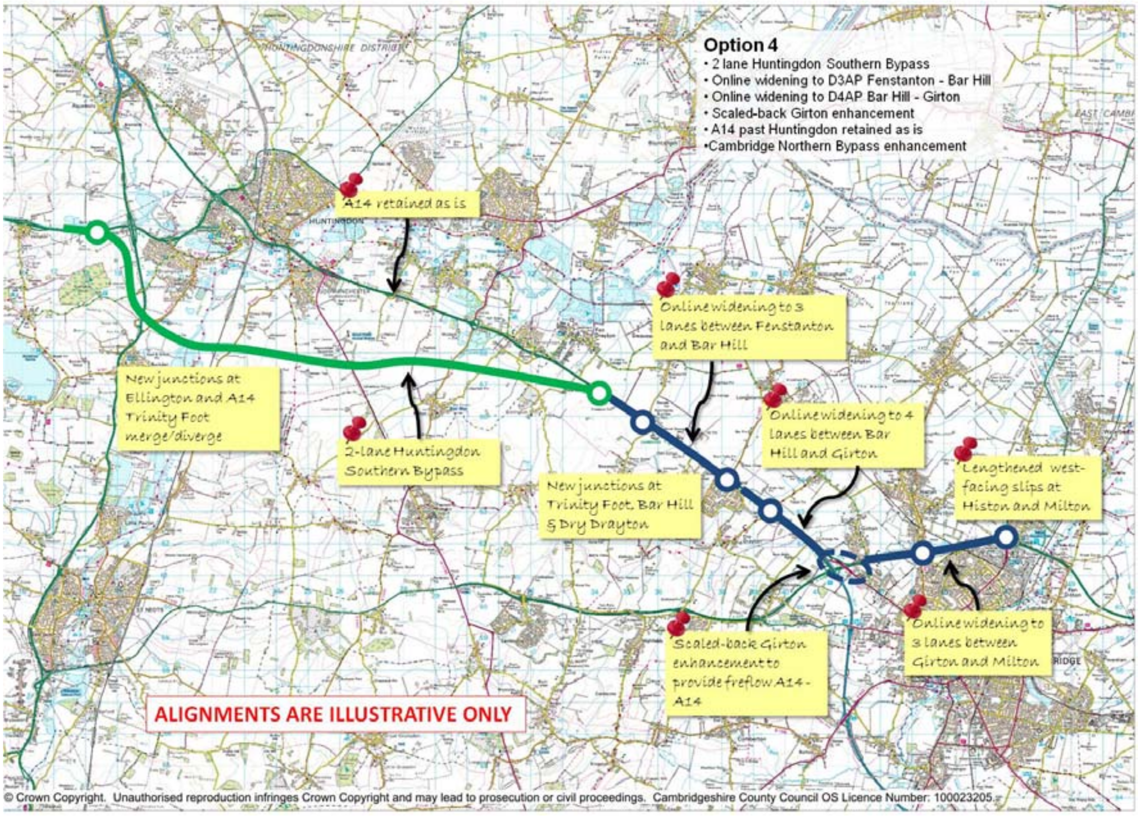


**Figure 12. Highway Option 5**

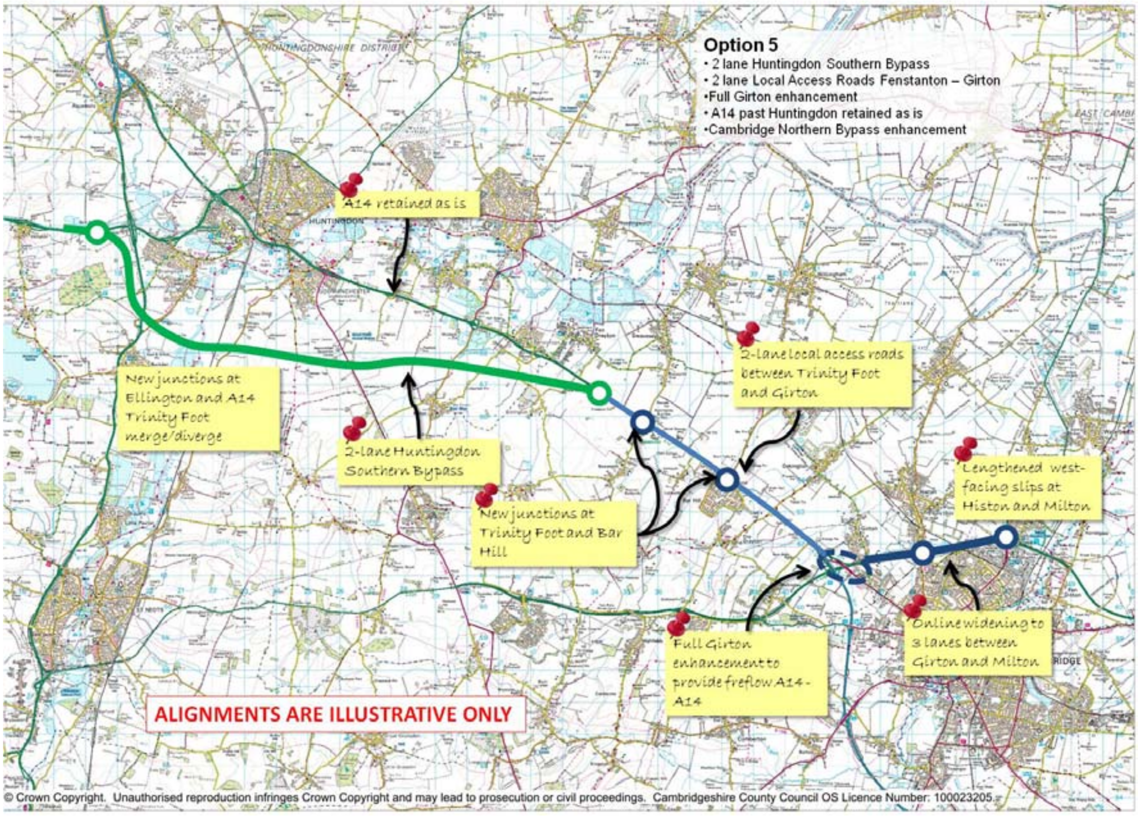
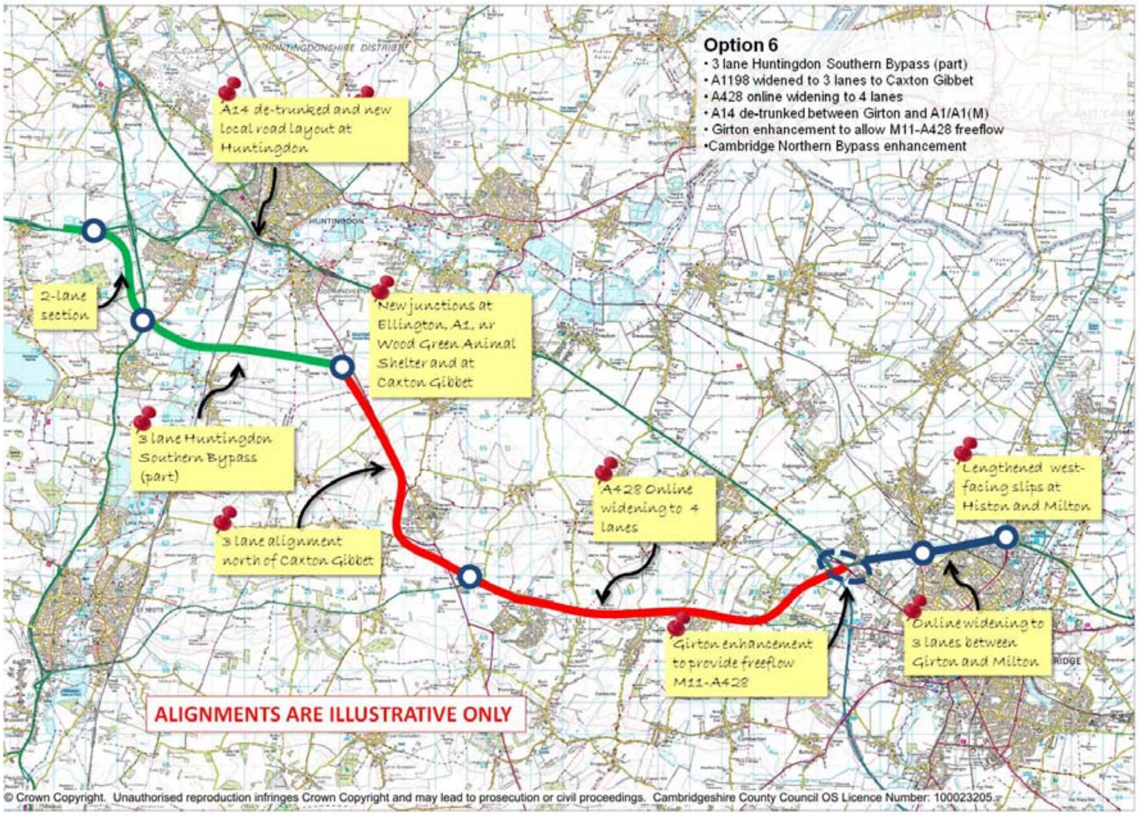



**Figure 13. Highway Option 6**



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# 5. Traffic demand and flow effects of the six shortlisted highway options

## Introduction

5.1. This chapter sets out the findings of the second-round testing of the six shortlisted highway options in terms of traffic demand and flow effects, specifically:

- strategic routing of traffic;
- changes in traffic flow on the A14 and local road network; and
- changes in traffic flow on key radial routes in Cambridge.

5.2. Although these effects are not a direct result of the economic assessment, they provide an important indicator of how the highway options may influence traffic patterns, including the degree to which strategic traffic could route away from Huntingdon in those options in which the A14 route to the west of Huntingdon is downgraded.

5.3. The model can only forecast the levels of traffic choosing to route via particular parts of the network based on the relative journey time and cost of each alternative. In reality, in their decisions about route, road users consider other factors such as the quality of the road and ease of use.

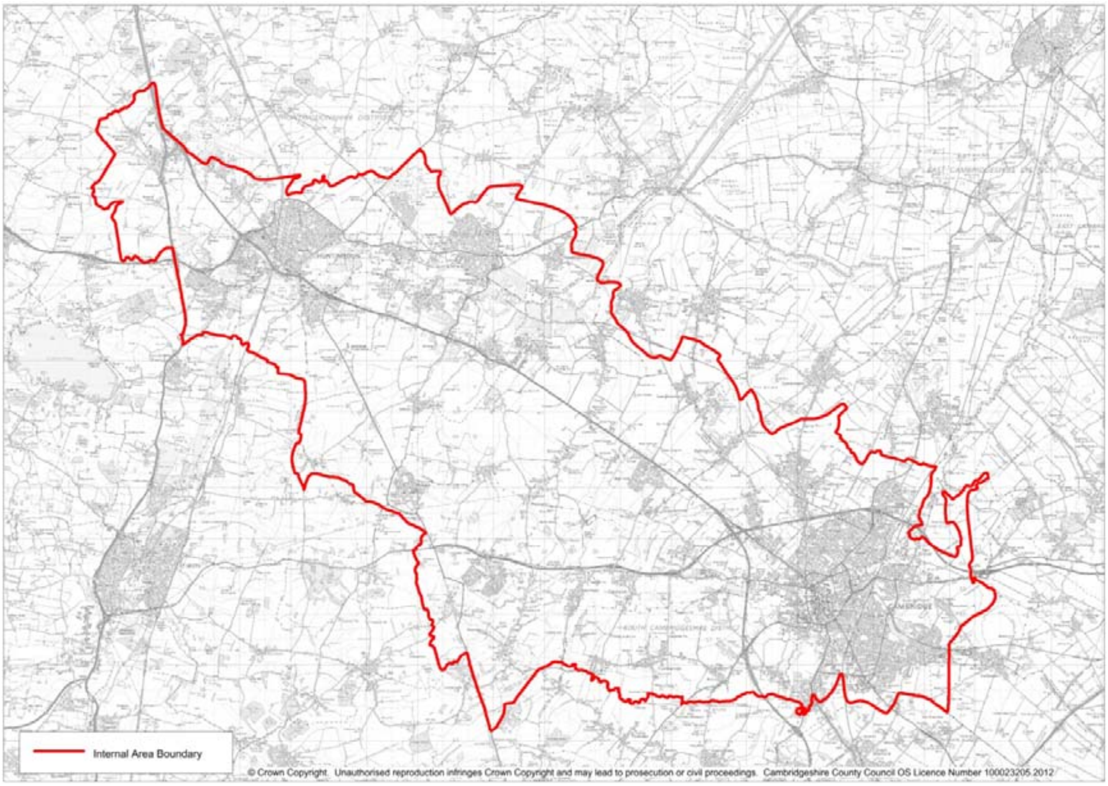
## Trip origins and destinations

5.4. The origins and destinations of trips using the existing A14 alignment and Huntingdon Southern Bypass (just north of Trinity Foot [14]) was assessed for each highway option. The analysis disaggregated trips by vehicle type and trip origin/destination as follows:

- internal: with both origin and destination within the local area shown in Figure 14;
- internal-external: with either origin or destination within the local area; and
- external: with both origin and destination outside the local area.

[14] *As this location is just north of the junction between the existing A14 and the Huntingdon Southern Bypass. Choosing this location allows for direct comparison between the do minimum and all of the package variants (other than Option 6).*

**Figure 14. Internal trip area assumed for trip analysis**




5.5. In the With Freight Package Do-Minimum in 2031, 25% of journeys have both origin and destination within the internal trip area shown above. By comparison, 49% of vehicles on the A14 just north of Trinity Foot are strategic, having both origin and destination outside of the local area (see Table 7), and 89% of HGVs. In total, 16% of vehicles at this point in the Do-Minimum are HGVs.

5.6. Table 7 shows the number of trips in each of the three origin/destination categories for the morning peak period in 2031 on the A14 just north of Trinity Foot. This is the combined flow on the Huntingdon Southern Bypass and existing A14 alignment. The same comparison cannot be made for Option 6 and are therefore not described below.

5.7. These patterns are quite different depending on vehicle type. For example, only 35 to 41% of car and LGV trips are deemed strategic compared to 78 to 87% of HGV trips (of the remaining HGV trips, only 2% would be considered to be local).

5.8. As the six highway options all deliver increases in capacity, it would be expected that traffic flows in the A14 corridor increase. This occurs for two reasons: firstly, as delays on the A14 reduce (and therefore the route becomes more attractive) traffic re-routes from the surrounding road network; and secondly the general effect of congestion suppressing demand for travel by road is reduced.

5.9. Indeed, the table and Figure 15, show that all packages result in an increase in traffic levels on the A14 in the study area as a result of the additional capacity provided and relative improvement in journey time compared to other routes. With the exception of Option 6, provision of a Huntingdon Southern Bypass, (Options 2 to 5) results in approximately 1,000 additional vehicles in the morning peak hour.

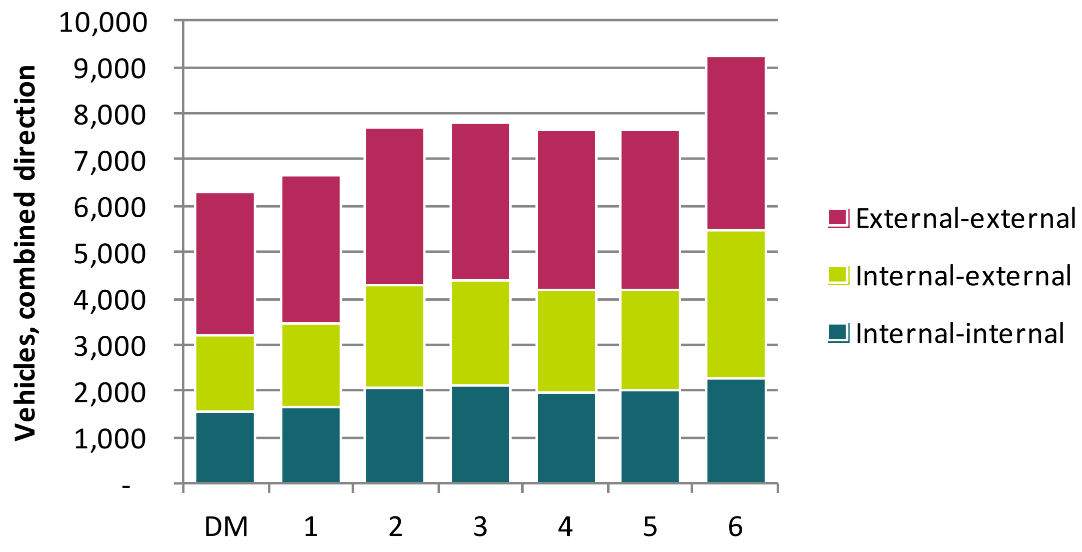
5.10. Local (internal-internal) journeys account for a slightly higher share of vehicles in the options, 25-27% of traffic north of Trinity Foot whilst external journeys account for a smaller share, 41-45% (with the exception of Option 1 where external traffic accounts for the same share of traffic as in the Do-Minimum.

**Table 7. Traffic by origin / destination (2031 morning peak hour, combined direction, just north of Trinity Foot, vehicles)**

| Highway option | CNB | HV | Internal - internal | | | Internal - external | | | External - external | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cars/LGVs | HGVs | All vehicles | Cars/LGVs | HGVs | All vehicles | Cars/LGVs | HGVs | All vehicles | All trips |
| Do-Minimum | No | Retained | 1,520 | 20 | 1,540 | 1,570 | 120 | 1,690 | 2,180 | 890 | 3,070 | 6,300 |
| 1 | Yes | Retained | 1,630 | 20 | 1,650 | 1,670 | 120 | 1,790 | 2,330 | 910 | 3,240 | 6,680 |
| 2 | No | Removed | 2,060 | 20 | 2,080 | 2,070 | 130 | 2,200 | 2,460 | 940 | 3,400 | 7,680 |
| 3 | Yes | Removed | 2,100 | 20 | 2,120 | 2,120 | 130 | 2,250 | 2,470 | 950 | 3,420 | 7,790 |
| 4 | Yes | Retained | 1,970 | 20 | 1,990 | 2,080 | 130 | 2,210 | 2,500 | 950 | 3,450 | 7,650 |
| 5 | Yes | Retained | 1,980 | 20 | 2,000 | 2,050 | 130 | 2,180 | 2,500 | 950 | 3,450 | 7,630 |
| 6 | Yes | Removed | 2,260 | 20 | 2,280 | 2,930 | 250 | 3,180 | 2,820 | 980 | 3,800 | 9,260 |

*Rows may not sum due to rounding*

**Figure 15. Traffic by origin / destination (2031 morning peak hour, combined direction, just north of Trinity Foot, vehicles)**



## Strategic traffic routing

5.11. The share of traffic forecast to route via the existing A14 alignment or via the Huntingdon Southern Bypass in the model is shown in Table 8 (note Option 1 does not include a Huntingdon Southern Bypass). Traffic levels are those just north of Trinity Foot, with the exception of Option 6 where traffic on the Huntingdon Southern Bypass (HSB) is that just west of the A1198.

**Table 8. Traffic using HSB (as a share of the total traffic using the HSB and existing A14 alignment just north of Trinity Foot), 2031 morning peak period, eastbound and westbound combined**

| Highway option | CNB | HV | Internal - internal | | | Internal - external | | | External - external | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cars/LGVs | HGVs | All vehicles | Cars/LGVs | HGVs | All vehicles | Cars/LGVs | HGVs | All vehicles | All trips |
| 1 | Yes | Retained | - | - | - | - | - | - | - | - | - | **-** |
| 2 | No | Removed | 6% | 5% | 6% | 47% | 74% | 51% | 95% | 87% | 91% | **61%** |
| 3 | Yes | Removed | 6% | 5% | 6% | 47% | 74% | 50% | 95% | 88% | 92% | **61%** |
| 4 | Yes | Retained | 0% | 0% | 0% | 19% | 48% | 23% | 46% | 49% | 47% | **30%** |
| 5 | Yes | Retained | 0% | 0% | 0% | 19% | 48% | 23% | 46% | 49% | 47% | **30%** |
| 6 | Yes | Removed | 12% | 16% | 12% | 47% | 55% | 48% | 91% | 79% | 86% | **58%** |

5.12. Table 8 suggests that the Huntingdon Southern Bypass would appeal most to traffic with an origin or destination outside the study area rather than local (internal-internal) trips. The table suggests that the vast minority of local (internal-internal) trips would use the Huntingdon Southern Bypass. According to the analysis of trip routings in the model only 6-12% of internal-internal traffic would use the HSB. This is perhaps not surprising, as many settlements and towns are closer to the existing A14 than the HSB. By comparison, the majority (up to 92%) of ‘strategic’ (external-external) traffic would route via the HSB. The share of ‘internal-external’ traffic using the HSB at this point lies roughly halfway between these two extremes.

5.13. The share of strategic (external-external) traffic using the HSB in Option 6 (86%) is forecast to be slightly lower than in comparable options (Options 2 and 3) reflecting the fact that the A1198/A428 route would be slightly less attractive to long-distance trips than a route via an upgraded A14 and HSB. This result largely arises because Option 6 is approximately three kilometres longer than the HSB options.

5.14. In terms of the differences between options that retain or remove the Huntingdon Viaduct, in those tests with a HSB where the Huntingdon Railway Viaduct is retained (Options 4 and 5), only one third (30%) of traffic is forecast to use the HSB, compared to 58 to 61% of traffic when the viaduct is removed (Options 2, 3 and 6). Therefore, approximately a further 30% of strategic traffic is expected to re-route onto the HSB if the viaduct is removed (this figure is 45% for strategic traffic).

5.15. For Option 2 and Option 3, 8% of external traffic (approximately 400 PCUs [15] in the morning peak hour) is forecast to continue to use the downgraded A14. Of this traffic, 80% is between the A1(M) corridor to the M11 corridor or the A14 corridor east of Cambridge (combined directions). For Option 6, the percentage is higher – 14% of external trips, or approximately 730 PCUs, of which, again 80% is between the A1(M) corridor to the north and the A14 and M11 corridors to the south and east. For all three options, the majority of these strategic (external-external) trips are HGVs.

[15] *Passenger Car Units. This standard metric is used to assess vehicle flow rates in the highway assignment model. PCU values used in the model are as follows: private cars and LGVs – 1.0 PCUs, heavy goods vehicles – 2.3 PCUs, buses – 2.5 PCUs.*

5.16. Whilst most of this strategic traffic continuing to pass adjacent to or through Huntingdon is expected to use the new distributor roads which replace the current A14 alignment, up to a third may route via Godmanchester and the Medieval Bridge in Huntingdon (although this does represent a reduction in traffic on these routes compared to the 2031 With Freight Package Do-Minimum conditions). The model predicts that some HGVs will choose a shorter route even though the downgraded route past Huntingdon (or the route through Huntingdon) has lower maximum speed limits than the Huntingdon Southern Bypass alternative. This occurs because HGVs will benefit less from the higher potential traffic speeds on the new alignment (as they have a lower maximum speed than cars) and have higher operating costs per kilometre (meaning that shorter routes are preferable to longer ones).

5.17. Table 9 shows how the generalised cost [16] of HGV trips in the model differs between three alternative routes. The differences in generalised cost are small, and in practise we might expect HGV users' choice of route to reflect the differences in quality of the two routes, and the stress of using them. Also, as was assumed in the previous EFD scheme planning, complementary measures such as traffic management, signage and weight restrictions could help prevent unwanted use of local roads by strategic traffic if needed.

**Table 9. Comparison of generalised costs in model for HGV journeys from Alconbury to Trinity Foot (Option 3, 2031, morning peak)**

| Route | Journey time (mins) | Distance (km) | Generalised cost |
|---|---|---|---|
| Via Huntingdon Southern Bypass | 20 | 25 | £12.76 |
| Via Huntingdon (Views Common Link) | 24 | 22 | £12.80 |
| Via Huntingdon (Ermine Street) | 23 | 22 | £12.56 |

## Changes in traffic flow

5.18. A series of SATURN plots showing forecast changes in traffic flow on the network between the With Freight Package Do-Minimum and package tests (Do-Something) are provided in Appendix C. Note all figures relate to Passenger Car Units (PCUs) in the morning peak period (08:00-09:00) in 2031. Green bars representing increases in flow, and blue bars representing decreases in flow. The plots provide an insight into the trip generation, redistribution and reassignment effects described above (the latter being the dominant effect). The key features of each plot are summarised below.

5.19. The highway options also result in forecast changes in traffic levels in Cambridge. These are summarised later in this chapter.

### Option 1 (new Local Access Roads, Cambridge Northern Bypass enhancement and Huntingdon Viaduct retained)

5.20. Compared to the With Freight Package Do-Minimum:

- An increase in flow eastbound between Bar Hill and Girton on the Local Access Roads (LARs) of 2,700 but a decrease of 2,200 on the main carriageway (representing a net increase of approximately 500 PCUs). 43% of all eastbound traffic is on the LARs at this point. Westbound, an increase of 2,550 PCUs on the LARs and a decrease of 2,300 PCUs on the main carriageway (representing a net increase of approximately 200 PCUs). 48% of all westbound traffic is on the LARs at this point. A lesser increase on the section between Bar Hill and Fenstanton, reflects the smaller increase in capacity on this section.
- The blue bars represent decreases on the main carriageway as local traffic has re-routed onto the LARs.
- Reductions in rat-running traffic previously avoiding the A14 to the north, for example through Willingham, Cottenham, Oakington and Histon. Reductions in rat-running traffic through Madingley (from the M11 and A428).

[16] *The total cost of a journey, taking account of value of time and vehicle operating costs*

- A large increase in flow (1,650 PCUs) eastbound on the Cambridge Northern Bypass, in particular between Girton and Histon, due to enhancements to Girton interchange and Cambridge Northern Bypass) removing the delays in this area. Between Histon and Milton the combined direction increase is over 1,400 PCUs. The removal of these delays also increases eastbound traffic on the A428 west of Girton.

### Option 2 (new D3AP Huntingdon Southern Bypass, online widening, no Cambridge Northern Bypass enhancement, Huntingdon Viaduct removed)

- Relatively small changes in flow south of Trinity Foot (in the order of 400 to 600 PCUs).
- Reduction in westbound traffic on the existing A14 between Trinity Foot and the A1(M) and Ellington from 1,500 to 2,600;
- A comparable increase in westbound traffic on the HSB of 2,750 vehicles in the morning peak period. As described above, the HSB carries 61% of traffic (just north of Trinity Foot).
- Depending on the form of the local road layout ultimately introduced, a share of strategic trips (400 PCUs in the morning peak hour) could continue to route through Huntingdon. An increase in eastbound traffic on Spittals Way of 360 PCUs because removal of the viaduct means that traffic routes through Huntingdon, including along Ermine Street, which is accessed via Spittals Way.
- Reductions in rat-running on the A1198 through Godmanchester between the HSB and current A14 alignment, over Huntingdon Medieval Bridge and the B1514 through Brampton (as some local traffic uses the new route). But some increases in traffic on the B1043 to the South West of Godmanchester.
- Rat-running to the north-east of the A14 is reduced, although the reduced traffic on the existing A14 results in some additional traffic to/from it, for example to/from Over and Hilton as traffic re-routes to the closest point on the A14 (where previously it may not have done so in order to avoid congestion on the A14).

### Option 3 (new D3AP Huntingdon Southern Bypass, online widening, with Cambridge Northern Bypass, Huntingdon Viaduct removed)

5.21. A similar picture to Option 2, except for the effects of the (additional) enhancements to Cambridge Northern Bypass as follows:

- An increase in eastbound traffic on the Cambridge Northern Bypass between Girton and Quy in both directions – between Histon and Milton the combined direction increase is over 1,400 PCUs (similar to Option 1).
- Larger increases than Option 2 in traffic on the M11, A428 west of Girton and on the A14 between Girton and Trinity Foot.
- Modest reductions in rat-running through, for example Oakington and Histon and Cambridge.

### Option 4 (new D2AP Huntingdon Southern Bypass, online widening, Cambridge Northern Bypass enhancement, Huntingdon Viaduct retained)

5.22. This option, with Huntingdon Railway Viaduct retained and a D2AP HSB with fewer junctions, can be compared to Option 3, which removes the viaduct and has a D3AP HSB. In comparing the flow difference plots (compared to the With Freight Package Do-Minimum) for Option 3 and Option 4:

- The changes in flow are smaller in Option 4, as less traffic re-routes onto the HSB. The HSB carries only 30% of traffic just north of Trinity Foot compared to 60% in Option 3.

- Traffic on the Huntingdon Railway Viaduct falls by 19% in the morning peak), 16% in the evening peak and 24% in the inter-peak compared to the 2031 Do-Minimum (i.e. with no improvement scheme. These traffic levels are 1-3% lower than the peak periods (and 10% lower in the inter-peak) than in the 2011 With Freight Package Do-Minimum.
- There are reductions in eastbound traffic between Brampton Hut and Spittals of 1,000 PCUs, but a slight increase between Spittals and the A1(M) on the A1 Spur, reflecting the fact that the new alignment predominantly serves traffic to/from the west rather than to/from the north.
- Traffic levels on the rest of the network are largely similar.
- Reductions in rat-running on the A1198 through Godmanchester between the HSB and current A14 alignment, over Huntingdon Medieval Bridge and the B1514 through Brampton (as some local traffic uses the new route). But some increases in traffic on the B1043 to the South West of Godmanchester.

### Option 5 (new D2AP Huntingdon Southern Bypass, new Local Access Roads, Cambridge Northern Bypass enhancement, Huntingdon Viaduct retained)

5.23. This option can be compared to Option 4, the difference being that the Option 5 assumes widening between Trinity Foot and Girton rather than LARs. Comparing the flow plots for the two highway options shows that:

- Traffic levels on the network north of Trinity Foot are largely the same, in other words the choice of LARs or widening does not affect route choice on HSB or the existing A14.
- Compared to the Do-Minimum, traffic on the Huntingdon Railway Viaduct falls by the same proportion as in Option 4 (i.e. 19% in the morning peak), 16% in the evening peak and 24% in the inter-peak. These traffic levels are 1-3% lower than the peak periods (and 10% lower in the inter-peak) than in the 2011 Do-Minimum.
- An increase in flow eastbound between Bar Hill and Girton on the LARs of 2,900 but a decrease of 2,000 on the main carriageway. A lesser increase on the section between Bar Hill and Fenstanton, reflecting the increased capacity on this section. Westbound, an increase of 2,350 on the LARs and a decrease of 2,000 on the main carriageway.
- Eastbound traffic on the A14 between Girton and Histon increases in Option 5 (compared to the Do-Minimum) by 1,670 PCUs. This increase is greater than for Option 1 (which is the same south of Trinity Foot) because the improvements north of Trinity Foot lead to more of the extra capacity south of Trinity Foot being utilised.

### Option 6 (new D3AP Huntingdon Southern Bypass, A428/A1198 enhancement, Cambridge Northern Bypass enhancement, Huntingdon Viaduct removed)

5.24. Compared to the Do-Minimum:

- Over half of vehicles transfer onto the A428/A1198 route (58%) resulting in a reduction in traffic levels on the existing A14 of 1,440 PCUs eastbound and 1,550 PCUs westbound (just east of Bar Hill). Immediately west of the A1198 junction, traffic levels on the A428 increase only slightly (by 199 PCUs eastbound and 28 westbound in the morning peak hour).
- Traffic levels are reduced both north and west of Spittals interchange showing that the new alignment is attractive to traffic to/from both the north and west. However, depending on the form of the local road layout ultimately introduced, a share of strategic trips (730 PCUs in the morning peak hour) could route through Huntingdon, resulting in the local roads being busier than they were in the Do-Minimum.
- Traffic on the Cambridge Northern Bypass increases by 1,691 PCUs eastbound between Girton and Histon, slightly above the highest increase observed (in Option 5).

- Rat-running to the north-east of the A14 is reduced, although the reduced traffic on the existing A14 results in some additional traffic to/from it, for example to/from Over and Hilton as traffic re-routes to the closest point on the A14 (where previously it may not have done so in order to avoid congestion on the A14).
- Reductions in rat-running on the A1198 through Godmanchester between the HSB and current A14 alignment, over Huntingdon Medieval Bridge and the B1514 through Brampton (as some local traffic uses the new route). But some increases in traffic on the B1043 to the South West of Godmanchester.

## Changes in traffic flows in Cambridge

5.25. The flow difference plots in Appendix C show the predicted effects of the highway options on traffic flows on key routes in Cambridge. Table 10 shows actual and percentage changes in traffic in the 2031 morning peak hour compared to the Do-Minimum on the key radial routes in Cambridge. The table also shows changes in traffic across a complete cordon drawn around the Cambridge urban area (as shown in Figure 16). For ease of understanding, only those flows which change by 5% or more are shown (other than in the right hand column).

**Figure 16. Cambridge complete traffic cordon**

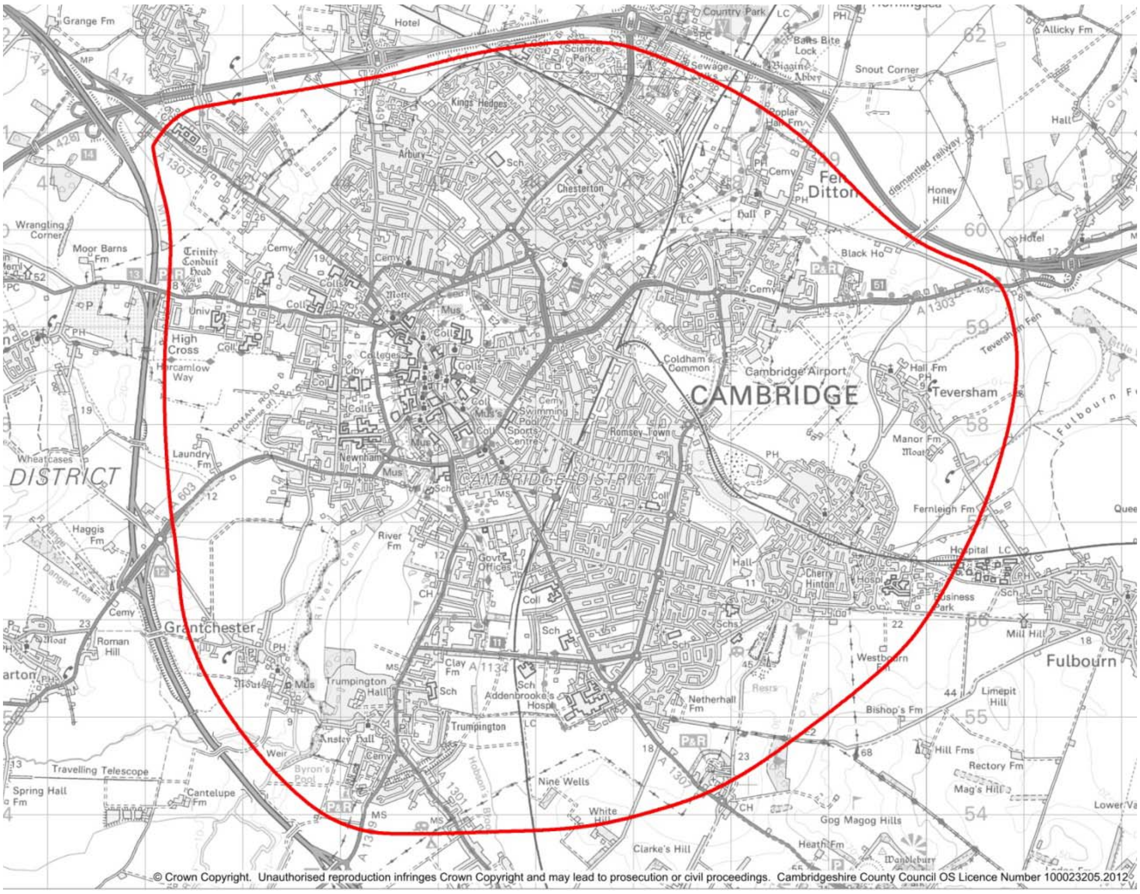


**Table 10. Actual and percentage change in traffic on key roads in Cambridge (2031 morning peak period, PCUs, compared to Do-Minimum, changes >5% only shown)**

| Highway option | CNB | HV | Key radial roads | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Huntingdon Rd | Histon Rd | Milton Rd | Newmarket Rd | Hauxton Rd | Barton Rd | Madingley Rd | Total cordon |
| | | | **Inbound** | | | | | | | |
| 1 | Yes | Retained | -180<br>-20% | +280<br>+14% | | | -80<br>-5% | -105<br>-13% | -70<br>-5% | -135<br>-1% |
| 2 | No | Removed | | | | | | +55<br>+7% | | +155<br>+1% |
| 3 | Yes | Removed | -140<br>-16% | +270<br>+13% | | | -105<br>-7% | -70<br>-9% | -75<br>-5% | -130<br>-1% |
| 4 | Yes | Retained | -150<br>-17% | +275<br>+13% | | | -110<br>-7% | -70<br>-9% | -70<br>-5% | -125<br>-1% |
| 5 | Yes | Retained | -155<br>-17% | +305<br>+15% | | | -115<br>-7% | -80<br>-10% | -75<br>-5% | -70<br>0% |
| 6 | Yes | Removed | -115<br>-13% | +285<br>+14% | | | -75<br>-5% | -85<br>-11% | -70<br>-% | -115<br>-1% |
| | | | **Outbound** | | | | | | | |
| 1 | Yes | Retained | -117<br>-13% | -101<br>-6% | +74<br>+7% | -88<br>-8% | +63<br>+5% | -51<br>-7% | | -205<br>-2% |
| 2 | No | Removed | -51<br>-5% | | | | | | +23<br>+5% | +135<br>+1% |
| 3 | Yes | Removed | -130<br>-14% | -90<br>-5% | +75<br>+7% | -81<br>-7% | +108<br>+9% | -65<br>-8% | | -175<br>-1% |
| 4 | Yes | Retained | -141<br>-15% | -99<br>-5% | +75<br>+7% | -78<br>-7% | +108<br>+9% | -62<br>-8% | 22<br>+5% | -185<br>-1% |
| 5 | Yes | Retained | -74<br>-8% | -89<br>-5% | +81<br>+8% | -81<br>-7% | +103<br>+9% | -85<br>-11% | | -135<br>-1% |
| 6 | Yes | Removed | | -163<br>-9% | +79<br>+8% | -84<br>-8% | +61<br>+5% | -44<br>-6% | +37<br>+8% | -175<br>-1% |

5.26. The table shows that those highway options incorporating enhancements to the Cambridge Northern Bypass would typically reduce morning peak traffic on the main radial routes in Cambridge or result in a change in traffic of less than 5% (and therefore not shown in the table). The overall change in traffic across the cordon as a whole is less than 1% both inbound and outbound.

5.27. The table does however show that there are some re-routing effects expected, although these are similar for all of the highway options. Localised assignment results like these should however be treated with some caution as local traffic routing can be excessively affected by automatic traffic signal optimisation in the highway model. At a more strategic level, the re-routing effects include:

- a reduction in through-traffic through Cambridge (as both inbound and outbound traffic falls in aggregate);
- increased traffic along Histon Road, as traffic now uses the trunk road networks (including the improved CNB) to get to Histon Interchange and Kings Hedges Road, whereas it used to filter through Cambridge from all directions;

- whilst the route into Cambridge is attractive along Histon Road and King Hedges Road, it is more difficult to turn right out of King Hedges Road to get back to the A14; making Milton Road more attractive; and
- a transfer of distance travelled from the local road network in Cambridge onto the strategic roads around Cambridge (the Cambridge Northern Bypass and M11). This is most apparent in the north-west of the city (e.g. reductions on Huntingdon Road and Histon Road) and the south-west (e.g. reductions on the A1134 and around Church End).

## Implications of traffic demand and flow effects on key decisions

5.28. Table 11 summarises the implications of the testing and appraisal results in terms of the five characteristics of the highway options which will be a key determinants of the nature of the preferred package(s).

**Table 11. Implications of traffic demand and flow effects on key decisions**

| Characteristic | Commentary |
|---|---|
| **Large scheme** (with Huntingdon Southern Bypass) **or smaller scheme** | Option 1 (the smaller scheme) would draw less additional demand onto the A14 than the larger schemes and would be less likely to lead to the isolated increases in flow on local roads in the larger schemes as traffic re-routes to join the A14 at the earliest opportunity. |
| Enhancement of **A14 or A428/A1198 corridor** (in addition to Huntingdon Southern Bypass) | The removal or retention of the Huntingdon Railway Viaduct is the key influencer of strategic routing. Enhancement of the A428/A1198 corridor would draw traffic onto that route from the existing A14 alignment. This option would result in the highest share of strategic traffic continuing to route close to or through Huntingdon (14%) for those options where the A14 is downgraded. |
| **Widening or Local Access Roads** on A14 (in addition to HSB) | There is little difference between Options 4 and 5 in terms of traffic routing or local traffic effects, other than the diversion of traffic from the main carriageway to the LARs themselves. |
| Retention (as strategic link) or removal of **Huntingdon Railway Viaduct** | Removal of the viaduct would have significant strategic routing effects for through-traffic. For those options where the viaduct is removed, the model predicts that up to 14% of strategic traffic, much of it HGVs to/from the A1(M) corridor, continues to use the replacement local road or route through Huntingdon. The largest increases in traffic on local roads are on Ermine Street and Spittals Way, although the new distributor road (Views Common Link) also carries a lot of traffic. Further design work is required to ensure that all strategic traffic routes away from Huntingdon. |
| Enhancements to **Cambridge Northern Bypass** | Enhancements would draw slightly more traffic onto the A14. However, as the enhancements relieve congestion east of Girton, the benefits of additional capacity elsewhere are unlocked. As a consequence, traffic flow on the CNB and A428 increase. Enhancements lead to some re-routing of traffic to/ from central Cambridge which could have localised negative impacts unless mitigated although total morning peak traffic on the Cambridge radials is forecast to fall in Options 1, 3, 4, 5 and 6. |

# 6. Journey time and delay effects of the six shortlisted highway options

## Introduction

6.1. This chapter sets out the findings of the second-round testing of the six shortlisted highway options in relation to journey time and delay effects, specifically:

- changes in selected end-to-end average journey times;
- changes in delays on different sections of the strategic road network;
- changes in network stress; and
- total journey time savings.

6.2. These measures are important because identifying ways of relieving the regular delays on the A14 due to congestion and random incidents is a key objective of this study. End-to-end journey times are of interest, as are total journey time savings and delays which are used in the economic appraisal. Further, journey time reliability is an important factor in supporting economic growth [17]. Therefore, network stress, which can exacerbate delays caused by unpredictable incidents, is also analysed here.

6.3. The journey time forecasting methodology predicted conditions on a typical (average) weekday (including day to day delays) and was not capable of accurately forecasting the effects of the highway options on delays caused by unpredictable incidents that may block or close the carriageway. There is no appropriate methodology to predict the incidence of, and delays caused by, random incidents. However, the stress measure is a good indicator (with higher stress levels resulting in greater delays when incidents occur). Aspects of highway design which can help reduce the impact of incidents such as provision of metre strips at the outer edges of the carriageways feature in the design of the options.

## End-to-end journey times

6.4. Selected average end-to-end journey times across the core study area (in congested conditions) were forecast for 2031 for the revised With Freight Package Do-Minimum and each of the highway options. The reductions in journey time compared to the Do-Minimum are presented in Table 12. The table also shows that the route via the Huntingdon Southern Bypass would be approximately one kilometre longer for east-west trips and five kilometres longer for north-south trips than the existing route. Option 6 would be four kilometres longer east-west and eight kilometres longer north-south than the existing route.

[17] *Sir Rod Eddington (1996) The Eddington Transport Study Volume 1,*

**Table 12. Average end-to-end journey times (Do-Minimum and change from Do-Minimum, 2031 morning peak period, all vehicles, minutes : seconds)**

| Highway option | CNB | HV | Ellington – Milton | | | Alconbury – Milton | | |
|---|---|---|---|---|---|---|---|---|
| | | | Dist (km) | East-bound | West-bound | Dist (km) | South-bound | North-bound |
| Do-Minimum | No | Retained | 35 | 43:15 | 36:14 | 35 | 40:44 | 34:59 |
| 1 | Yes | Retained | 35 | -07:57 | -03:56 | 35 | -07:59 | -03:56 |
| 2 | No | Removed | 36 | -11:38 | -12:04 | 40 | -03:21 | -07:06 |
| 3 | Yes | Removed | 36 | -17:19 | -14:00 | 40 | -09:01 | -09:03 |
| 4 | Yes | Retained | 36 | -17:43 | -14:13 | 35 | -11:17 | -09:39 |
| 5 | Yes | Retained | 36 | -18:48 | -13:53 | 35 | -12:47 | -09:22 |
| 6 | Yes | Removed | 39 | -18:07 | -12:49 | 43 | -10:21 | -08:19 |

6.5. Table 12 shows that all the highway options are predicted to result in lower end-to-end journey times than in the Do-Minimum. Option 6 would offer the shortest average journey times, despite it being three kilometres longer than options with the full Huntingdon Southern Bypass. Typically the larger options would deliver reductions in journey times of 10 to 20 minutes east-west and three to 10 minutes shorter north-south. Journey time reductions tend to be greater in the direction where the delays in the Do-Minimum are larger, and therefore where there is more potential to reduce delays by providing additional capacity.

6.6. Option 1 would deliver the smallest time saving for east-west journeys despite it including enhancements to Cambridge Northern Bypass. Option 2, which provides a new Huntingdon Southern Bypass but no improvements to Cambridge Northern Bypass delivers higher savings than Option 1, but lower than those highway options which enhance Cambridge Northern Bypass as well. The Cambridge Northern Bypass improvements would result in a reduction in eastbound (peak) journey time of six minutes.

6.7. Reductions in east-west journey times between Ellington and Milton would be greater (by a third to a half) than north-south between Alconbury and Milton. Those options which provide additional capacity along the whole route between Ellington and Milton are expected to provide the largest journey time savings in either direction. Local access roads in Option 5 would do more to reduce eastbound journey times than online widening (Option 4), but less to speed up westbound traffic. Options that retain the viaduct would reduce journey time for southbound traffic by a significantly greater amount (over a minute), because they offer a shorter route. Note these are average times within each period.

6.8. Table 13 shows that for cars and LGVs, these reductions in end-to-end journeys represent a 5 to 12% fall in journey times for internal trips, but proportionately less for the longer internal-external and external-external trips (2 to 5% and 1 to 2% respectively compared to the Do-Minimum). Journey time savings for HGVs would be smaller than for cars and LGVs as HGVs are less able to take advantage of the higher speeds enabled by reduction in delays. Again, the options that would remove the viaduct lead to slightly smaller reductions in average journey times.

6.9. In comparing the highway options, again it is clear that Option 1 would deliver fairly modest improvements due to its limited form, as would Option 2 due to the lack of enhancements to the Cambridge Northern Bypass. The other options perform similarly.

**Table 13. Average change in journey time by trip origin/destination (compared to Do-Minimum), 2031 morning peak period, eastbound and westbound combined**

| Highway option | CNB | HV | Light vehicles | | | HGVs | | |
|---|---|---|---|---|---|---|---|---|
| | | | Internal | Internal-external | External | Internal | Internal-external | External |
| 1 | Yes | Retained | -4.6% | -1.9% | -0.8% | -4.6% | -1.6% | -1.0% |
| 2 | No | Removed | -9.7% | -3.0% | -1.3% | -3.3% | -1.2% | -1.1% |
| 3 | Yes | Removed | -11.9% | -4.2% | -1.8% | -5.7% | -2.2% | -1.7% |
| 4 | Yes | Retained | -10.1% | -4.4% | -2.2% | -9.6% | -3.8% | -2.3% |
| 5 | Yes | Retained | -11.1% | -4.7% | -2.2% | -10.8% | -4.1% | -2.4% |
| 6 | Yes | Removed | -11.7% | -4.1% | -1.9% | -3.7% | -1.4% | -1.3% |

## Delays

6.10. An analysis of delays (extra travel time compared to free-flow, traffic conditions) in the morning peak (2031) was undertaken for the revised With Freight Package Do-Minimum and highway options. The analysis was based on a typical (average) weekday and therefore did not take account of delays caused by random incidents such as accidents and breakdowns. The network was sub-divided into a number of segments to identify delays (against free flow conditions) at a more aggregate level and to allow easier comparison between options. Journey times were calculated based on times from the exit of the upstream junction to the exit of the downstream junction.

6.11. The locations of delays are shown in a series of plots provided in Appendix D. In summary, the model predicted that, in the 2031 morning peak:

- In the Do-Minimum, there would be notable delays south/eastbound between Spittals and Histon, with a four-minute delay approaching Girton and a delay of nearly eight minutes between Girton and Histon. Delays would be only slightly less severe north/westbound in the morning peak, with a delay of nearly four minutes between Godmanchester (jn 24) and Spittals (jn 23) although delays on the Cambridge Northern Bypass are significantly less in this direction.
- In Option 1, south/eastbound delays north of Trinity Foot (jn 28) due to higher traffic levels, but there would be a considerable reduction in delays on the section to Girton as a result of the additional capacity provided by the LARs. The long delays between Girton and Histon would fall due to the enhancements to the Cambridge Northern Bypass. Delays would slightly worsen on the A428 eastbound as the Cambridge Northern Bypass improvements draw more through traffic along this route. In the north/westbound direction, delays on the Cambridge Northern Bypass would also effectively be removed whilst those elsewhere on the A14 would remain broadly as in the Do-Minimum.
- In Option 2, the online A14 enhancements (coupled with HSB) are expected to resolve most of the delays on the A14 mainline between Girton and Spittals, with only minor delays south/eastbound approaching Girton. However, delays eastbound from Girton towards Histon would worsen slightly due to additional traffic passing through this point, but without enhancements on the Cambridge Northern Bypass. There would also be a notable increase in delay on the A1 southbound approaching Brampton Hut (to over three minutes above free flow time); the additional traffic now using this section due to the downgrading of the A14 past Huntingdon results in traffic levels reaching the theoretical lane capacity of this section. Delays eastbound

between Brampton Hut and Spittals are forecast to be removed as a result of the Huntingdon Southern Bypass.

- In Option 3, delays on the A14 north of Trinity Foot would be resolved, along with the long delays in both directions on the Cambridge Northern Bypass. However, the four-minute delay southbound approaching Girton would remain (due to increases in traffic). As with Option 2, a marked increase in delay on the A1 approaching Brampton Hut is forecast. Also, in common with Option 1, there would be a slight increase in delays on the A428 eastbound approaching Girton (this does not occur in Option 2 as it is a result of the improved capacity, and therefore attractiveness, of the A428/A14 route due to enhancements to the Cambridge Northern Bypass.)
- In Option 4, most delays on the A14 north of Trinity Foot would be removed. However, retaining the route past Huntingdon for strategic traffic would mean that delays northbound between Godmanchester (jn 24) and Spittals (jn 23) are reduced, rather than removed altogether; although additional delays southbound on the A1 approaching Brampton Hut (as in Options 2 and 3) are avoided. However, in common with Option 3, this option would not remove the delay southbound approaching Girton (although it does not worsen) and; whilst delays eastbound from Girton would be removed by the Cambridge Northern Bypass enhancement, delays on the A428 eastbound approaching Girton are expected to worsen (as in Options 1 and 3).
- The pattern of delays expected in Option 5 is broadly similar to that in Option 4. However, the application of LARs rather than widening would bring benefits in terms of markedly reduced (although not totally obviated) delays east/southbound between Trinity Foot and Girton on the main carriageway, and delays of less than one minute on the LARs between Trinity Foot (jn 28) and Girton (jn 31). The LARs highway package however would be marginally less efficient at reducing delays eastbound between Girton and Histon (jn 32) than the widening options due to the increased number of merges on this stretch of road.
- Option 6 would perform best in reducing or removing altogether delays of a minute or more from the network, including on the A14 main carriageway and A428 (expected increases in morning peak traffic on the A428 west of the A1198 are small). As with the other highway options which include removal of the Huntingdon Railway Viaduct, there would be an increase in delay southbound on the A1 approaching Brampton Hut (of nearly three minutes). Like Option 5, Option 6 would also be slightly less efficient than Options 3 or 4 (which both feature online widening of the main A14 carriageway north of Girton) at totally removing delays on the A14 eastbound from Girton. In both cases that appears to be because in Options 3 and 4 the delays occur upstream instead.

## Journey time reliability and network stress

6.12. The forecasting methodology adopted was based on a typical weekday during the year and therefore did not reflect variability of journey times caused by irregular events such as breakdowns and accidents. However, this variability can lead to additional costs to businesses (which factor in additional journey time to ensure on time deliveries) and inconvenience to the travelling public (such as ensuring punctuality, as above, or through late arrival, stress and so on).

6.13. The ratio between forecast traffic volume and highway capacity on a given section of road is a common measure of the extent to which the network is under stress. As the share of capacity utilised increases, so does network stress and delays experienced by traffic due to congestion. Typically, when volume exceeds 85% of available capacity, delays begin to increase disproportionately.

6.14. Appendix E contains a series of plots showing those links in the highway assignment model where traffic volume is forecast to exceed 85% of capacity (2031 forecast year, morning peak period). As the volume/capacity ratio is related to delays, there are some similarities between these plots and the delay plots in Appendix D.

6.15. Of particular interest was whether the highway options would lead to increased stress on the network in particular locations (in addition to relieving stress elsewhere). Comparison of the first two plots shows that Option 1 would reduce network stress between Trinity Foot and Girton as would be expected. However, they also show that Option 1 would increase stress on some northbound sections between Trinity Foot and Spittals interchange, as the scheme enables a greater volume of traffic to pass through this section.

6.16. Options 2, 3 and 6 (all of which include a Huntingdon Southern Bypass) would clearly be much more effective than Option 1 at removing stress on links on the A14 between Spittals interchange and Girton (and on the Cambridge Northern Bypass in the case of Option 3). However, all would lead to volume exceeding 85% of capacity on the A141 westbound approaching Spittals interchange (but these could be mitigated with re-timing of the traffic signals), on the A1 southbound between Alconbury and Brampton Hut; northbound on the M11 approaching Girton interchange and eastbound on the A428 section immediately before Girton interchange.

6.17. By comparison, Options 4 and 5 (which retain the A14 adjacent to Huntingdon) are forecast to avoid the additional stress on the A1 southbound between Alconbury and Brampton Hut. The forecast increase in stress on the A141 westbound approaching Spittals interchange occurs in all options, and the stress on this link is also high in the Do-Minimum.

## Total journey time savings

6.18. Table 14 shows the forecast total journey time savings resulting from each option. Options 3 to 6 would each generate over two million vehicle hours of savings in 2031 whilst Option 2 would generate slightly less. Option 1 would generate approximately half the journey time savings of the others. The table also shows the share of savings which are generated in the three main time periods. For all options other than Option 1, roughly 30-40% of benefits accrue in the peaks and 50% in the inter-peak. This balance is different for Option 1 as it would provide significantly more relief in the peaks as a result of enhancements (to Girton and the Cambridge Northern Bypass) but less benefit during the inter-peak, as these limited enhancements in supply would not aid travellers so much in reduced congestion conditions. By comparison, the addition of the Huntingdon Southern Bypass would provide a benefit throughout the day.

**Table 14. Overall journey time savings (million vehicle hours, 2031 annual)**

| Highway option | CNB | HV | Annual vehicle hours (2031, millions) | | | Share of savings by time period | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Cars & LGVs | HGVs | All vehicles | 08:00-10:00 | 10:00-16:00 | 17:00-19:00 | 19:00-08:00 |
| 1 | Yes | Retained | 0.92 | 0.12 | 1.04 | 21% | 41% | 23% | 15% |
| 2 | No | Removed | 1.44 | 0.27 | 1.70 | 11% | 62% | 18% | 9% |
| 3 | Yes | Removed | 1.93 | 0.33 | 2.26 | 15% | 55% | 20% | 10% |
| 4 | Yes | Retained | 2.32 | 0.45 | 2.78 | 14% | 54% | 18% | 14% |
| 5 | Yes | Retained | 2.50 | 0.48 | 2.98 | 15% | 53% | 19% | 13% |
| 6 | Yes | Removed | 1.82 | 0.20 | 2.02 | 17% | 62% | 21% | 0% |

6.19. The Net Present Values of monetised journey time savings are provided in Chapter 11.

# Implications of journey time and delay effects on key decisions

6.20. Table 15 summarises the implications of the testing and appraisal results in terms of the five characteristics of the highway options which will be a key determinant of the nature of the preferred package(s).

**Table 15. Implications of journey time and delay effects on key decisions**

| Characteristic | Commentary |
|---|---|
| **Large scheme** (with Huntingdon Southern Bypass) **or smaller scheme** | Option 1 would deliver much smaller reductions in end-to-end journey times than the larger packages. Option 1 would fail to resolve delays north of Trinity Foot and would actually result in an increase in stress in this area. It is forecast to generate less than half the journey time savings of some of the larger highway options. |
| Enhancement of **A14 or A428/A1198 corridor** (in addition to Huntingdon Southern Bypass) | There would be little difference between A14 and A428/A1198 options in terms of resultant east-west or north-south end-to-end journey times although the A428/A1198 improvements would do less for HGV journey time savings. Option 6 (the A428/A1198 option) would generate smaller journey time savings than those options with A14 improvements and HSB. |
| **Widening or Local Access Roads** on A14 (in addition to HSB) | There would be little difference between widening or LARs in east-west or north-south end-to-end journey times. LARs would perform better in reducing delays on the A14 approaching Girton but would be poorer at resolving eastbound delays on the Cambridge Northern Bypass. Option 5 (LARs) is forecast to generate slightly higher journey time savings than Option 4 (widening). |
| Retention (as strategic link) or removal of **Huntingdon Railway Viaduct** | Little difference in east-west end-to-end journey times is expected between removing or retaining the viaduct. North-south journey times would be only marginally better with the viaduct retained. Retention of the viaduct would mean that delays approaching Spittals from the south would remain (although reduced from over 3 minutes in the Do-Minimum and Option to 1 minute), whilst removing it is forecast to generate delays of up to four minutes on the A1 southbound approaching Brampton Hut and increased network stress on the A141 westbound approaching Spittals interchange (which can be mitigated by re-timing signals given removal of A14-A14 movement). Retaining the viaduct (Option 4 v Option 3) is forecast to generate 23% more journey time savings overall. |
| Enhancements to **Cambridge Northern Bypass** | The CNB enhancements are forecast to save up to six minutes on eastbound / southbound journeys in the morning peak and would generate 33% more journey time savings (Option 3 v Option 2). Enhancements to CNB would slightly worsen delays on the A428 eastbound approaching Girton. |

# 7. Accident effects of the six shortlisted highway options

## Number and severity of accidents

7.1. The number and severity of personal injury accidents forecast on the A14 (existing and new alignments) and all links in the modelled study area are shown in Table 16. The accident savings were derived by applying accident rates to links in the model, with rates being determined by the category of road design (and free flow speeds, with higher-speed standard of road having lower accident rates). The rates used were based on those observed in the corridor (reported during the A14 ECI) or default accident rates (based on the standard COBA software).

7.2. Those highway options which would result in an increase in vehicle kilometres travelled on higher standard categories of road (and therefore a decrease in vehicle kilometres travelled on lower standards) will generate accident savings. Note however, that overall increases in distance travelled offset some of the benefits. As a result of the macro approach used to calculate accident benefits, some caution must be applied when considering accident effects on individual sections of route.

7.3. Accident forecasts on the A14 also reflect the length of route designated as being part of the A14. In all tests, the length of the A14 is longer than in the Do-Minimum meaning that increases in accidents on the A14 are a result of calculation based on longer sections of route rather thanan increase in accidents.

**Table 16. Number and severity of personal injury accidents (2031, annual)**

| Highway option | CNB | HV | Fatal accidents | | | All accidents | | |
|---|---|---|---|---|---|---|---|---|
| | | | A14 | All links in study area | | A14 | All links in study area | |
| | | | No. | No. | v. Do-min | No. | No. | v. Do-min |
| Do-Minimum | No | Retained | 2.6 | 28.1 | - | 183 | 2,084 | - |
| 1 | Yes | Retained | 2.4 | 28.1 | - | 162 | 2,071 | -0.6% |
| 2 | No | Removed | 2.4 | 27.2 | -3.0% | 180 | 2,037 | -2.3% |
| 3 | Yes | Removed | 2.4 | 27.2 | -3.1% | 184 | 2,029 | -2.6% |
| 4 | Yes | Retained | 2.7 | 27.4 | -2.4% | 194 | 2,035 | -2.3% |
| 5 | Yes | Retained | 2.4 | 27.5 | -2.0% | 166 | 2,037 | -2.2% |
| 6 | Yes | Removed | 2.2 | 27.2 | -3.1% | 175 | 2,033 | -2.4% |

7.4. The Net Present Values of monetised accident benefits are provided in Chapter 11.

7.5. The table shows that Option 1 would have the smallest impact on safety, as traffic effects would be limited, although the higher standard widened route provided by this option also reduces the total accident rate. The overall effect reflects a reduction in accidents south of Trinity Foot and on many local roads, including in Cambridge, but a potential increase on the A14 north of Trinity Foot and on some local roads, such as those through Lolworth and Swavesey due to slightly higher traffic levels.

7.6. Option 2 is forecast to result in a 2.3% reduction in accidents and 3% reduction in fatalities due to the improved standard of the A14 and reduction in traffic on local roads. Although the total number of accidents across the study area is predicted to fall, there are some sections of road where accidents would rise as they are carrying more traffic (and, in some cases, this additional traffic is drawn from roads with lower accident rates). Examples include the A141 north of Huntingdon and the A1 between Brampton and the A1(M) at Alconbury.

7.7. Option 3 would reduce the total number of accidents on the modelled network by the largest amount of any highway option - 2.6%, reflecting the improved highway design between the Huntingdon Southern Bypass and Girton (as Option 2) but also improvements to the Cambridge Northern Bypass. Option 4 would have slightly smaller savings than Option 3 as traffic to/from the A1(M) continues to use the lower-standard existing route past Huntingdon.

7.8. Retention of the viaduct in Option 4, when compared directly with Option 3, demonstrates that the larger net reduction in accidents is achieved by the option that removes the viaduct.

7.9. Option 5 would result in approximately 14% fewer accidents on the A14 than the widening option (Option 4) due to the lower accident rates associated with D2AP main carriageway plus D2 LARs compared to a D3/D4AP road.

7.10. Option 6 would lead to a relatively large reduction in accidents on the A14 as traffic would be drawn from the existing (unimproved) A14 alignment to a higher standard alternative. Accident numbers would also fall on the A14 and some surrounding roads such as the A1123 and existing A1198. As with some of the other options this option would also lead to increases in accidents on some links due to higher traffic volumes, for example on the A1 north of Brampton, on the A428 between Caxton Gibbet and Girton, and on local roads feeding the A428 corridor from the south. As with all options this option is forecast to achieve a net reduction in accidents across the study area.

## Implications of accident effects on key decisions

7.11. Table 17 summarises the implications of the testing and appraisal results in terms of the five characteristics of the highway options which will be a key determinants of the nature of the preferred package(s).

**Table 17. Implications of accident effects on key decisions**

| Characteristic | Commentary |
|---|---|
| **Large scheme** (with Huntingdon Southern Bypass) **or smaller scheme** | Option 1 would have limited impact on accidents although it would lead to a 10% reduction in accidents on the A14 (from 183 to 162) due to improved design. Larger schemes attract more traffic to the A14, resulting in more accidents on the A14 itself, but overall larger schemes reduce accidents as they draw traffic away from lower standard alternative routes. |
| Enhancement of **A14 or A428/A1198 corridor** (in addition to Huntingdon Southern Bypass) | Option 6 (the A428/A1198 option) would result in a relatively large decrease in accidents, comparable with other large options which remove Huntingdon Viaduct (i.e. Option 3) and larger than options which retain it. However, it would increase accidents on the A428 due to higher traffic flows. |
| **Widening or Local Access Roads** on A14 (in addition to HSB) | Options 4 and 5 are forecast to result in broadly the same number of accidents in total. However, the widening option (Option 4) would result in slightly more accidents than the LARs option (Option 5). |
| Retention (as strategic link) or removal of **Huntingdon Railway Viaduct** | Removal of the viaduct (Option 3) is forecast to result in a lower number of accidents (total and fatal) than retaining it (Option 4) as traffic instead would use the higher standard Huntingdon Southern Bypass. |
| Enhancements to **Cambridge Northern Bypass** | The Cambridge Northern Bypass enhancements would result in slightly more accidents in total (comparing Options 2 and 3), due to additional demand for travel, but reduced accidents on the A14 itself, due to a higher standard of road. |

# 8. Environmental effects of the six shortlisted highway options

## Greenhouse gas emissions

8.1. The total forecast change in carbon dioxide emissions for each highway option is shown in Table 18. Emissions were estimated based on link length, speed and flow [18]. The emissions changes were derived by applying emissions rates to links in the model, with rates being determined by speed and traffic flow composition.

**Table 18. Change in carbon dioxide ($CO_2$) emissions (compared to Do-Minimum, 2031, million tonnes per annum)**

| Highway option | CNB | HV | Light vehicles | Heavy vehicles | All vehicles |
|---|---|---|---|---|---|
| 1 | Yes | Retained | +1.50 | +0.05 | +1.55 |
| 2 | No | Removed | +8.43 | +5.86 | +14.29 |
| 3 | Yes | Removed | +9.65 | +6.07 | +15.71 |
| 4 | Yes | Retained | +7.16 | +3.70 | +10.86 |
| 5 | Yes | Retained | +5.73 | +2.40 | +8.13 |
| 6 | Yes | Removed | +12.46 | +7.63 | +20.09 |

8.2. All the highway options are forecast to increase $CO_2$ emissions as a result of increased speed (and therefore emissions per kilometre) and, in most cases, increased travel distance. Option 6 would result in the highest increases in emissions and Option 1 the lowest increase (as speeds increase the least and vehicle kilometres remain broadly constant). Options that remove the Huntingdon Viaduct would result in higher increases in emissions than those that retain it due to the additional distance travelled by some through-traffic.

## Air quality

8.3. In reading this section, it is important to remember that what is presented is an analysis of emissions based on traffic at particular locations on the road network. Air quality is actually determined by concentrations of pollutants at particular locations (see footnote), which are affected by a number of factors in addition to the amount of pollutants emitted by motor vehicles. However, the following analysis provides an indication for each option of the locations where more or less pollutants would be emitted by motor vehicles. The analysis below describes the change in level of emissions for each option across the study area, and describes how the location of increased/decreases of emissions relate to areas where air quality is poorer in the Do-Minimum.

[18] *Estimates of emissions were calculated on the basis of functions relating emissions levels to vehicle speed and traffic composition, using average speeds for each modelled link for each modelled hour. This is in line with guidance (WebTAG Unit 3.3.5) and the fact that the emissions functions used are derived from average journey speeds. However, it should be noted that the relationship between emissions and speed is not linear. High emissions rates per kilometre occur at low speeds, typically dropping to minimum at about 50mph and then rising again with increased speed. The use of average speeds can therefore underestimate emissions and the impact of changes in traffic conditions on emissions. This is particularly relevant in congested areas where an average link speed may be the result of very low (and polluting) speeds on the lead up to a congested junction and faster speeds across the rest of the link. Relief of congestion at the junction would achieve significant reductions in emissions but changes estimated through the change in overall link speed would be relatively small. The averaging between more and less congested periods of the modelled hour would have a similar effect, typically underestimating the impact of changes in congestion on emissions.*

8.4. Table 19 summarises the predicted increases in emissions of oxides of nitrogen ($NO_x$) and particulate matter with an average diameter of less than 10 µm ($PM_{10}$) as a result of each highway option. The emissions changes are derived by applying emissions rates to links in the model, with rates being determined by speed and traffic flow composition[19]. As above, Option 6 results in the highest increases in emissions, Option 1 the lowest, and those highway options which remove the Huntingdon Railway Viaduct result in larger increases in emissions (when the impacts across the whole study area are considered) than those which retain it. However the distribution of increases/decreases in emissions must also be considered.

**Table 19. Change in $NO_x$ and $PM_{10}$ emissions (compared to Do-Minimum, 2031, thousands of tonnes per annum)**

| Highway option | CNB | HV | Light vehicles | | Heavy vehicles | | All vehicles | |
|---|---|---|---|---|---|---|---|---|
| | | | $NO_x$ | $PM_{10}$ | $NO_x$ | $PM_{10}$ | $NO_x$ | $PM_{10}$ |
| 1 | Yes | Retained | +21.8 | +0.9 | +0.1 | +0.0 | +21.9 | +0.9 |
| 2 | No | Removed | +87.0 | +5.9 | +49.0 | +1.5 | +136.0 | +7.4 |
| 3 | Yes | Removed | +98.8 | +6.7 | +50.7 | +1.5 | +149.4 | +8.2 |
| 4 | Yes | Retained | +75.5 | +5.2 | +32.0 | +0.7 | +107.5 | +5.9 |
| 5 | Yes | Retained | +64.4 | +4.0 | +17.3 | +0.3 | +81.7 | +4.3 |
| 6 | Yes | Removed | +130.9 | +8.9 | +61.1 | +2.1 | +192.0 | +10.9 |

8.5. The changes shown in the table are net effects, reflecting localised increases and decreases in emissions as a result of changes in traffic flow (with lower flows leading to lower emissions) and traffic speeds (with $NO_x$ emissions at their lowest between 20-40 mph and $PM_{10}$ emissions increasing with speed). The forecast changes in $NO_x$ emissions in the three largest Air Quality Management Areas (AQMAs) in the area, all of which relate to $NO_x$ emissions, are shown in Table 20.

**Table 20. Change in $NO_x$ emissions by AQMA (compared to Do-Minimum, 2031, tonnes)**

| Highway option | CNB | HV | A14 Huntingdon | | A14 Fenstanton-Girton-Milton | | Cambridge city centre | |
|---|---|---|---|---|---|---|---|---|
| 1 | Yes | Retained | +275 | +0% | +13022 | +6% | -918 | -3% |
| 2 | No | Removed | -62,067 | -71% | +25,147 | +11% | +581 | +2% |
| 3 | Yes | Removed | -62,073 | -71% | +34,791 | +16% | -504 | -2% |
| 4 | Yes | Retained | -26,109 | -30% | +34,698 | +16% | -518 | -2% |
| 5 | Yes | Retained | -26,080 | -30% | +17,532 | +8% | -665 | -2% |
| 6 | Yes | Removed | -54,499 | -68% | -37,211 | -17% | -576 | -2% |

8.6. The table shows that all options other than Option 1 are forecast to result in a very large fall in $NO_x$ emissions in the A14 Huntingdon AQMA; in those where the viaduct is removed and route adjacent to Huntingdon downgraded, this reduction is as much as 71%. Emissions in the AQMA covering the A14 between Fenstanton and Milton tend to be larger due to greater traffic flow and higher speeds, particularly for Options 2, 3 and 4, but not on the same scale as the beneficial impact of Options 2, 3 and 6 at Huntingdon. Option 6 would draw traffic away from the Fenstanton-Milton AQMA.

[19] *Potential impact on local air quality was estimated on the basis of the scale of change in emissions of local pollutants (NOx and PM10), using the regional methodology set out in DMRB. This provides a good indication of the likely scale and direction of impact on air quality but cannot be considered a direct indicator of air quality, which depends on concentrations of pollutants in the atmosphere at sensitive location and is therefore dependant on a number of locally specific factors such as building location, potential for dispersion and other local sources of the pollutants. The issue with average speeds, described in the footnote above, applies for air quality too.*

8.7. All options including an enhancement of the Cambridge Northern Bypass would lead to a 2% reduction in $NO_x$ emissions in the Cambridge city centre AQMA, as traffic would be drawn onto the A14. Where the CNB is not enhanced, the additional traffic in the corridor, and the tendency for some of this to route via Cambridge due to additional congestion on the CNB, would result in a 2% increase.

8.8. There are no AQMAs relating to $PM_{10}$ emissions in the study area. Typically, the options result in increases in $PM_{10}$ emissions on the A14 and reductions on the local road network and in those areas where the A14 has been downgraded.

## Noise

8.9. Table 21 shows the proportion of the modelled network affected by a perceptible change in noise levels (defined as an increase or decrease of 3dB or more). The noise level changes were derived by applying emissions rates to links in the model, with rates being determined by speed and traffic flow composition.

**Table 21. % of network with change in noise levels (compared to Do-Minimum, 2031)**

| Highway option | CNB | HV | % of network with increase | % of network with decrease | % of network with increase (net) |
|---|---|---|---|---|---|
| 1 | Yes | Retained | 1.4% | 0.6% | 0.8% |
| 2 | No | Removed | 3.6% | 2.7% | 1.0% |
| 3 | Yes | Removed | 3.7% | 2.7% | 0.9% |
| 4 | Yes | Retained | 3.2% | 1.0% | 2.3% |
| 5 | Yes | Retained | 4.3% | 1.7% | 2.6% |
| 6 | Yes | Removed | 5.8% | 2.6% | 3.2% |

8.10. The locations where perceptible changes in noise were forecast to be experienced are as follows:

- Option 1: Increases on the A14 between Fen Drayton and Milton affecting in particular the settlements of Bar Hill and Girton;
- Options 2 and 3: Increases on the A14 between Fen Drayton and Milton, although typically lower than in Option 1. Reductions in noise in the vicinity of the A14 between Brampton Hut and Spittals interchanges. Inevitable increases in noise levels in the immediate vicinity of the Huntingdon Southern Bypass alignment,
- Option 4: Similar increases in noise levels south of Trinity Foot and due to the Huntingdon Southern Bypass as Options 2 and 3. Negligible impact on noise levels on existing A14 alignment between Trinity Foot and the A1(M) and Brampton Hut.
- Option 5: Increases on the A14 between Girton and Fenstanton similar to those in Option 1. Increases in the vicinity of Huntingdon Southern Bypass similar to those in other options with this new alignment.
- Option 6: Increases in noise in the vicinity of the A428 between Caxton Gibbet and Girton, and increases in the vicinity of the remainder of the new/improved alignment between Caxton Gibbet and Ellington Reductions in noise on the existing A14 alignment between Brampton Hut and Spittals similar to the other highway options where this section is downgraded (Options 2 and 3).

## Local environmental impacts

8.11. A comparative environmental assessment of the long list of highway packages was conducted in Output 2, the findings of which can be found in the Output 2B/2C Report (summarised in Table 10 of that report). The following summarises the local environmental impacts of the six highway options. An overview environmental impact appraisal is provided in Appendix F.

### Landscape

8.12. The smallest option, Option 1, would have limited landscape effects as the option involves improvements within the existing A14 corridor – overall assessed as Slight Adverse. There would be some impacts on the fenland edge farmland character area and tranquillity of nearby villages. The Cambridge Northern Bypass enhancements are assessed as having a Neutral impact on landscape.

8.13. Those options which include the Huntingdon Southern Bypass (Options 2 to 6) would have a potentially Large Adverse effect on landscape as this offline section passes through mostly open, large scale arable landscape with some woodlands, valley floodplains and fenland. The settlements of Conington, Hilton, Offord Cluny, Buckden and Brampton are situated within these character areas. The HSB would have a Large Adverse effect on Ouse Valley landscape character which is deemed as being of high value and would have a Large Adverse effect on landscape pattern and tranquillity. The section along the A1 to Ellington would have a Slight Adverse effect on landscape pattern and tranquillity of nearby villages. If lit, these options would adversely affect the rural character. Options 2 to 5 would also lead to Slight Adverse landscape effects between Fenstanton and Girton in the same way as Option 1.

8.14. An equivalent local landscape character area assessment is not available for most of the A428/A1198 corridor. However, the topography continues to rise gently in a southerly direction with the A428 west of Hardwick on a local ridge; and there are three Registered Parks and Gardens along this section - Madingley Hall (Grade II) lies close to the east end of the A428 at Madingley, the American Military Cemetery (Grade I) is situated to the south of the A428 near Madingley and is bounded by the Cambridge Road and the A1303 and; Childerley Hall (Grade II*) in Dry Drayton.

### Townscape

8.15. Those options which remove the Huntingdon Viaduct (Options 2, 3 and 6) would result in positive townscape but some adverse effects due to partial loss of townscape spaces due to the replacement scheme, and potentially from additional lighting. Depending on traffic re-routing effects, traffic reduction in towns and villages could lead to a benefit in townscape character, access and human interaction, although without appropriate mitigation there is potential for additional traffic passing through Huntingdon if the viaduct is removed.

8.16. Overall, Options 1, 4 and 5 were assessed as Neutral, Options 2 and 3 as slight beneficial and Option 6 as overall Moderate Adverse due to the effects on setting and tranquillity on the western edge of Papworth Everard.

### Heritage of historic resources

8.17. It was not possible to assess the effect of the options on settlements and villages at some distance from the option alignments. The following sections highlight potential locations and effects.

8.18. All options traverse a landscape which is known for the potential for undesignated buried archaeological remains of medium importance, particularly relating to the Prehistoric and Roman periods. These remains have not been fully located and mapped. Topsoil removal and excavations for construction would result in their removal. With appropriate survey and mitigation works, the effect would be Moderate Adverse and sometimes Slight Adverse.

8.19. The Huntingdon Southern Bypass (part of Options 2 to 5) would alter the visual character of unlisted historic buildings at Rectory Farm, Lodge Farm and Graffham Road Cottages Brampton resulting in a Slight Adverse effect. There would be a Slight Adverse effect on the historic landscape of undesignated water meadows north of Offord Cluny due to the severance of the meadows by the option. The HSB would also result in a Moderate Adverse effect on the setting of Offord Cluny Conservation Area due to visual intrusion and Slight Adverse effects on two Grade II listed buildings in Offord Cluny. There would also be a Slight Adverse effect on the Hilton Conservation Area due to increase in noise level but the setting would not be affected. Reduction in traffic and noise levels with the Fenstanton Conservation Area and one Grade II* Listed Building within it, would result in a Slight Beneficial effect. At Conington there would be a Slight Adverse effect on 7 Listed Buildings and on the undesignated historic parkland of Conington Hall due to increased noise levels, although there would be no visual effect.

8.20. The Cambridge Northern Bypass enhancements (Options 1, 3, 4, 5 and 6) would have a Moderate Adverse effect on the visual setting and character on the Baits Bite Lock and Fen Ditton Conservation Areas and the Grade II* Listed Building of Biggen Abbey, and Slight Adverse effect on the Grade II LB Poplar Hall although the effects would be mitigated or cease in the long term following the completion of the construction works. The demolition of the undesignated historic Pill Box at the Girton Interchange would result in a Slight Adverse effect. Complexes of remains are known to exist near Clare College Farm, Hazlewell Farm, Grange Farm, west of the Girton Interchange, and the Histon junction. However, it is possible that other, hitherto unknown remains exist along other stretches of the option alignment.

8.21. Removal of the Huntingdon Railway Viaduct (Options 2, 3 and 6) would result in a moderate beneficial effect on the setting of the listed Huntingdon Station cartilage and structure, the LBII former Huntingdon County Hospital and the Scheduled Monument earthworks on Mill Common.

8.22. There are two Scheduled Monument within the environs of the A1198 (affected by Option 6); a moated site at Pastures Farm just west of Caxton Gibbet, and moated site at Papworth Hall in Papworth Everard. Their settings may be affected by Option 6, resulting in a Moderate Adverse effect. The historic mansion and Grade II Registered Park and Garden at Madingley Hall lies close to the east end of the A428 at Madingley; Grade II* Registered Park and Garden at Childerley Hall in Dry Drayton. While the upgrading of this A road may already have resulted in adverse effects to such assets, the option may further affect the settings of these designated monuments resulting in Moderate Adverse effects.

8.23. Overall, all six options were assessed as having Moderate Adverse effects on heritage of historic resources. Note however, that it is possible that other, hitherto unknown, remains exist which have not been accounted for.

### Biodiversity

8.24. None of the options would impact on statutory designated sites, although Options 2 to 6 would affect non-statutory designated sites, whilst Option 1 would not, and would result in Neutral or positive impacts on protected or notable species.

8.25. The Huntingdon Southern Bypass (in Options 2 to 6) would result in be some loss of habitat at Buckden Gravel Pits County Wildlife Site (CWS) resulting in adverse impacts on important bird populations. There would also be adverse impacts on badgers due to loss of a badger sett and disruption to existing badger territories (no badger setts would be lost in Option 1 although there may still be some adverse effects on badgers). Other impacts on protected or notable species are likely to be Neutral or positive.

8.26. In relation to the Option 6, the existing A1198/A428 route is within one kilometre of three Sites of Special Scientific Interest (SSSIs) which are also ancient woodlands. These are Papworth Wood (approx. 800 metres from alignment), Knapwell Wood (approx. 550 metres from the alignment), and Madingley Wood (approx. 70 metres from the A428 alignment). Option 6 also runs within approximately one kilometre of one SSSI ancient woodland (Elsworth Wood). There is one non-statutory designated site adjacent to the A1198; a grassland site at the junction with Barnfield Lane north of Papworth St Agnes. Direct impacts on these sites can be avoided with careful design and direct impacts minimised through appropriate mitigation. Other than the grassland at Barnfield Lane, no important habitats were identified adjacent to the current route. Species data was not available for assessment of this section.

8.27. The Cambridge Northern Bypass enhancement is not expected to have any additional significant impacts.

8.28. Overall, Option 1 was assessed as Neutral for biodiversity impacts whilst Options 2 to 6 were assessed as Moderate Adverse.

### Water environment

8.29. None of the options would affect an SSSI or a groundwater Site Protection Zone (SPZ).

8.30. All six options would cross flood zone 3 at a main river. Options 1 and 6 have one river crossing whilst Options 2 to 5 each have three river crossings. These are as follows:

- Cottenham Lode (Options 1 to 5)
- Ouse (Options 2 to 6);
- West Brook (Options 2 to 5).

8.31. Similarly, Options 1 and 6 would impact one area of ecological quality whilst Options 2 to 5 each impact on three areas.

8.32. Overall Option 1 was assessed as potentially being slightly beneficial to the water environment whilst Options 2 to 6 were assessed as having a Neutral impact.

8.33. Those options which downgrade the A14 alignment (Options 2, 3 and 6) may reduce the impermeable area. However, this may be partially or fully offset by an increase in impermeable area due to the Huntingdon Southern Bypass (although Option 6 is likely to result in less increase than Options 2 to 5).

## Implications of environmental effects on key decisions

8.34. Table 22 summarises the implications of the testing and appraisal results in terms of the five characteristics of the highway options which will be a key determinant of the nature of the preferred package(s).

**Table 22. Implications of environmental effects on key decisions**

| Characteristic | Commentary |
|---|---|
| **Large scheme** (with Huntingdon Southern Bypass) **or smaller scheme** | Option 1 (the smaller scheme) would result in lower levels of greenhouse gas, $NO_x$ and $PM_{10}$ emissions than the larger schemes, and increases in noise levels limited to Fenstanton-Girton. Increases $NO_x$ emissions in the A14 Huntingdon AQMA, but lower increases in the A14 Fenstanton-Milton AQMA. Negative local environmental impacts of the larger schemes are greater. |
| Enhancement of **A14 or A428/A1198 corridor** (in addition to Huntingdon Southern Bypass) | Option 6 (the A428/A1198 option) would result in higher levels of greenhouse gas, $NO_x$ and $PM_{10}$ emissions than the other larger schemes; however Option 6 would reduce $NO_x$ emissions in the A14 Fenstanton-Milton AQMA. Option 6 would also result in a larger proportion of the network experiencing a perceptible increase in noise levels, although largely in sparsely populated areas with the exception of Papworth Everard and a number of settlements such as Buckden which are also affected by those options which include a Huntingdon Southern Bypass. |
| **Widening or Local Access Roads** on A14 (in addition to HSB) | Widening options (such as Option 4) would cause smaller increases in levels of greenhouse gas, $NO_x$ and $PM_{10}$ emissions than the LARs option (Option 5) as widening results in higher speeds between Trinity Foot and Girton. However, the widening option would result in a slightly larger share of the network experiencing perceptible increases in noise levels. |
| Retention (as strategic link) or removal of **Huntingdon Railway Viaduct** | Removal of the Huntingdon Railway Viaduct would lead to larger increases in emissions of greenhouse gases, $NO_x$ and $PM_{10}$ than options in which the viaduct is retained (Option 3 vs. Option 4). Noise levels would be reduced in the vicinity of Brampton whilst there would be only a small increase in noise as a result of more traffic using the Huntingdon Southern Bypass and generally away from populated areas. Removal of the viaduct would lead to townscape benefits and reductions in $NO_x$ emissions in the A14 Huntingdon AQMA. |
| Enhancements to **Cambridge Northern Bypass** | Comparison of Options 2 and 3 shows that the Cambridge Northern Bypass enhancements would increase emissions by approximately 10% but reduce emissions in the Cambridge city centre AQMA by 2% (without the enhancements, emissions rise by 2%). There would be a negligible impact on noise levels. |

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# 9. Total monetised benefits of the six shortlisted highway options

9.1. The total forecast monetised benefits for each highway option are shown in Table 23. All figures are Present Value (PV), 2002 prices (in line with prevailing WebTAG appraisal guidance at the time of preparation) over a 60 year appraisal period and assume, for the purposes of economic appraisal, a 2021 opening year.

**Table 23. Total monetised benefits (Present Value, millions, 2002 prices)**

| Highway option | CNB | HV | Economic efficiency - commuters | Economic efficiency – business users/providers | Accidents | Greenhouse gases | Indirect taxation revenues | Total PV Benefits |
|---|---|---|---|---|---|---|---|---|
| 1 | Yes | Retained | £238 | £271 | £18 | £3 | -£6 | **£523** |
| 2 | No | Removed | £329 | £478 | £100 | -£14 | £30 | **£922** |
| 3 | Yes | Removed | £444 | £624 | £111 | -£16 | £32 | **£1,195** |
| 4 | Yes | Retained | £563 | £852 | £97 | £1 | £0 | **£1,512** |
| 5 | Yes | Retained | £632 | £908 | £88 | £9 | -£16 | **£1,621** |
| 6 | Yes | Removed | £373 | £455 | £104 | -£35 | £71 | **£968** |

*Note: Noise, air quality and reliability benefits have not been monetised.*

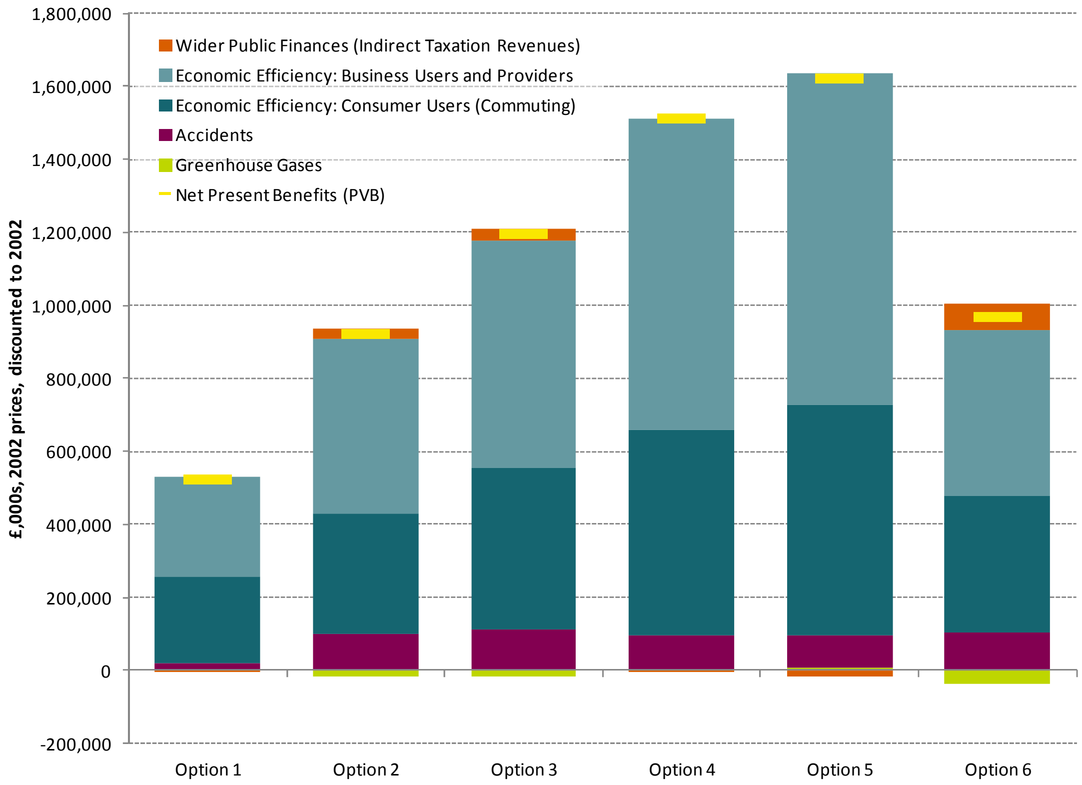
9.2. The table shows that economic efficiency benefits through journey time savings account for the vast majority of monetised benefits with the remaining elements accounting for less than 10% of the total. It should be noted however that, in line with standard practice, not all benefits and dis-benefits are monetised in this way (such as those relating to noise, emissions, local environmental impacts, townscape and landscape).

9.3. Options 4 and 5 would generate the highest level of total monetised benefit. Both retain the Huntingdon Railway Viaduct; indeed those highway options which do so perform better, as downgrading the existing route would require strategic traffic to/from the A1(M) corridor to travel further (adversely affecting journey time savings as well as distance-related metrics such as greenhouse gas emissions). However, some of the non-monetised benefits (such as air quality and townscape) would be greater for those options where the viaduct is removed.

9.4. Option 1 would generate only a third of the overall monetised benefits of the best-performing options and approximately half those of the next-worse performing options, Options 2 and 6.

9.5. Total benefits for each highway option are shown in Figure 17.

**Figure 17. Total monetised benefits (Present Value, millions, 2002 prices)**




# Implications of total benefits on key decisions

9.6. Table 24 summarises the implications of the testing and appraisal results in terms of the five characteristics of the highway options which will be a key determinant of the nature of the preferred package(s).

**Table 24. Implications of total benefits on key decisions**

| Characteristic | Commentary |
|---|---|
| **Large scheme** (with HSB) **or smaller scheme** | Option 1 would generate the smallest overall monetised benefit – roughly half those of the next-lowest options, Options 2 and 6, and roughly a third of the best-performing options. |
| Enhancement of **A14 or A428/A1198 corridor** (in addition to HSB) | The benefits generated by all three options with enhancements to the A14, Huntingdon Southern Bypass and Cambridge Northern Bypass (Options 3 to 5) would be at least 25% higher (and up to 65% higher) than those generated by Option 6 (the A428/A1198 alignment). |
| **Widening or Local Access Roads** on A14 (in addition to HSB) | Option 5 (with LARs) would generate the highest monetised benefits, 7% higher total benefits than Option 4 (the widening comparator). In particular, Option 4 would generate higher commuter time savings (+12%). |
| Retention (as strategic link) or removal of **Huntingdon Railway Viaduct** | In terms of monetised benefits, Option 4 (which retains the viaduct) would generate 27% more total benefits than Option 3 (which would remove the viaduct and provides a higher-capacity HSB). Journey time savings for business users and providers would be 37% higher if the viaduct were retained (Option 4 vs. Option 3). |
| Enhancements to **Cambridge Northern Bypass** | Options with enhancements to Cambridge Northern Bypass would generate higher benefits. Option 3 would generate nearly 30% more benefits than the comparable Option 2 for example (with commuter time savings being 35% higher). |

# 10. Total costs of the six shortlisted highway options

## Introduction

10.1. This section sets out the capital and operating costs associated with each of the highway options. Costs are presented in Q4 2011 prices (i.e. current year) and Q4 2019 prices (i.e. mid-point of the construction period as assumed for the economic appraisal of options). The Q4 2011 costs are presented in the current, undiscounted amounts and as Present Values (PV, i.e. discounted). This section also sets out the methodologies used to derive the costs.

## Capital costs

### Derivation of cost estimates

10.2. Capital cost estimates were prepared by Atkins in collaboration with the Highways Agency. The basic works costs estimates were derived based on historic unit rates for length of new/widened carriageway, number of structures (by type) and other features required.

10.3. On-costs to convert from basic construction costs to outturn project costs were calculated using uplift factors agreed with the Highways Agency. The factors were determined through an iterative refinement of the methodology and assumptions used by Atkins and the Highways Agency until agreement on them was reached. In both cases, the methods and assumptions used were based on historic outturn costs. The factors used were as follows:

- On costs to derive construction cost:
  - Project overheads and method-related charges: 42% of works cost.
  - Construction phase design duties: 3% of works cost.
  - Insurance and other items: 3% of works cost.
  - Fees (e.g. for design): 9% of works cost.
- On costs to derive project cost:
  - Development phase costs: 8% of construction cost.
  - Highways Agency and employer's agent costs: 4% of construction cost.
  - Non-recoverable VAT: 12% of construction cost.
  - HUB contribution: 0.5% of construction cost.
  - Highways Agency managed project-specific costs: 3% of construction cost.
  - Utilities: 7% of construction cost.
  - Land: 5% of construction cost.
  - Environmental mitigation; 0% of construction cost.
- On costs to derive pre-inflation budget cost:
  - Risk (including unscheduled items): 25% of project cost.
  - HA uncertainty: 13% of project cost.
  - HA programme risk: 12% of project costs plus risk and uncertainty.

10.4. The cost expenditure profile, as shown in Table 25, follows that of the EFD scheme and assumes a 2018 construction start and a 2021 opening year (although the actual years of construction and opening may be different).

**Table 25. Capital cost profile**

| Financial year | Share of capital cost | Expenditure |
|---|---|---|
| 2015/16 | 1% | Preparation |
| 2016/17 | 2% | Preparation |
| 2017/18 | 6% | Construction, land, supervision |
| 2018/19 | 26% | Construction |
| 2019/20 | 31% | Construction |
| 2020/21 | 29% | Construction |
| 2021/22 | 5% | Snagging, opening year |

## Capital cost estimates

10.5. The total capital (budget) costs for each option are shown in Table 26 below. They include allowance for real changes in construction costs between 2006 (the year for which prices are calculated) and construction year costs are shown both in Q4 2011 and Q4 2019 prices.

**Table 26. Capital cost estimate components (millions, total budget cost)**

| Highway option | Q4 2011 prices | Q4 2019 prices |
|---|---|---|
| 1 | £506 | £687 |
| 2 | £1,029 | £1,399 |
| 3 | £1,120 | £1,522 |
| 4 | £900 | £1,224 |
| 5 | £895 | £1,217 |
| 6 | £1,168 | £1,589 |

*Note: Estimation of capital costs at Q4 2019 prices based on long-term historic data. These costs are inclusive of non-recoverable VAT which accounts for 12% of the construction costs or 8.6% of the total project cost in each case.*

10.6. The costs at Q4 2011 prices in the table above can be compared with the estimated capital costs of the EFD scheme following the value management exercise undertaken by the Costain/Skanska consortium in August 2010. The Q4 2011 costs shown above are *broadly* comparable with the estimated total outturn cost (excluding inflation and historic costs, but including programme risk) of the EFD scheme at this time of £878 million (in 2008 prices).

## Capital costs for use in the economic appraisal

10.7. The capital costs shown above were adjusted for use in the economic appraisal in three ways:

- conversion to 2002 prices by removing the effects of general inflation from 2002 onwards;
- discounting to 2002 values; and
- conversion from ‘factor prices’ to ‘market prices’.

10.8. These adjustments were calculated in line with the current WebTAG and Green Book guidance at the time of preparation assuming:

- the capital cost profile above;
- a 2002 price base [20];
- construction cost inflation rates from 2002 to 2011 based on actual inflation rates from the BIS RoadCon index;
- construction cost inflation rates 2011-2019 based on the Highways Agency’s Range Estimating Tool;

[20] *WebTAG guidance was updated in August 2012 to recommend a price base of 2010 for economic appraisal.*

- underlying inflation rates based on historic RPI (2002-2011), Bank of England forecasts (2012-2014);
- underlying inflation for 2015 onwards assumed to be 3.5% per annum;
- an annual discount rate of 3.5% pa (3.0% pa after 30 years) to a discount year of 2002; and
- removal of unrecoverable VAT and inclusion of indirect taxation at 20.9% [21].

10.9. The Net Present Values of the budget costs estimates are shown in Table 27 below. The values in the middle column were used to calculate Benefit: Cost Ratios in the following chapter. In line with standard appraisal practice, these values are based on market prices (i.e. excluding unrecoverable VAT) and include indirect taxation [22]. For information, the Net Present Value of Costs excluding the indirect taxation but including non-recoverable VAT is also shown to indicate the representative cost to the Highways Agency.

**Table 27. Budget cost estimates (Present Value, millions, 2002 prices, discounted)**

| Highway option | Present Value of capital costs (market prices) | *PV excluding indirect taxation & including VAT* |
|---|---|---|
| 1 | £243 | *£220* |
| 2 | £494 | *£447* |
| 3 | £537 | *£486* |
| 4 | £432 | *£391* |
| 5 | £430 | *£389* |
| 6 | £561 | *£508* |

## Maintenance costs

10.10. Net maintenance costs for the new and enhanced section of road were derived based on network length and unit cost rates, maintenance profiles and duration drawn from DMRB [23]. Costs were estimated for a 60 year period (therefore including renewals) and assuming a 2021 opening year for the Do-Minimum and each highway option (relevant links only).

10.11. Net (i.e. additional to Do-Minimum) maintenance costs are shown in Table 28.The discounted values in the right hand column exclude non-recoverable VAT and include indirect taxation (i.e. they are market prices).

*[21] See WebTAG Unit 3.5.6. The adjustment to market prices was applied to 100% of the capital cost although in reality it is anticipated that a (currently unknown) share of the capital cost will be paid for through local contributions and toll revenue.*

*[22] The discounted capital cost is increased by 20.9% to reflect the level of tax increase required to fund the expenditure, taking into account reductions in tax income due to higher tax rates restricting taxable expenditure.*

*[23] DfT (2012) Design Manual for Roads & Bridges Volume 14 – Economic Assessment of Road Maintenance*

**Table 28. Net maintenance cost estimates (Net Present Cost, millions)**

| Highway option | Average cost per annum (Q4 2011 prices) | Average cost per annum (Q4 2019 prices) | Discounted (60 years, 2002 prices, millions, market prices) |
|---|---|---|---|
| 1 | +£0.5 | +£0.6 | +£6 |
| 2 | +£1.4 | +£1.7 | +£17 |
| 3 | +£1.5 | +£1.9 | +£19 |
| 4 | +£1.5 | +£1.8 | +£18 |
| 5 | +£1.0 | +£1.3 | +£13 |
| 6 | +£1.9 | +£2.4 | +£23 |

### Huntingdon Railway Viaduct

10.12. The Highways Agency plans to undertake further remedial work to extend the life of the Huntingdon Railway during the winter of 2012/13. This will keep the viaduct serviceable "for the foreseeable future" although the Highways Agency is currently unable to define the exact life of the structure. Some uncertainty therefore remains over the long-term costs associated with retaining the viaduct structure over and above those committed for the 2012/13 works.

10.13. The Highways Agency therefore proposed three potential scenarios for the purposes of this appraisal:

- Scenario 1: No further work is required beyond that already planned.
- Scenario 2: Includes strengthening of the deck elements that have not been previously strengthened (assumes additional out-turn maintenance cost of £10 million 30 years after opening - in 2011 prices, exclusive of VAT).
- Scenario 3: Includes replacement of the viaduct deck (assumes additional out-turn maintenance cost of £100 million 30 years after opening – in 2011 prices, exclusive of VAT).

10.14. These costs affect Options 1, 4 and 5 only.

10.15. For the purposes of the economic appraisal, these costs were converted to 2002 prices, discounted (to reflect the fact that it is assumed these costs would be incurred in 30 years time) and converted to market prices. The £10 million in 2011 prices is equivalent to £9.1 million in 2002 market prices (£2.1 million discounted), whilst the £100 million in 2011 prices is equivalent to £91 million in 2002 market prices (£21.4 million discounted). The 2002 market prices, also discounted to 2002 values for use in the economic appraisal, are shown in Table 29. These costs exclude non-recoverable VAT and include indirect taxation (i.e. they are market prices).

**Table 29. Additional maintenance costs associated with further work to Huntingdon Railway Viaduct (Net Present Cost, 2002 prices, discounted)**

| Highway option | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| 1 | £0.0 | **£2.1** | **£21.4** |
| 2 | £0.0 | £0.0 | £0.0 |
| 3 | £0.0 | £0.0 | £0.0 |
| 4 | £0.0 | **£2.1** | **£21.4** |
| 5 | £0.0 | **£2.1** | **£21.4** |
| 6 | £0.0 | £0.0 | £0.0 |

## Implications of total costs on key decisions

10.16. Table 30 summarises the implications of the testing and appraisal results in terms of the five characteristics of the highway options which will be a key determinant of the nature of the preferred package(s).

**Table 30. Implications of total costs on key decisions**

| Characteristic | Commentary |
|---|---|
| **Large scheme** (with Huntingdon Southern Bypass) **or smaller scheme** | Option 1 would be the least-expensive highway option, with a total budget capital cost of £506 million. The comparable costs of the other (larger) options range from £895 to £1,168. |
| Enhancement of **A14 or A428/A1198 corridor** (in addition to Huntingdon Southern Bypass) | With a total budget capital cost of £1,168 million, Option 6 (the A428/A1198 option) would be the most expensive highway option. However, it would be only £48 million more expensive than Option 3 (which would include the full-length HSB, widening of the A14 and improvements at Girton instead of the A428/A1198 enhancement). |
| **Widening or Local Access Roads** on A14 (in addition to HSB) | Option 5 (LARs) has an estimated total budget capital cost £5 million lower than the comparable option with widening between Girton and the Huntingdon Southern Bypass (Option 4). This is within the margins of error of the cost estimating process. |
| Retention (as strategic link) or removal of **Huntingdon Railway Viaduct** | Retention of the Huntingdon Railway Viaduct and provision of a D2AP rather than D3AP HSB (Options 4 and 3 respectively) would reduce the total budget capital cost by £220 million compared to removing the viaduct and replacing it with the EFD local road configuration. However, there may be additional remedial works required on the Viaduct at a future date costing up to £100 million. |
| Enhancements to **Cambridge Northern Bypass** | Enhancements to the Cambridge Northern Bypass would have an additional total budget cost of £91 million (comparing Options 2 and 3). |

*Note: All costs quoted in the table above are in Q4 2011 prices. Costs are capital costs only.*

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# 11. Summary and recommendations from highway option testing

## Summary of benefits and costs

11.1. Table 31 provides a summary of the actual benefits and costs of each highway option. The best highway option against each criterion is shaded in green, the worst in red. The Appraisal Summary Tables (AST) for these options are contained in Appendix H.

**Table 31. Summary of benefits and costs (annual benefits shown, for 2031)**

| Highway option | CNB | HV | Economic efficiency *(change in vehicle hours, annual millions)* | | | Accidents *(change in PIAs, all links in model, annual)* | | Emissions *(change, 1,000s of tonnes, annual)* | | | Noise *(% all network with perceptible change)* | | Overall local environmental impacts *(subjective assessment)* | | | | | Costs *(2011 prices)* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cars & LGVs | HGVs | All | Fatal | All | $CO_2$ | $PM_{10}$ | $NO_x$ | Increase | Decrease | Landscape | Townscape | Heritage | Bio-diversity | Water environmt. | Capex *(budget cost, m)* | Maint-enance *(avg. annual, net, m)* |
| 1 | Yes | Retained | -0.92 | -0.12 | -1.04 | *No change* | -0.6% | +1,550 *(+0.3%)* | +0.9 *(+0.3%)* | +21.9 *(+0.6%)* | 1.4% | 0.6% | Slight -ve | Neutral | Moder-ate -ve | Neutral | Slight +ve | £506 | £0.5 |
| 2 | No | Removed | -1.44 | -0.27 | -1.70 | *-3.0%* | -2.3% | +14,294 *(+3.0%)* | +7.4 *(+2.3%)* | +136.0 *(+3.5%)* | 3.6% | 2.7% | Large -ve | Slight +ve | Moder-ate -ve | Moder-ate -ve | Neutral | £1,029 | £1.4 |
| 3 | Yes | Removed | -1.93 | -0.33 | -2.26 | *-3.1%* | -2.6% | +15,711 *(+3.3%)* | +8.2 *(+2.5%)* | +149.4 *(+3.8%)* | 3.7% | 2.7% | Large -ve | Slight +ve | Moder-ate -ve | Moder-ate –ve | Neutral | £1,120 | £1.5 |
| 4 | Yes | Retained | -2.32 | -0.45 | -2.78 | *-2.4%* | -2.3% | +10.862 *(+2.3%)* | +5.9 *(+1.8%)* | +107.5 *(+2.7%)* | 3.2% | 1.0% | Large -ve | Neutral | Moder-ate -ve | Moder-ate –ve | Neutral | £900 | £1.5 |
| 5 | Yes | Retained | -2.50 | -0.48 | -2.98 | *-2.0%* | -2.2% | +8,131 *(+1.7%)* | +4.3 *(+1.3%)* | +81.7 *(+2.1%)* | 4.3% | 1.7% | Large -ve | Neutral | Moder-ate -ve | Moder-ate –ve | Neutral | £895 | £1.0 |
| 6 | Yes | Removed | -1.82 | -0.20 | -2.02 | *-3.1%* | -2.4% | +20,092 *(+4.2%)* | +10.9 *(+3.3%)* | +192.0 *(+4.9%)* | 5.8% | 2.6% | Large -ve | Moder-ate -ve | Moder-ate -ve | Moder-ate -ve | Neutral | £1,168 | £1.9 |

*Note: Costs associated with further renewals/maintenance of the Huntingdon Railway Viaduct are not included in this table (i.e. the table reflects the Scenario 1 position)*

# Summary appraisal results and Benefit : Cost ratios

11.2. A summary of the monetised appraisal results of the highway options is provided in Table 32. In line with WebTAG guidance at the time of preparation, the present values of costs and benefits are shown in 2002 prices. Note that monetised benefits relate to economic efficiency and accident benefits only (other categories of benefits are not monetised). Ranges are used to show where costs (and therefore Net Present Values and BCRs) vary depending on assumptions about costs relating to future maintenance costs for Huntingdon Railway Viaduct (see Chapter 10 for details)

**Table 32. Summary of highway option appraisal (Present Value millions, 2002 prices and discounts, 60 year appraisal) under 3 cost scenarios**

| Highway option | CNB | HV | Present Value of benefits | Present Value of costs | Net Present Value | PV Benefit / PV Cost (BCR) |
|---|---|---|---|---|---|---|
| 1 | Yes | Retained | £523 | £249 - £270 | £253 - £274 | 1.94 - 2.10 |
| 2 | No | Removed | £921 | £511 | £410 | 1.80 |
| 3 | Yes | Removed | £1,195 | £556 | £639 | 2.15 |
| 4 | Yes | Retained | £1,512 | £450 - £472 | £1,040 - £1,062 | 3.20 - 3.36 |
| 5 | Yes | Retained | £1,621 | £443 - £464 | £1,157 - £1,179 | 3.49 - 3.66 |
| 6 | Yes | Removed | £968 | £584 | £384 | 1.66 |

*Note Present Value of costs are based on market prices (i.e. exclusive of non-recoverable VAT and inclusive of indirect taxation). Net Present Value is the Present Value of benefits less the Present Value of costs.*

11.3. The relative performance of the highway options in terms of Present Value of benefits and costs is described in Chapters 9 and 10 respectively. With the highest PV benefits and lower PV costs Options 4 and 5 would deliver notably higher Net Present Values (NPVs) than the other options and consequently achieve the best Benefit : Cost Ratios (BCRs) of around 3.5. Option 3 would have relatively high benefits but, due to its higher costs, it has a lower NPV and poorer BCR than Options 4 and 5. Option 3 would have much higher benefits than Option 1 but also much higher costs, resulting in a similar BCR. Options 2 and 6 have similar benefits (albeit lower than Option 3), and similar costs resulting in BCRs of 1.6 - 1.8.

## Summary of impact assessment

11.4. The intention of the second-round of highway package testing was to select one or two highway options for further analysis, based on a better understanding of the relative performance of the six options tested. Specifically, the highway options were selected in order to inform judgements on the relative performance of five key characteristics of the options.

11.5. The relative performance of the highway options against these five characteristics are described below.

- The smaller option (Option 1) has limited impacts, positive or negative

| Advantages of smaller scheme | Disadvantages of smaller scheme |
|---|---|
| ✓ Few unwanted traffic effects<br>✓ Lowest increases in $CO_2$, $PM_{10}$ and $NO_x$ emissions.<br>✓ Smallest noise and local environmental impacts.<br>✓ Less expensive than larger options.<br>✓ Delivers benefits relative to cost (BCR of around 2, better than some other options) | ✗ Generates a third of the journey time savings of some larger options.<br>✗ Does not resolve many congestion issues.<br>✗ Does little to reduce accidents.<br>✗ Relatively low Net Present Value<br>✗ BCR significantly lower than best-performing options.<br>✗ Would not, in isolation, lend itself to tolling. |

- an enhancement of the A14 with a Huntingdon Southern Bypass is preferable to enhancement of the A428/A1198 alignment (Option 6);

| Advantages of A14/HSB route | Disadvantages of A14/HSB route |
|---|---|
| ✓ Generates up to 50% more journey time savings.<br>✓ Lower emissions, noise and environmental impacts.<br>✓ Lower capital costs (by at least £48m in Q4 2011 prices) and lower net maintenance costs.<br>✓ Much higher BCR – A428/A1198 option has lowest BCR | ✗ Offers fewer network-wide benefits than A1198/A428.<br>✗ A428/A1198 route significantly reduces $NO_x$ emissions in A14 AQMA (but could lead to designation of a new AQMA). |

- Local Access Roads (LARs) perform better than widening on the A14 (in combination with HSB)

| Advantages of LARs | Disadvantages of LARs |
|---|---|
| ✓ Slightly higher journey time savings (c. 5-10%).<br>✓ Better at reducing delays between Trinity Foot and Girton.<br>✓ Smaller increase in $CO_2$, $PM_{10}$ and $NO_x$ emissions.<br>✓ Greater decrease in length of network with perceptible noise nuisance.<br>✓ Higher monetised benefits, for less cost (therefore higher BCR).<br>✓ Enables tolling of main carriageway and provision of free local route.<br>✓ Greater operational flexibility and resilience. | ✗ Slightly smaller reduction in accidents than widening.<br>✗ Greater increase in length of network with perceptible noise nuisance.<br>✗ More complex enhancement of Girton interchange required.<br>✗ Draws more traffic into A14 corridor from elsewhere. |

- the relative performance of retaining or removing the Huntingdon Railway Viaduct varies between the different criteria;

| Advantages of removing viaduct | Disadvantages of removing viaduct |
|---|---|
| ✓ Strategic traffic removed from vicinity of Huntingdon.<br>✓ Higher reduction in the number of accidents.<br>✓ Larger network length with perceptible reduction in noise levels.<br>✓ Townscape benefits in Huntingdon.<br>✓ Reduces $NO_x$ emissions in Huntingdon AQMA.<br>✓ Enables worthwhile revenues to be collected by tolling Huntingdon Southern Bypass.<br>✓ Allows removal of infrastructure of unknown serviceable lifespan. | ✗ Huntingdon Southern Bypass offers only a marginal time saving for north-south traffic compared to Do-Minimum.<br>✗ A small share of strategic traffic routes through Huntingdon although this will depend on the detailed design ultimately adopted.<br>✗ Journey time savings 20% lower.<br>✗ Approx. one third larger increase in $CO_2$, $PM_{10}$ and $NO_x$ emissions.<br>✗ 27% lower monetised benefits.<br>✗ Significantly higher capital cost.<br>✗ Lower BCR (of 1.7 - 2.2) compared to retaining viaduct (around 3.5 for the larger options) |

- there is a strong case for including enhancements to the Cambridge Northern Bypass (CNB) in the preferred scheme.

| Advantages of CNB enhancement | Disadvantages of CNB enhancement |
|---|---|
| ✓ A third more journey time savings.<br>✓ Six minutes removed from Girton-Milton journey in peak direction.<br>✓ Slightly higher accident benefits.<br>✓ Reduces $NO_x$ emissions in central Cambridge.<br>✓ 30% more monetised benefits for 9% more cost. | ✗ Slightly higher (<10%) increase in emissions.<br>✗ £91 million higher capital cost (Q4 2011 prices). |

## Recommendations

11.6. The summary above shows that the best-performing highway options are those which:

- are larger, thereby offering solutions to a greater number of problems;
- provide a full Huntingdon Southern Bypass and provide Local Access Roads between the HSB and Girton; and
- enhance the Cambridge Northern Bypass.

11.7. However, the appraisal offers less of a steer on the issue of retention or downgrading of the existing A14 alignment adjacent to Huntingdon. Whilst the monetised elements of the appraisal tend to support retaining the existing route, most of the non-monetised elements point towards downgrading.

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# 12. Effects of tolling of highway option

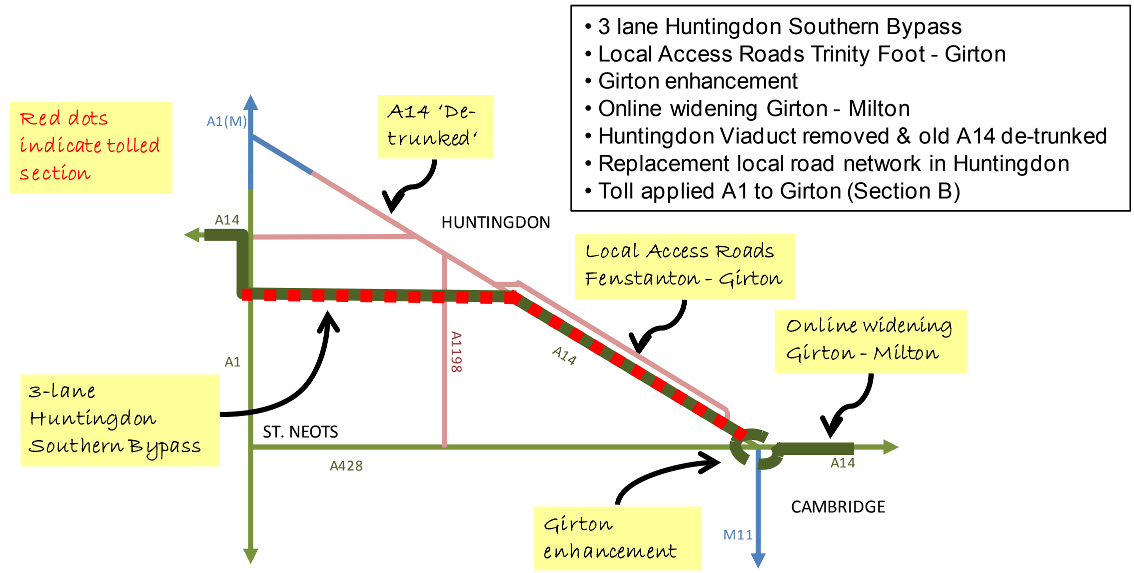
## Selection of option for testing tolling effects

12.1. The results set out in the previous chapter were discussed by the Project Board on the 21st June 2012. This discussion included consideration of which highway option to use as the basis for examination of tolling impacts. On the basis that the Project Board sought to identify an option which is both beneficial in economic, environmental and social terms, and one which could be partly self-funding (through application of a toll for use of the additional capacity provided), the basis for the tolling tests was agreed as an option which:

- has the potential for delivering the most benefits (i.e. one which includes Huntingdon Southern Bypass, enhancements to the A14 between CNB and Girton and enhancements to the Cambridge Northern Bypass);
- would offer a free local alternative route (partly by providing Local Access Roads parallel to the section of tolled main carriageway and via the old A14 north of Trinity Foot); and
- would minimise unwanted diversionary effects due to the toll (i.e. downgrades the existing route past Huntingdon; and provides other anti-diversionary measures on the surrounding local road network).

12.2. These aims led logically to the creation of a new option that blended the characteristics of Options 3 and 5. This new, previously un-tested, option was labelled Option 7 and is shown in Figure 18.

**Figure 18. Schematic layout of Option 7**



## Initial tolling assumptions

12.3. The Project Board agreed the key characteristics of the tolling regime to be tested. These were seen as the starting point for the testing, with opportunity to modify them and consider alternatives as the modelling progressed. The initial assumptions are summarised in Table 33.

**Table 33. Summary of tolling regime initial assumptions**

| Characteristic | Description | Modelling approach |
|---|---|---|
| Tolled section | Short: Ellington to Trinity Foot (Test A)<br>Medium: Ellington to Girton (Test B)<br>Long: Ellington to Milton (Test C) | |
| Toll application | All vehicles using any part of the tolled section.<br>Toll applied to each journey. | Toll applied to all links leading only to tolled section (e.g. on slips). |
| Time period | All day, every day of the year from opening day. | |
| Tariff levels (2011 prices) | £2 for cars and light goods vehicles<br>£4 for heavy goods vehicles | Full cashbox tariffs applied in model.<br>Applicable from opening year. |
| Tolling method | Not defined, but a free-flow method (i.e. unlikely to be traditional toll booths). | No delay to the user to make payment assumed. |
| Discounts and exemptions | None assumed at this stage, although it was noted that, in reality, there would likely be a small number of exemption classes (e.g. the emergency services). | None modelled. |

12.4. The initial tariff level selected was based on the approximate monetary value of time (based upon WebTAG road user values of time) that would arise from the average journey. This calculation produced a value of approximately £2 for light vehicles and £4 for heavy vehicles in 2011 prices.

## Initial approach to forecasting

### Types of effects forecast

12.5. It is important to be clear about two modelling issues at this point. Firstly, at this stage highway trip generation and distribution effects were estimated using the DIADEM software. The impacts of the best-performing tolled option were also estimated using the Cambridge Sub-Regional Model (CSRM). As the latter is a multi-modal model and allows explicitly for modal switch, estimates of highway demand effects of the toll will vary slightly between the two approaches. Secondly, like all models, the assignment model used for the tolling tests was limited in terms of the road network which is explicitly represented. This means that some alternative strategic routes well outside the coverage of the model were not represented, specifically in this case the M1 corridor. As a consequence, the tolling tests may have over-estimated demand in the corridor as traffic which could divert via the M25/M1 as an alternative to the M11/A1(M) was retained within the modelled network [24].

[24] *Modelling work by the Highways Agency, albeit at a fairly simplistic level, suggests that application of a toll on the A14 could result in up to 5% of long-distance trips diverting to the M1 corridor.*

12.6. The modelling of the toll included a forecast of changes in the patterns of demand for travel as a result of the toll being introduced. The following three different types of change were reflected in the DIADEM approach:

- suppression of the total number of trips made (trip generation);
- changing trip origins, destinations and trip lengths (trip distribution); and
- re-routing of trips at a local and strategic level (re-assignment).

### Modelling anti-diversionary measures

12.7. In practice, application of a toll will lead to some diversion onto non-tolled alternative routes on the local road network. To minimise these effects in practice, it will be necessary to apply anti-diversionary measures on the local road network, such as traffic management measures, signage and HGV bans on some local roads may be needed. It will be important that the design of such measures avoids reducing the efficiency of the local road network, thereby penalising unfairly those not using the new A14 capacity.

12.8. In modelling the toll, the most serious likely diversionary effects were initially identified by running the model with a very high toll; changes to the coding of the modelled network were made to represent measures to reduce the capacity of some links that would form part of the diversionary routes. Note however, that the changes to the modelled network were simplistic (the capacity of relevant links was halved) and in themselves were not intended to represent specific measures but that the assumptions are indicative of what could be achieved with traffic engineering measures. The links for which capacity was halved in the model were:

- Impington (Milton Road / Butt Lane);
- Dry Drayton (Scotland Road);
- Ramper Road;
- Rampton (High Street);
- Abbots Ripton (all routes to village centre);
- Buckden (Mill Road);
- Grafham (all routes to village centre);
- Offord D’Arcy (High Street);
- Graveley (Toseland Road);
- Gamlingay (Station Road / Hatley Road); and
- Longstanton (High Street – north end).

12.9. The modelling did not include any mitigation measures to deter diversion on the local road networks in either Huntingdon (beyond the removal of the Huntingdon Viaduct and replacement with a local road network) or Cambridge as it was considered that, in so doing, the local functionality of these road networks could be constrained. Whilst it may be possible to deter some toll-avoiding traffic from travelling through Cambridge and Huntingdon, for example by limiting access to or from the A14, such measures would require careful consideration. The impacts of not applying mitigation measures in Huntingdon or Cambridge are discussed later in this chapter.

12.10. It should be noted that at this stage no attempt was made to define the nature of these measures other than as described above. Further, there will inevitably be substantial iteration and re-testing of all elements of the scheme design (including anti-diversionary measures) as development of the project progresses further. The measures tested here are simply intended to counter unwanted diversion to allow reasonable assessment of the likely impacts of tolling, should appropriate measures be in place.

### Actual versus perceived toll levels

12.11. There is currently some debate about the relationship between actual toll levels charged and the level of toll perceived by drivers, specifically that drivers using a tolled road behave in a way which suggests that the toll level is lower than it actually is. There are thought to be three possible reasons for this:

- toll road users tend to perceive the journey time via the un-tolled route as being longer than it actually is;
- toll road users place a high value on the expected reliability of the tolled road and choose their route accordingly; and
- use of smartcards, tokens and contactless technology, coupled with an increasing trend towards user accounts and payment by direct debit mean that fewer drivers pay tolls using cash.

12.12. Understanding of these effects is currently limited but, if true, they suggest that models used to forecast demand for travel in a scenario including a tolled road could under-estimate their use. There are other model-related issues which exacerbate the potential real life effects above and thereby mean that traditional highway assignment models will inherently under-predict usage of toll roads. For example:

- if toll road users do indeed perceive the journey times un-tolled alternatives as being longer than they are, models which rightly represent the average hour rather than a worst case scenario on the un-tolled alternative will route fewer vehicles via a tolled route as the relative benefit of doing so is less;
- related to the above, models make routing decisions based on full and prior knowledge of the typical journey times of each route for a given set of conditions; in reality of course traffic conditions vary from day-to-day and even drivers who know the alternative routes do not have this knowledge and tend to make decisions based on their "worst case scenario" of the un-tolled route; and
- toll road users place a high value on the expected reliability of the tolled road and route accordingly, although this is not reflected in the model.

12.13. An example of this in practice is a model developed by Atkins which included the M6 Toll Road, Atkins found it necessary to apply in the model only half of the actual toll in order to replicate observed behaviour.

12.14. In practice, there is little experience of modelling tolled roads in the UK and therefore few examples of modelling a lower toll than that which will be charged. At this stage of the study it is deemed inappropriate to attempt to do so although further work will be required to determine whether such an approach is justified in the future.

## Assessment of Option 7 with initial tolling assumptions

### Overall changes in demand for travel

12.15. The estimated changes in demand for travel (car and light van trips only) due to the application of a £2 toll for cars and LGVs and £4 toll for HGVs are shown in Table 34 (see Chapter 5 for the definition of internal and external). Note that, as these figures were derived from the model's demand matrices, they represent changes due to trip suppression and re-distribution (changing trip origins and/or destinations), but NOT re-routing effects. The table shows the change compared to the revised With Freight Package Do-Minimum (i.e. with no improvement scheme) and compared to an improved, but un-tolled, scheme.

**Table 34. Change in demand with tolled Option 7 (car and light van trips, morning peak, 2031)**

| Tolling option (which section tolled) | Change compared to Do-Minimum (i.e. no improvement scheme) | | | | Change compared to un-tolled Do-Something Option 7 | | | |
|---|---|---|---|---|---|---|---|---|
| | Internal | Internal-external | External | Total | Internal | Internal-external | External | Total |
| A. Ellington to Trinity Foot | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | -0.5% | 0.2% | -0.1% |
| B. Ellington to Girton | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | -0.5% | 0.2% | -0.1% |
| C. Ellington to Milton | 0.0% | -0.7% | 0.3% | -0.1% | -0.1% | -1.1% | 0.5% | -0.2% |

12.16. The table shows that applying a toll to the improvement scheme Option 7 is estimated to reduce total demand by up to 0.2%. The reductions in demand compared to the With Freight Package Do-Minimum are smaller because the demand in the Option 7 tolled test is higher (reflecting the additional capacity provided). In other words, the increases in underlying demand brought about by the improvement scheme are more than offset by introduction of a £2/£4 toll. However, these changes are small, and within the margins of error of the modelling.

## Strategic traffic routing

12.17. Table 35 shows the impact of the £2/£4 toll on traffic flows on selected links. The shading indicates those links which are within the tolled section in the model. These predicted changes in traffic flow are a result of trip generation, redistribution and reassignment effects; as the previous table shows, the first two of these have a limited impact on overall demand, meaning that the vast majority of change in flow is due to reassignment (re-routing) of traffic to avoid the toll. The nature of this re-routing is considered, with the aid of flow difference plots, in paragraph 12.20 below.

**Table 35. Forecast traffic Flow (PCUs per hour, combined directions) at selected locations (morning peak hour, 2031) with £2/£4 toll**

| Tolled section option | Location | | | | |
|---|---|---|---|---|---|
| | H'don Southern Bypass | South of Trinity Foot | | | Cambridge Northern Bypass |
| | | Mainline | LARs | Total | |
| *Option 7, no toll* | 5,550 | 6,630 | 2,790 | 9,410 | 8,850 |
| A. Ellington - Trinity Foot | 4,360 | 6,470 | 2,630 | 9,100 | 8,830 |
| B. Ellington – Girton | 4,910 | 4,920 | 3,260 | 8,170 | 8,820 |
| C. Ellington – Milton | 4,980 | 5,420 | 3,210 | 8,630 | 5,930 |
| *Effect of toll (relative to Option 7 no toll)* | | | | | |
| *A. Ellington - Trinity Foot* | -22% | -2% | -6% | -3% | 0% |
| *B. Ellington – Girton* | -12% | -26% | +17% | -13% | 0% |
| *C. Ellington – Milton* | -10% | -18% | +15% | -8% | -33% |

12.18. The table shows that the model predicts:

- The effect of tolling on sections of road immediately to the east of the tolled section is limited (-2% for Option A and 0% for Option B), compared to on the tolled section. This suggests that diversion to avoid the toll is fairly localised.
- Tolling reduces flow on the Section A by up to 22%, on Section B by up to 26% and on Section C by up to 33%.

- The longer the section tolled, the less reduction in demand on the Huntingdon Southern Bypass, suggesting willingness to make a localised diversion around a short tolled section (as flow is only reduced by 2% south of Trinity Foot in Option A).
- The medium length tolled section results in a maximum diversion away from the A14 of 1,240 vehicles (on the Trinity Foot-Girton section), slightly more than the maximum diversion when the shortest is tolled (1,190 PCU, Option A) but much less than the maximum diversion if the longest section is tolled (2,920 PCUs on the Cambridge Northern Bypass, Option C).
- Tolling the complete length between Ellington and Milton reduces flow on the Cambridge Northern Bypass by a third. Given that so many westbound vehicles would divert from the A14 at Milton to avoid paying the toll, the further diversionary impact north of Girton is minimal.

12.19. In each of the three tolling scenarios one of the expected impacts of the toll is to divert mainly local traffic from the (tolled) mainline A14 to the Local Access Roads. However, traffic also diverts elsewhere, as described below.

## Changes in traffic flow

12.20. Appendix G contains a series of plots showing the effects of applying a toll on traffic flow in the morning peak hour (in PCUs – passenger car units). The green bars represent increases in flow, and blue bars represent decreases in flow. Note that the modelling was only able to take a superficial approach to examination of anti-diversionary measures. In practice, some of the diversion onto local roads could be mitigated by implementation of such measures. Further, diversion of traffic onto the local access roads between Trinity Foot and Girton could be reduced by lowering the speed limits on the local access roads below 70 mph (for those tests where the A14 mainline is tolled in this location).

### Toll applied to Ellington – Trinity Foot (Option A, £2/£4 toll)

12.21. The forecast change in traffic flow in the morning peak hour due to application of a £2/£4 toll is shown in Figure G1 (the comparison is therefore with an un-tolled Option 7).

12.22. The main effect is that a share of traffic would switch back to the downgraded A14 alignment past Huntingdon, despite the longer journey times associated with these routes. This would result in approximately 900 fewer PCUs eastbound on the Huntingdon Southern Bypass. The model also forecasts some diversion through Godmanchester and Huntingdon itself (for example Stukeley Road B1044) as an alternative to the downgraded A14 alignment.

12.23. It is forecast that there would be some more minor diversion from the B1043 Huntingdon Road onto the A1 between Brampton and St Neots; and some localised diversion on the east side of St Neots. There would be no notable increases in traffic (compared to an un-tolled Option 7) on key radials within Cambridge.

12.24. Figure G2 compares the traffic flows with a toll applied to Option 7 between Ellington and Trinity Foot (Option A) to the Do-Minimum. The plot shows that a tolled Option 7 would result in additional traffic in Huntingdon, St. Ives and Longstanton compared to no enhancement, although there is a notable reduction in traffic on the B1514 Thrapston Road / Huntingdon Road / Brampton Road / Hartford Road / Main Street both north east and south west of the A14.

12.25. Traffic levels under this tolled Option 7 scenario would generally be lower than in the 2031 Do-Minimum on key corridors in Cambridge, with similar patterns to those observed in the non-tolled tests (see paragraph 5.24).

### Toll applied to Ellington – Girton (Option B, £2/£4 toll)

12.26. The forecast change in traffic flow in the morning peak hour due to application of a £2/£4 toll is shown in Figure G3 (the comparison is therefore with an un-tolled Option 7).

12.27. It is notable that applying the toll over a longer section of route (i.e. as far south as Girton) would greatly reduce the level of traffic diverting via Huntingdon to avoid the toll. Application of the toll on the main carriageway between Trinity Foot and Girton would clearly result in a diversion of traffic onto the un-tolled Local Access Roads, as shown in Table 35, although this could potentially be reduced through lower speed limits on the Local Access Roads; and, as this capacity is provided as part of the scheme, it does not cause the same concerns as those over traffic that is diverting via inappropriate routes.

12.28. Elsewhere, effects are forecast to be less marked, with only a small increase in traffic using the A428; and diversion from the B1043 to the A1 (as with Option A). Traffic on key radials in Cambridge would typically increase by 1-3% although higher increases are forecast outbound on Huntingdon Road. Increases in traffic levels on radial roads in Cambridge are limited typically to less than 2%.

12.29. Figure G4 compares the traffic flows with a toll applied to Option 7 between Ellington and Girton (Option B) to the Do-Minimum. As with Option A, a tolled Option 7 would increase traffic on local roads in Huntingdon and St Ives (although to a lesser extent than in Option A) and Longstanton (to a greater extent than Option A).

12.30. Again, traffic levels under this tolled Option 7 scenario would generally be lower than in the 2031 Do-Minimum on key corridors in Cambridge with similar increases on Histon Road and Milton Road to those observed with the shorter tolled section (Option A).

### Toll applied to Ellington – Milton (Option C, £2/£4 toll)

12.31. The forecast changes in traffic flow in the morning peak hour due to application of a £2/£4 toll is shown in Figure G5 (the comparison is therefore with an un-tolled Option 7).

12.32. The main feature is the forecast diversion of 25% of traffic from the Cambridge Northern Bypass onto alternative routes, predominantly through Cambridge but also via Milton and Histon. The biggest increases in traffic on radial routes in Cambridge are forecast to be:

- +350 PCUs (+15%) Milton Road inbound and +100 PCUs (+9%) outbound;
- +260 PCUs (+52%) Madingley Road outbound;
- +170 PCUs (+23%) Barton Road inbound and +170 PCUs (+25%) outbound;
- +150 PCUs (+19%) Huntingdon Road inbound and +230 PCUs (+26%) outbound; and
- +120 PCUs (+30%) Newmarket Road outbound.

12.33. As before, the plot shows that there would be some diversion via Huntingdon, but at similar levels to Option B, and therefore less than in Option A. As Table 35 shows, extension of the tolled section to Milton would result in a lower diversion from the A14 mainline between Trinity Foot and Girton as the toll at this level is broadly equivalent to the journey time saving and thus more benefit to paying the toll, but a higher increase in traffic on the local access roads.

12.34. There would be a more pronounced increase in traffic on the A428 and M11 than in tests assuming a shorter tolled section, although traffic levels on the A428 are still below those in the Do-Minimum (as shown in Figure G5).

12.35. Figure G6 compares the traffic flows with a toll applied to Option 7 between Ellington and Milton (Option C) to the Do-Minimum. As would be expected, traffic levels on local roads in Huntingdon, St Ives, Cambridge and the villages to the north of the Cambridge Northern Bypass are, in some cases, above those forecast in the Do-Minimum, notably on Milton Road inbound (+320 PCUs or +14%); Milton Road outbound (+180 PCUs or +17%) and Madingley Road outbound (+265 PCUs or +54%).

### Summary of traffic impacts of £2/£4 toll

12.36. The application of a toll as modelled would have a limited impact on underlying demand (trip generation and redistribution) although enough to suppress the additional demand generated as a result of the additional capacity provided by the route enhancement.

12.37. In terms of traffic flow, the toll is forecast to reduce demand by 20 to 35% along the mainline A14 where tolled. However, all three Options would increase, to a degree, traffic routing through Huntingdon, and tolling Ellington – Milton (Option C) also dramatically increases traffic routing through Cambridge.

### Monetised benefits

12.38. The total forecast benefits for the tolled tests described above are shown in Table 36. All figures are Present Value (PV) in 2002 prices over a 60 year appraisal period.

**Table 36. Total monetised benefits (Present Value, millions, 2002 prices) Option 7**

| Tolled section | Toll (cars & LGVs / HGVs, 2011 prices) | Economic efficiency: commuters | Economic efficiency: Business users & providers | Accidents | Greenhouse gases | Indirect taxation revenue | Total PV benefits |
|---|---|---|---|---|---|---|---|
| *No toll* | | *£486* | *£651* | *£25* | *£-9* | *£19* | *£1,171* |
| A. Ellington - Trinity Foot | £2.00 / £4.00 | £-77 | £146 | £26 | £-15 | £0 | £80 |
| B. Ellington – Girton | £2.00 / £4.00 | £-76 | £181 | £13 | £-13 | £-10 | £95 |
| C. Ellington - Milton | £2.00 / £4.00 | £-497 | £-78 | £-30 | £-11 | £-46 | £-663 |

12.39. The results summarised in Table 36 show that the un-tolled Option 7 improvement scheme would generate total monetised benefits of over £1 billion compared to the With Freight Package Do-Minimum. However, in all tests where a £2/£4 toll is applied, this benefit would be largely eroded and in Option C there would be a large net dis-benefit compared to the Do-Minimum. This indicates that the impact of the toll in terms of its cost, or dis-benefit through longer diversionary routes, would be greater than the benefits of the improvement scheme to those using it (or non-users receiving indirect benefits).

12.40. Commuter users (who value their time less than business users) would experience dis-benefits in all of the £2/£4 tolled options.

12.41. The longer scheme (Ellington to Milton) would experience the same problems as the shorter schemes but tolling the Cambridge Northern Bypass adds additional traffic to already congested conditions in Cambridge.

### Capital and net operating costs

12.42. Using the same costing approach as used for estimating the capital costs of Options 1 to 6, the total pre-inflation budget cost of Option 7 without the toll was estimated at £1,114 million (in Q4 2011 prices, or £1,515 million in Q4 2019 prices). Net average annual maintenance costs (compared to the Do-Minimum) over a 60 year appraisal period would be approximately £1.05 million (Q4 2011 prices, or £1.34 million in Q4 2019 prices). The combined Net Present Cost of the scheme is £548 million in 2002 market prices (discounted, including indirect taxation). These costs exclude capital or operating costs associated with the tolling regime (although an allowance is made for these costs in the derivation of net toll revenue).

12.43. Based upon experience in the United States, the cost of operating a toll road, assuming free flow toll collection and efficient back-office processes and operations, varies from approximately 10% to 40%. The lower figure represents the low-end estimate of an efficient toll collection scheme operating in free flow conditions with high levels of automatic payment. The higher figure covers the whole cost of the operating and maintaining a toll road. Other evidence suggests that minimum transaction costs for some schemes could be as high as £1 per vehicle.

12.44. Further work is required to agree a more robust revenue collection cost. In the meantime, this appraisal assumed net revenue of 20% below gross revenue to cover collection and enforcement, as well as the initial capital cost of installing and maintaining the vehicle detection system. This is a broad assumption; further investigation is required to develop more accurate assumptions about toll collection costs and toll system installation and maintenance costs.

### Toll revenue

12.45. Forecast annual toll revenue in 2031 (in 2011 prices) is presented in Table 37 calculated by applying the relevant tariff to each vehicle forecast to use any part of the tolled section of road. The forecast net annual revenue ranges from £42.8 million in the Ellington to Trinity Foot option to £84.6 million for the Ellington to Milton option [25].

**Table 37. Annual toll revenue in 2031 (2011 prices, millions)**

| Tolled section | Toll (cars & LGVs / HGVs, 2011 prices) | Gross annual toll revenue | Net annual toll revenue |
|---|---|---|---|
| *No toll* | | *N/A* | *N/A* |
| A. Ellington - Trinity Foot | £2.00 / £4.00 | £47.5 | £42.8 |
| B. Ellington – Girton | £2.00 / £4.00 | £56.1 | £50.7 |
| C. Ellington – Milton | £2.00 / £4.00 | £93.8 | £84.6 |

### Economic appraisal

12.46. A summary of the economic appraisal is shown in Table 38. It shows that Option 7 without a toll would generate a Net Present Value (NPV) of £623 million and a Benefit to Cost Ratio (BCR) of 2.2 to 1. This is a similar BCR to Option 3 as described in Table 32).

12.47. If a £2/£4 toll was applied to the shortest section (A) benefits would fall sharply, resulting in a negative NPV and therefore a BCR of less than 1.0. If a toll was applied between Ellington and Girton (Section B), benefits and toll revenue would be higher, but still resulting in a negative NPV, albeit only slightly negative. This scenario does generate a BCR of 0.93. Application of a toll along the longest section (C) would generate large dis-benefits compared to the Do-Minimum (with freight package) which, despite the highest toll revenue, would result in a large negative NPV (the BCR for this option is not informative about its economic performance as both costs and benefits are negative).

12.48. In all cases, tolling would lead to negative NPVs and BCRs of less than one.

[25] *The equivalent undiscounted net annual toll revenues are £35.4 million for Section A, £41.8 million for Section B and £69.9 million for section C.*

**Table 38. Summary of £2/£4 tolled Option 7 appraisal (Present Value, millions, 2002 prices and discounts, 60 year appraisal, DIADEM results)**

| Tolled section | Toll (cars & LGVs / HGVs, 2011 prices) | Present Value of benefits | Present Value of costs | PV of (net) toll revenue | PV of costs net of (net) toll revenue | Net Present Value | BCR |
|---|---|---|---|---|---|---|---|
| *No toll* | | *£1,171* | *£548* | *£0* | *£548* | *£623* | *2.14* |
| A. Ellington – Trinity Foot | £2.00 / £4.00 | £80 | £548 | £373 | £175 | -£95 | 0.46 |
| B. Ellington - Girton | £2.00 / £4.00 | £95 | £548 | £446 | £102 | -£8 | 0.93 |
| C. Ellington - Milton | £2.00 / £4.00 | -£663 | £548 | £744 | -£196 | -£468 | N/A |

*Note: The Present Value of Costs comprises capital costs, net maintenance and renewal costs relevant to each option. The Present Value of the Net tolling revenue reduces the cost of the scheme to the transport budget. The Net Present Value in this case is therefore calculated by subtracting the PV of costs of the scheme to the transport budget (i.e. net of the PV of net toll revenue) from the PV of benefits. The BCR is calculated by dividing the PV of benefits by the PV of costs to the transport budget (net of the PV of net toll revenue).*

## Further test of £1/£2 toll

12.49. Notwithstanding the potential limitations of modelling perceived tolls (see paragraph 12.11), none of the three toll tests described above were forecast to generate a Net Present Value which would result in the scheme being developed further. Therefore, a further test was carried out using the mid-length tolled section (Option B) with a toll of £1 for cars and light goods vehicles, and £2 for heavy goods vehicles (2011 prices). A lower toll level was chosen as it was anticipated that this would result in higher economic benefits (and hence a higher Net Present Value). Application of that toll to Section B was chosen in preference to Section A (as Section B was likely to generate more revenue and result in less un-wanted diversion) and in preference to Section C (as Section C had been forecast to result in unacceptable levels of traffic diversion via Cambridge).

### Overall changes in demand for travel

12.50. The estimated changes in demand for travel (car and light van trips only) due to the application of a £1 toll for cars and LGVs and £2 toll for HGVs are shown in Table 39 (see Chapter 5 for the definition of internal and external). Note that, as these figures were derived from the model's demand matrices, they represent changes due to trip suppression and re-distribution (changing trip origins and/or destinations), but NOT re-routing effects. The table shows the change compared to the revised With Freight Package Do-Minimum (i.e. with no improvement scheme) and compared to an improved, but un-tolled, scheme.

**Table 39. Change in demand with tolled Option 7 (car and light van trips, morning peak, 2031) with lower toll**

| Tolling option (which section tolled) | Change compared to Do-Minimum (i.e. no improvement scheme) | | | | Change compared to un-tolled Do-Something Option 7 | | | |
|---|---|---|---|---|---|---|---|---|
| £1/£2 toll | Internal | Internal-external | External | Total | Internal | Internal-external | External | Total |
| B. Ellington to Girton | 0.1% | 0.1% | -0.1% | 0.0% | 0.0% | -0.3% | 0.1% | 0.0% |

12.51. Table 34 shows that applying a £2/£4 toll to the improvement scheme Option 7 is estimated to reduce total demand by up to 0.2%. In comparison, Table 39 shows that with the lower £1/£2 toll applied to section B, there is virtually no change in overall demand – the differences are all so small, they are within the margins of error of the forecasting process.

### Strategic traffic routing

12.52. Table 40 shows the impact of the £1/£2 toll on traffic flows on selected links. The shading indicates those links which are within the tolled section in the model. These forecast changes in traffic flow are a result of trip generation, redistribution and reassignment effects; as the previous table shows, the first two of these has negligible impact on overall demand, meaning that the vast majority of change in flow is due to reassignment (re-routing) of traffic to avoid the toll. The nature of this re-routing is considered, with the aid of flow difference plots, in paragraph 12.55 below.

**Table 40. Forecast traffic Flow (PCUs per hour, combined directions) at selected locations (morning peak hour, 2031) with £1/£2 toll**

| Tolled section option £1/£2 toll | Location | | | | |
|---|---|---|---|---|---|
| | H'don Southern Bypass | South of Trinity Foot | | | Cambridge Northern Bypass |
| | | Mainline | LARs | Total | |
| *Option 7, no toll* | 5,550 | 6,630 | 2,790 | 9,410 | 8,850 |
| **B. Ellington – Girton** | **5,430** | **5,450** | **3,240** | **8,690** | **8,830** |
| *Effect of toll (relative to Option 7 no toll)* | | | | | |
| *B. Ellington - Girton* | -2% | -18% | +16% | -8% | 0% |

12.53. Compared to Table 35, which shows predicted changes in flow with the £2/£4 tariff, this table shows that:

- tolling would have virtually no effect on flows on the sections of road immediately to the east of the tolled section (this suggests that strategic diversion to avoid the toll would be limited);
- tolling would reduce flow on the tolled section and LARs combined by 8% (compared to 13% with the higher toll on this section), and by approximately 18% on the tolled section alone (compared to 26% with the higher toll on this section); and
- the £1/£2 toll would reduce flows on the Huntingdon Southern Bypass by only 2%, suggesting that few vehicles would choose to avoid the tolled route in favour of a free alternative (this is perhaps not surprising as many westbound vehicles would have paid to access the tolled section further east at Girton).

12.54. The largest impact of the toll is expected to be diversion from the (tolled) mainline A14 to the (un-tolled) Local Access Roads (LARs) between Trinity Foot and Girton. The intention is that the LARs offer a free alternative for local trips. An analysis of the traffic using the LARs at this point shows that 89% of traffic using the LARs would have at least an origin or destination inside the internal area (see Figure 14).

12.55. There are some other relatively minor diversionary effects expected, as shown in the flow difference plots in Appendix G. Figure G7 shows the effects of tolling (compared to the un-tolled Option 7): very little traffic would now divert off the Huntingdon Southern Bypass when the toll is applied. Similarly, the flow reduction on the A14 main carriageway between Trinity Foot and Girton would be less than in the £2/£4 Option B test. Figure G8 shows that there would still be diversionary effects away from the tolled A14, but to a lesser extent than the higher toll test.

### Monetised benefits

12.56. Table 41 shows the total monetised benefits of the £1/£2 toll applied to Option 7, for comparison with the equivalent for a £0 toll and £2/£4 toll (also shown, repeated from Table 36). The total Net Present Value of benefits for the £1/£2 test is forecast to be approximately half way between the un-tolled and the £2/£4 toll option (Section B tolled). The benefits are significantly higher with a £1/£2 toll rather than a £2/£4 toll, including some benefits to commuter users (which were not present in the £2/£4 test).

**Table 41. Total monetised benefits (Present Value, millions, 2002 prices) Option 7 with lower toll**

| Tolled section | Toll modelled (cars & LGVs / HGVs) | Economic efficiency: commuters | Economic efficiency: Business users & providers | Accidents | Greenhouse gases | Indirect taxation revenue | Total PV benefits |
|---|---|---|---|---|---|---|---|
| *B. Ellington – Girton* | *No toll* | *£486* | *£651* | *£25* | *-£9* | *£19* | *£1,171* |
| **B. Ellington – Girton** | **£1.00 / £2.00** | **£147** | **£380** | **£28** | **-£7** | **-£11** | **£537** |
| *B. Ellington – Girton* | *£2.00 / £4.00* | *£-76* | *£181* | *£13* | *£-13* | *£-10* | *£95* |

## Capital and net maintenance costs

12.57. Capital and maintenance costs would be the same as those for the £2/£4 tests as described in paragraphs 12.42 to 12.45 above.

## Toll revenue

12.58. Forecast annual toll revenue in 2031 (2011 prices) is presented in Table 42, along with the revenue for the £2/£4 toll applied to the same section for comparison. The forecast net annual toll revenue is £33.1 million compared to £50.7 million in the £2/£4 equivalent test [26]. Therefore, although the forecast toll is only half that of the £2/£4 test, the forecast revenue has fallen by only 35%.

**Table 42. Annual toll revenue in 2031 (2011 prices, millions) with £1/£2 toll**

| Tolled section | Toll (cars & LGVs / HGVs, 2011 prices) | Gross annual toll revenue | Net annual toll revenue |
|---|---|---|---|
| **B. Ellington – Girton** | **£1.00 / £2.00** | **£36.6** | **£33.1** |
| *B. Ellington – Girton* | *£2.00 / £4.00* | *£56.1* | *£50.7* |

## Economic appraisal

12.59. A summary of the economic appraisal of Option 7 with a £1/£2 toll applied to the Ellington-Girton section is shown in Section 11. The lower toll re-coups approximately 40% of the benefits lost due to the application of a £2/£4 toll but reduces the toll revenue by 35%. The Present Value of benefits would be just under half those of the un-tolled Option 7. Toll revenue would be lower than the £2/£4 scenario, but overall results in a higher NPV than the £2/£4 of £281 million (again approximately half the value of the un-tolled scheme). The treatment of toll revenue as a negative cost means that the BCR of the £1/£2 toll scenario is actually higher than the un-tolled Option 7, by virtue of much lower net costs.

[26] *The annual undiscounted net toll revenue is £27.3 million (compared to £41.8 million with a £2/£4 toll).*

**Table 43. Summary of £1/£2 tolled Option 7 appraisal (Present Value millions, 2002 prices and discounts, 60 year appraisal, DIADEM results)**

| Tolled section | Toll (cars & LGVs / HGVs, 2011 prices) | Present Value of benefits | Present Value of costs | PV of (net) toll revenue | PV of costs net of (net) toll revenue | Net Present Value | BCR |
|---|---|---|---|---|---|---|---|
| *No toll* | | *£1,171* | *£548* | *£0* | *£548* | *£623* | *2.14* |
| B. Ellington - Girton | £1.00 / £2.00 | £537 | £548 | £293 | £255 | £281 | 2.10 |
| *B. Ellington - Girton* | *£2.00 / £4.00* | *£95* | *£548* | *£446* | *£102* | *-£8* | *0.93* |

*Note: The Present Value of Costs comprises capital costs, net maintenance and renewal costs relevant to each option. The Present Value of the Net tolling revenue reduces the cost of the scheme to the transport budget. The Net Present Value in this case is therefore calculated by subtracting the PV of costs of the scheme to the transport budget (i.e. net of the PV of net toll revenue) from the PV of benefits. The BCR is calculated by dividing the PV of benefits by the PV of costs to the transport budget (net of the PV of net toll revenue).*

### Appraisal Summary Tables

12.60. Appraisal Summary Tables for Option 7 with and without a £1 toll for light vehicles and £2 toll for heavy vehicles can be found in Appendix H.

## Testing using the Cambridge Sub-Region Model

12.61. The Cambridge Sub-Region Model (CSRM) is Cambridgeshire County Council's transport demand model. The model offers an alternative, more complex, way of forecasting the effects of the A14 scheme (including with a toll) than the DIADEM model which was used for the testing of tolls described previously in this chapter. The CSRM is more complex because, in addition to predicting highway trip generation and distribution effects (similar to DIADEM), it also predicts changes to the overall number of public transport trips (trip generation) and changes in public transport travel patterns (trip distribution). The CSRM also reflects the interaction between changes in transport supply and land use across the sub-region. It should be noted that the same highway assignment model (A14 HAM) is used in both the CSRM and DIADEM approaches.

12.62. The use of the CSRM at this stage of the study had two important roles: it provided a means of validating the level of benefits calculated using the DIADEM model; and also provided a more detailed set of land use and transport responses to the toll on the A14.

12.63. Option 7 with a £1/£2 toll on section B was selected to be modelled in the CSRM and the results of this test are presented below. To allow for the incremental effects of the tolling to be understood, a second CSRM test of the un-tolled Option 7 was also undertaken.

### Overall changes in demand for travel

12.64. The estimated changes in demand from the CSRM for travel (car and light van trips only) due to the application of a £1 toll for cars and LGVs and £2 toll for HGVs are shown in Table 44 (see Chapter 5 for the definition of internal and external). The equivalent DIADEM forecasts are provided for comparison. Note that, as these figures were derived from the model's demand matrices, they represent changes due to modal shift, trip suppression and re-distribution (changing trip origins and/or destinations), but NOT re-routing effects. The table shows the change compared to the revised With Freight Package Do-Minimum (i.e. with no highway improvement scheme) and compared to an improved, but un-tolled, scheme.

**Table 44. Change in demand with tolled Option 7 (car and light van trips, morning peak, 2031) – CSRM test**

| Tolling option (which section tolled) £1/£2 toll | Change compared to Do-Minimum (i.e. no improvement scheme) | | | | Change compared to un-tolled Do-Something Option 7 | | | |
|---|---|---|---|---|---|---|---|---|
| | Internal | Internal-external | External | Total | Internal | Internal-external | External | Total |
| B. Ellington to Girton (CSRM) | 0.5% | 0.7% | 0.0% | 0.3% | -0.5% | -0.1% | -0.1% | -0.1% |
| B. Ellington to Girton (DIADEM) | 0.1% | 0.1% | -0.1% | 0.0% | 0.0% | -0.3% | 0.1% | 0.0% |

12.65. Previously the DIADEM software predicted that application of a £1/£2 toll to Option 7 would have a marginal effect on demand; the largest effect being a reduction in internal-internal trips of 0.3% compared to the without toll test. Table 44 shows that the CSRM predicted slightly different demand effects of the toll, notably that internal trips fall by 0.5%. Interestingly, the CSRM results also showed that the demand with a £1/£2 toll is higher for internal and internal-external trips than in the Do-Minimum; in other words the increase in demand for travel brought about by Option 7 would be larger than the suppression effect of the toll.

12.66. Table 44 shows that CSRM predicted a fractionally higher demand response to tolling than in the DIADEM model, but the scale of change in demand in both models is very small, the differences being within the tolerances of the testing for this study. This suggested that the results of the tolling tests using DIADEM (earlier in this chapter) would not be materially different had the CSRM been used instead of DIADEM.

### Strategic traffic routing

12.67. Table 45 shows the forecast impact of the £1/£2 toll applied to Option 7 on traffic flows on selected links using Option 7 with and without toll using the CSRM. The results are very similar to those shown in Table 40, again highlighting consistency between the CSRM and DIADEM model.

12.68. The shading in Table 45 indicates those links which are within the tolled section in the model. These changes in traffic flow, due to reassignment (re-routing) of traffic to avoid the toll. The nature of this re-routing is considered, with the aid of flow difference plots in Appendix G.

**Table 45. Forecast traffic Flow (PCUs per hour, combined directions) at selected locations (morning peak hour, 2031) – Option 7 £1/£2 toll - CSRM test**

| Tolled section option £1/£2 toll | Location | | | | |
|---|---|---|---|---|---|
| | H'don Southern Bypass | South of Trinity Foot | | | Cambridge Northern Bypass |
| | | Mainline | LARs | Total | |
| *Option 7, no toll* | 5,740 | 6,730 | 2,860 | 9,590 | 8,880 |
| B. Ellington - Girton | 5,550 | 5,600 | 3,260 | 8,850 | 8,880 |
| *Effect of toll (relative to Option 7 no toll)* | | | | | |
| *B. Ellington - Girton* | -3% | -17% | +14% | -8% | 0% |

12.69. As with the DIADEM model test described above, the impact of the £1/£2 toll on traffic flows on selected links using Option 7 with and without toll using the CSRM can be described as:

- tolling would have no effect on traffic levels on sections of road immediately to the east of the tolled section;
- tolling would reduce flow on the tolled section by up to 17% (compared to 18% on an equivalent basis using the DIADEM model).
- the impact of the toll on the Huntingdon Southern Bypass would be slightly higher as traffic falls by 3% (compared to 2% using the DIADEM model).

12.70. The main impact of the toll would be to divert traffic from the (tolled) mainline A14 to the (un-tolled) Local Access Roads. Excluding this effect, the diversion away from the tolled carriageway and LARs onto other roads would be only 8%. As the LARs would be provided as part of the scheme capacity, they could be managed in a way that discourages through traffic from using them. Also, diversion onto the LARs is of less concern than traffic diverting onto inappropriate routes using local roads.

### Monetised benefits

12.71. Table 46 shows the total monetised benefits of Option 7 with and without a £1/£2 toll as predicted using the CSRM. The comparable results using DIADEM are also shown in italics. Overall, the forecasts are similar, with total PV benefits of the tolled option being 4% lower using CSRM than DIADEM (and 8% in the un-tolled option). There are some larger variances between the results of the two approaches in the component elements of benefit, in particular those accounting for a relatively small share of the total (i.e. accidents, greenhouse gases and indirect taxation revenue).

**Table 46. Total monetised benefits (Present Value, millions, 2002 prices) Option 7 – CSRM test**

| Tolled section | Toll modelled (cars & LGVs / HGVs, 2011 prices) | Economic efficiency: commuters | Economic efficiency: Business users & providers | Accidents | Greenhouse gases | Indirect taxation revenue | Total PV benefits |
|---|---|---|---|---|---|---|---|
| **No toll (CSRM)** | **No toll** | **£410** | **£647** | **£2** | **-£21** | **£38** | **£1,077** |
| **B. Ellington-Girton (CSRM)** | **£1.00 / £2.00** | **£149** | **£386** | **-£16** | **-£21** | **£19** | **£517** |
| *No toll (DIADEM)* | *No toll* | *£486* | *£651* | *£25* | *-£9* | *£19* | *£1,171* |
| *B. Ellington-Girton (DIADEM)* | *£1.00 / £2.00* | *£147* | *£380* | *£28* | *-£7* | *-£11* | *£537* |

### Toll revenue

12.72. Forecast annual toll revenue in 2031 using CSRM (2011 prices) is presented in Table 47. Again, both models show very similar results, with forecast gross annual revenue being £33.4 million using DIADEM and £33.1 million using CSRM.

**Table 47. Annual toll revenue in 2031 (2011 prices, millions) Option 7 – CSRM £1/£2 toll test**

| Tolled section | Toll (cars & LGVs / HGVs) | Gross annual toll revenue | Net annual toll revenue |
|---|---|---|---|
| **B. Ellington – Girton (CSRM)** | **£1.00 / £2.00** | **£37.2** | **£33.4** |
| *B. Ellington – Girton (DIADEM)* | *£1.00 / £2.00* | *£36.6* | *£33.1* |

### Economic appraisal

12.73. A summary of the economic appraisal of the un-tolled and £1/£2 toll test is shown in Table 48 (the summary results of the equivalent DIADEM-based tests are shown for comparison in italics). The differences between the CSRM and DIADEM-based approaches in terms of PV benefits are discussed above and account for the majority of divergence between the appraisal results (forecasts of toll revenue are within 1.5% of each other and benefits within 8%). The resultant BCRs using CSRM are 8 to 18% lower than those based on the DIADEM tests.

**Table 48. Summary of £1/£2 tolled Option 7 appraisal (Present Value, millions, 2002 prices and discounts, 60 year appraisal, CSRM results)**

| Tolled section | Toll (cars & LGVs / HGVs, 2011 prices) | Present Value of benefits | Present Value of costs | PV of (net) toll revenue | PV of costs net of toll revenue | Net Present Value | BCR |
|---|---|---|---|---|---|---|---|
| No toll (CSRM) | | £1,077 | £548 | £0 | £548 | £528 | 1.96 |
| B. Ellington – Girton (CSRM) | £1.00 / £2.00 | £517 | £548 | £297 | £252 | £265 | 2.05 |
| *No toll (DIADEM)* | | *£1,171* | *£548* | *£0* | *£548* | *£623* | *2.14* |
| *B. Ellington – Girton (DIADEM)* | *£1.00 / £2.00* | *£537* | *£548* | *£293* | *£256* | *£281* | *2.10* |

*Note: The Present Value of Costs comprises capital costs, net maintenance and renewal costs relevant to each option. The Present Value of the Net tolling revenue reduces the cost of the scheme to the transport budget. The Net Present Value in this case is therefore calculated by subtracting the PV of costs of the scheme to the transport budget (i.e. net of the PV of net toll revenue) from the PV of benefits. The BCR is calculated by dividing the PV of benefits by the PV of costs to the transport budget (net of the PV of net toll revenue).*

## Conclusions from examination of tolling effects

12.74. In considering the performance of the tolled options it was concluded that:

- The £2 charge for cars and light vehicles was calculated to be broadly equivalent to the journey time saving brought about by the enhancement scheme.
- The benefits of the enhancement scheme would be accrued by those using the A14 whilst those on local roads may experience dis-benefits due to diversion and/or additional congestion. The analysis in this chapter suggests that this can be limited by reducing the opportunities for strategic traffic to divert, charging a lower toll and by tolling a section of optimal length, which appears to be the medium length section (Section B) between Ellington and Girton.
- The option tested would remove the obvious alternative route for those who choose not to pay the toll (via the Huntingdon Viaduct). Other diversionary routes through villages were discouraged in the modelling by reducing capacity assumed for certain roads (which could be achieved through traffic engineering measures).
- Of the three options tested, tolling between Ellington and Girton (Section B) appears to best manage the diversionary impacts of the toll.
- Tolling of the long section including the Cambridge Northern Bypass could lead to unacceptable diversion onto the local road network in and around Cambridge which would be difficult to mitigate.
- Tolling the short section appears likely to result in more diversion than tolling the section from Ellington to Girton.
- Charging £1 for cars and light vehicles and £2 for HGVs from Ellington to Girton would reduce the diversion and resultant dis-benefits, resulting in an option that delivers higher net present benefits.

12.75. Whilst a higher toll would generate additional revenue, it could also significantly erode the economic, social and environmental benefits of the enhancement. Halving the modelled toll levels from £2 for cars and LGVs and £4 for HGVs to £1 and £2 for cars/LGVs and HGVs, respectively, are forecast to reduce net toll revenue by 35%. Tolling of an enhanced A14 at £1 for light vehicles and £2 for heavy vehicles could raise up to £33 million net toll revenue per annum in 2031 (in 2011 prices undiscounted).

# 13. Summary and conclusions

## Introduction

13.1. Output 3 of the A14 Study refined and appraised public transport, freight and highway packages intended to work in combination to alleviate the challenges of congestion, delays, poor resilience and poor safety experienced on the A14 between the A1 and Cambridge. This report sets out in detail the approaches adopted, their rationale and outcomes of the package refinement and appraisal.

13.2. The systematic process of assessing the impacts of the packages was necessarily complex but can be summarised as involving:

- refinement of the composition of the public transport package and testing its impacts using the CSRM model;
- in parallel, refinement of the composition of the rail freight package and testing its impacts using the GB Freight Model;
- then, assuming implementation of the freight package as a baseline, refinement of a number of highway packages and testing their impacts using the A14 Highway Assignment Model;
- identification of the best-performing highway option against the agreed transport objectives; and
- an examination of the potential impacts of tolling a highway option.

13.3. The remainder of this chapter summarises the nature of the preferred modal packages and their impacts and draws conclusions from the study as a whole.

## Summary of packages and their impacts

13.4. This section describes the preferred public transport, freight and highway packages and their impacts in terms of the known challenges and objectives for intervention. Unless otherwise stated, analysis is for the forecast year of 2031.

### Do-Minimum (no intervention)

13.5. In common with standard practice, the impacts of the packages in the future were assessed against a Do-Minimum scenario representing a version of the future in which the packages are not implemented, but which includes committed changes to the transport networks and land uses. They were not therefore compared to current conditions, but a best estimate of what conditions may be in the future. In this case, the forecast year is 2031. In this section, conditions forecast for the 2031 Do-Minimum are compared with those in the model for the 2011 base year.

13.6. The overall demand for travel in the study area was forecast to increase by approximately 30% between 2011 and 2031. The increase in car/LGV traffic was predicted to be 31% in the morning peak hour and 33% in the evening peak hour, HGV traffic was forecast to increase by a smaller percentage: 14% in the morning peak hour and 18% in the evening peak hour.

13.7. This growth in demand for travel results in increased levels of traffic in the study area (as shown in Figure 19). For example, southbound traffic on the A14 in the morning peak hour was forecast to rise by 22% between 2011 and 2031. Some other examples of increases in traffic levels on strategic roads are given in Table 49.

**Figure 19. Increase in traffic in morning peak hour: 2011 to 2031 Do-Minimum**

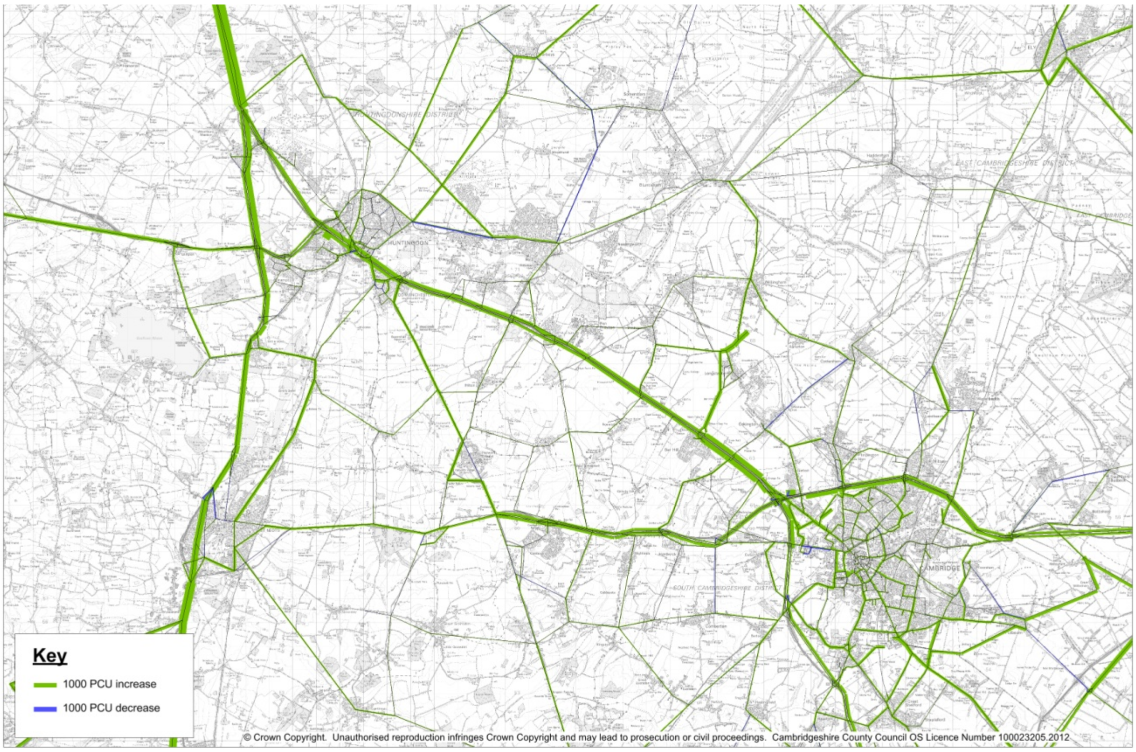



**Table 49. Examples of changes in forecast traffic flow between 2011 and 2031 Do-Minimum**

| Road/section | Morning peak hour | | Evening peak hour | |
|---|---|---|---|---|
| | East / south bound | West / north bound | East / south bound | West / north bound |
| A14 (between Godmanchester and St. Ives) | +22% | +14% | +12% | +12% |
| A14 (between Bar Hill and Girton) | +22% | +28% | +15% | +11% |
| A14 (between Histon and Milton) | +11% | +24% | +8% | +31% |
| A428 (between Caxton Gibbet and Girton) | +41% | +56% | +60% | +29% |

13.8. Traffic entering and leaving Cambridge in the morning peak was forecast to rise by 24% and 45% (inbound and outbound respectively, across the cordon shown in Figure 16). The highest increases in Do-Minimum traffic were forecast on Huntingdon Road (up 77% inbound and 93% outbound) with lower but also significant increases on all other radials, for example Histon Road (11% inbound, 74% outbound) and Milton Road (3% inbound, 33% outbound).

13.9. The model forecast a marked increase in delays (i.e. journey time compared to free-flow conditions) between 2011 and 2031 as a consequence of the expected traffic growth. For example, the delay eastbound between Trinity Foot and Girton was forecast to double from two minutes to four minutes, and from Girton to Histon from three minutes to over seven minutes. Eastbound delays between Brampton Hut and Spittals interchange were forecast to treble. There is a similar picture in the westbound direction, with generally a doubling of delay between Trinity Foot and Godmanchester, and a near-trebling of delay, to over three and a half minutes, between Godmanchester and Spittals interchange.

13.10. As a consequence of these forecast increases in delay, total end-to-end journey times in the peak direction would increase by a third to a half between 2011 and 2031 (Ellington to Milton from 30 to 43 minutes and Alconbury to Milton from 29 to 44 minutes).

13.11. Accidents in the modelled area would also worsen; the total number of injury accidents in the modelled area would increase by 27%, fatal accidents by 21%. However, improved vehicle technology means that emissions of $NO_x$, $PM_{10}$ and $CO_2$ were forecast to fall in the study area between 2011 and 2031 (by 56%, 37% and 29% respectively).

## Preferred public transport package

### Description

13.12. The preferred public transport package would comprise a new Park & Ride site at Alconbury, a new local bus service running between Cambridge city centre, Bar Hill and Cambridge Science Park and an express bus service between Peterborough and Cambridge (a service which Stagecoach has subsequently confirmed it will operate).

13.13. The public transport package would provide:

- significantly improved public transport connectivity between Bar Hill, Cambridge Science Park and planned new Science Park station;
- a Park & Ride service which negates the need to drive on the A14 south of Spittals interchange; and
- direct connections to Alconbury Enterprise Zone, central Huntingdon and three Park & Ride sites from central Peterborough and central Cambridge

13.14. The nature of the existing transport networks, and disparate trip patterns in the study area, suggest that the measures tested offer the best scope for improving public transport connectivity and of shifting demand from road to public transport and that there are no other affordable options which would result in a much larger shift, particularly of local demand. In comparison, there appears to be much greater scope to transfer freight from road to rail, as is discussed in the following chapter.

### Forecast impacts

13.15. The public transport package was forecast to result in only a modest increase in net public transport demand in the study area of 150 passengers in the morning peak period (three hours) in 2031. This equates to a 1-2% increase in public transport trips in the study area. As these are net figures, they include some abstraction of passengers from existing rail and bus services and Park & Ride sites.

13.16. The proposed Park & Ride site at Alconbury was forecast to attract 60 vehicles in the morning peak (three hour period) in 2031. This assumed a dedicated bus service to/from the site. The local bus service was forecast to attract approximately 110 passengers, and the express bus approximately 170 passengers in the same period.

13.17. The relatively modest patronage forecasts mean that the public transport package would have only a small impact in terms of removing traffic from the A14 (of 120 vehicles in the morning peak three hour period). As this equates to less than 1% of traffic in this period, the public transport package in isolation would not resolve the problems on the A14 identified in Output 1 of this study. However, this is not to say that in themselves the individual elements of the public transport package do not necessarily have merit in themselves, for example in improving public transport accessibility, although the modest additional patronage forecast suggests that these benefits are limited.

## Preferred freight package

### Description

13.18. The purpose of the package would be to reduce HGV demand along the A14 corridor by encouraging a transfer of freight from road to rail. Given the nature of freight movements in the core study area, the focus was on modal shift of traffic moving from the Haven Ports to the Midlands and North.

13.19. As such, the preferred freight package would be predominantly measures on the Felixstowe to Nuneaton (F2N) route which would enable quicker journey times, operation of longer trains and could allow additional freight paths to be provided. These include:

- Ipswich North Chord;
- installation of second track between Ely and Soham;
- double-tracking sections of Felixstowe branch line;

- enhancement of freight loops at March; and
- re-modelling of Ely North Junction.

13.20. The package would also include private sector delivery of new/expanded Strategic Rail Freight Infrastructure.

### Forecast impacts

13.21. The nature of the proposed rail freight interventions mean that the benefits of this modal shift would be felt over a wide area, in particular eastern England. The forecasting suggested that, by 2031, the package would remove approximately 1,300 HGVs from the road network travelling to/from the Haven Ports area during an average 24 hour period (this effect is due to both elements of the freight package – enhancements to the F2N corridor and expansion of Strategic Rail Freight Interchanges nationally).

13.22. The rail freight package was forecast to reduce HGV traffic on the A14 in the core study area by up to 11% compared to a Do-Minimum scenario without the package. Reductions of this scale would offset 60 to 80% of the forecast growth in HGV traffic which would otherwise have occurred between 2011 and 2031.

13.23. A scenario in which the freight package is implemented, and therefore these reductions in HGV traffic achieved, forms the baseline against which the highway packages were assessed (the With Freight Package Do-Minimum).

## Preferred highway option (un-tolled)

### Description

13.24. This report describes in detail the systematic process by which the six highway packages shortlisted at the end of Output 2 of this study were refined and appraised in order to identify the best-performing highway option. In summary, the analysis showed that the best-performing highway options are those which would:

- be larger, thereby offering solutions to a greater number of problems;
- provide a full Huntingdon Southern Bypass and provide Local Access Roads between the HSB and Girton; and
- enhance the Cambridge Northern Bypass.

13.25. If Option 5 were tolled then much more of the strategic traffic would be expected to continue using the old A14 via Huntingdon (although this specific scenario has not been tested). As a consequence, Option 7 would be more likely to perform well as a tolled scheme. Option 5 and Option 7 are compared in this section as to how they are likely to perform as transport schemes.

13.26. The appraisal offers less of a steer on the issue of retention or downgrading of the existing A14 alignment adjacent to Huntingdon (see section 11.5). Whilst the monetised elements of the appraisal tend to support retaining the existing route (with the exception of accident benefits, which would be greater with the viaduct removed), most of the non-monetised elements point towards downgrading.

13.27. Therefore, at this stage it would be difficult to select a single definitive best-performing un-tolled package from

- Option 5; and
- a version of Option 5 which downgrades the existing A14 alignment and provides a 3-lane Huntingdon Southern Bypass with additional junctions with the A1 and A1198 (subsequently named as Option 7 and used as the basis for examination of tolling).

13.28. **However, option 5 is unlikely to perform well as a tolled scheme, as it is likely to lead to more of the traffic remaining on the existing A14 adjacent to Huntingdon.**

13.29. Both options would include the Huntingdon Southern Bypass with junctions with the existing A14 near Ellington and Trinity Foot, dual 2-lane Local Access Roads between Trinity Foot and Girton, enhancements to Girton interchange to provide for free-flow movement between the north and west of the junction; widening of the Cambridge Northern Bypass to dual 3-lane between Girton and Milton; and lengthening of the west-facing slip roads at Histon and Milton.

13.30. The options differ in that:

- in Option 5 the existing A14 alignment north of Trinity Foot would be retained as is and therefore the Huntingdon Southern Bypass is a dual 2-lane road with no intermediate junctions between Ellington and Trinity Foot; whilst
- in Option 7 the existing A14 alignment north of Trinity Foot would be downgraded and the Huntingdon Railway Viaduct removed, therefore the Huntingdon Southern Bypass would be a dual 3-lane road (the additional capacity to accommodate traffic to/from the A1(M)) with intermediate junctions with the A1 and A1198 for local traffic.

### Forecast impacts

13.31. Unsurprisingly, Options 5 and 7 have marked impacts on traffic patterns in the study area, as described in detail elsewhere in this report. These impacts are summarised below in terms of the key challenges identified on the A14 identified in Output 1 of the study, namely:

- peak congestion and delay on the A14 which impacts on strategic long term movements and local traffic;
- peak congestion and delay on key local roads;
- lack of resilience in the A14 corridor, often impacting on local road traffic; and
- safety on the A14.

*Peak congestion and delay on the A14*

13.32. The following is based on forecasts of delays (measured as journey time compared to the free-flow time) in the morning peak period, although typically similar delays in the evening peak could be expected in the opposite direction of travel.

13.33. All the options tested would reduce peak period congestion and delays to a greater or lesser extent compared to the 2031 Do-Minimum. Option 5 would remove most of the delays on the A14 north of Trinity Foot, including on the section between Brampton Hut and Spittals interchanges (traffic flow on the Huntingdon Viaduct is forecast to be 20% below the Do-Minimum in the morning peak hour). However, as the A14 past Huntingdon would be retained, delays would continue to occur in the morning peak northbound between Godmanchester and Spittals interchange, albeit greatly reduced. Delays on the main carriageway southbound between Trinity Foot and Girton would be halved but also remain. The option would however remove the significant delays eastbound from Girton on the Cambridge Northern Bypass.

13.34. Overall, the average peak direction journey between Ellington and Milton would be over 18 minutes quicker in Option 5 than in the Do-Minimum; and approximately 13 minutes between Alconbury and Milton despite increases in traffic of up to 900 Passenger Car Units (PCUs) in the peak hour.

13.35. In Option 7, the downgrading of A14 north of Trinity Foot would resolve the delays between Godmanchester and Spittals interchange and on the Cambridge northern Bypass, however some delays are expected to remain on the section between Trinity Foot and Girton, as in Option 5. This option has the potential to increase delays southbound on the A1 in the morning peak between Alconbury and Brampton Hut interchange as this becomes the sole route for strategic traffic.

13.36. Peak direction journey times would fall by a similar amount as in Option 5 east-west (approximately 18 minutes in the morning peak Ellington to Milton), and journeys from Alconbury to Milton would be10 minutes quicker on average despite the increased length of the new route.

*Peak congestion and delay on key local roads*

13.37. The enhancement of the A14 in Options 5 and 7 would provide additional capacity which would both reduce diversion off the A14 to avoid congestion, and would encourage local traffic to join the A14 at the earliest opportunity. Both impacts would significantly reduce peak period traffic levels (and therefore congestion and delay) on key local roads.

13.38. The plots in Appendix C show the extent of the forecast reduction in traffic flow. In Option 5, reductions would be most marked in Huntingdon (the eastern end of the A141, the B1514, ring road and Medieval Bridge), Brampton, on the A1123 (Huntingdon – Ely), in Godmanchester (B1044), on the A1198 (Godmanchester - Caxton Gibbet), and in central Cambridge. There are also forecast to be some localised increases as local traffic routes to the Huntingdon Southern Bypass instead of the current A14 (e.g. on the B1043 south-west of Godmanchester) and on the A141 westbound approaching Spittals Interchange in the morning peak (although this could be mitigated by re-timing of traffic signals as the strategic A14-A14 movement has been removed from the interchange).

13.39. The pattern is similar for Option 7, although even with the removal of the Huntingdon Railway Viaduct some strategic traffic would continue to route via Huntingdon, including along Ermine Street. Conversely, downgrading of the A14 would reduce rat-running on the A1198 through Godmanchester between the Huntingdon Southern Bypass and the current A14 alignment, over Huntingdon Medieval Bridge and the B1514 through Brampton.

13.40. In Cambridge, some isolated changes in traffic flows on the key radials are expected, although the net effect would be a 2% reduction in traffic entering or leaving Cambridge.

*Lack of resilience in the A14 corridor*

13.41. The concept of network resilience relates to the degree to which the network (or sub-sections thereof) is able to cope with the unexpected disruption or closure of one or more sections due to an unforeseen incident. This resilience can be influenced by the ability of the affected route to cater for demand when capacity is reduced, or on a wider scale, the availability of alternative routes. The forecasting methodology adopted was based on a typical weekday during the year and therefore did not reflect variability of journey times caused by irregular events such as breakdowns and accidents.

13.42. However, the ratio between forecast traffic volume and highway capacity on a given section of road is a common measure of the extent to which the network is under stress and therefore the degree to which it is resilient, or otherwise, to unforeseen incidents. As the share of capacity utilised increases, so does network stress and delays experienced by traffic due to congestion.

13.43. An analysis of where traffic volume exceeds 85% of available capacity in the 2031 morning peak hour showed that Option 5 would reduce stress on the A14 between Spittals interchange and Girton due to provision of additional capacity in the form of the Huntingdon Southern Bypass to the north and the Local Access Roads further south. However, Option 5 would also result in some increases in stress, in particular on the A141 westbound approaching Spittals interchange (although this could be mitigated by adjusting signal timings as the A14-A14 traffic movement would no longer need to be accommodated).

13.44. In downgrading the existing A14 alignment between the A1(M) and Trinity Foot, Option 7 would remove network stress on this section. However, as all strategic traffic then routes via the A1 between Alconbury and Brampton, Option 7 would result in increased network stress on this section (despite some assumed capacity improvements). Option 7 would also increase stress on the A141 approaching Spittals interchange from the east (as above) Huntingdon and northbound on the M11 approaching Girton.

13.45. Overall, both Options 5 and 7 would improve resilience of the wider network as they provide additional road capacity meaning that, for example, closure of a lane will result in a smaller proportionate loss of total capacity. Further, both provide two routes between Trinity Foot and the A1/A1(M), albeit one would be downgraded in Option 7, meaning that local diversionary routes would be available to the Highways Agency in the event of a major incident in this section. Similarly, the Local Access Roads (LARs) between Trinity Foot and Girton would offer diversionary alternatives should incidents occur on the LARs or main carriageway in this section.

*Safety on the A14*

13.46. All options tested were forecast to result in reductions in the overall number and severity of personal injury accidents. In Option 5, the total number of accidents in the modelled area was forecast to fall by 2.2% by 2031 and fatal accidents by 2.0%. The total number of accidents on the A14 was forecast to fall by 9.2%. In the un-tolled Option 7, the total number of accidents and fatal accidents in the modelled area was forecast to fall by less than they were in Option 5 (falls of 1.0% and 0.2% respectively). The total number of accidents on the A14 was also forecast to fall by less (1.8%)

*Local environmental impacts*

13.47. Inevitably, the higher speeds which would result in Options 5 and 7 would lead to in an increase in $CO_2$ emissions, although Option 5 would result in the lowest increase amongst the six shortlisted highway options tested. For Option 7, the additional distance travelled by strategic north-south traffic due to downgrading of the current A14 alignment past Huntingdon would mean that $CO_2$ emissions would be higher than with Option 5.

13.48. Both Option 5 and Option 7 would significantly reduce emissions of oxides of nitrogen ($NO_x$) in the $NO_x$-related Air Quality Management Area (AQMA) at Huntingdon. Option 5 would reduce emissions by 30% whilst Option 7, which would downgrade the route in the vicinity, would reduce emissions by 70%. Emissions of $NO_x$ would increase in both options in the AQMA along the A14 between Fenstanton, Girton and Milton due to increased traffic levels (by 8% in Option 5 and 9% in Option 5) whilst emissions in the central Cambridge AQMA are forecast to fall slightly due to improvements to the Cambridge Northern Bypass. Overall, those highway options which would remove the Huntingdon Railway Viaduct (such as Option 7) are expected to result in larger increases in emissions than those which retain it (such as Option 5).

13.49. Options 5 and 7 would result in a greater share of the network experiencing a perceptible increase in noise levels than the share experiencing perceptible reductions. However, much of the increase can be accounted for by the Huntingdon Southern Bypass which passes through a relatively sparsely populated area (although, of course some settlements will be affected). The highest increases in noise are forecast on the A14 between Girton and Fenstanton and around the Huntingdon Southern Bypass.

13.50. The Huntingdon Southern Bypass has been assessed as having a Large Adverse effect on landscape as this offline section would pass through mostly open, large scale arable landscape with some woodlands, valley floodplains and fenland. Option 5 would have a Neutral effect on townscape whilst the removal of Huntingdon Viaduct would result in a positive townscape benefit in Option 7. All options would traverse a landscape which is known for the potential for undesignated buried archaeological remains of medium importance, which have not been fully located and mapped, meaning that there may be some unforeseen heritage impacts. Most known heritage impacts relate to some historic buildings, historic landscape and Conservation Areas in the vicinity of Huntingdon Southern Bypass. Neither Option 5 nor Option 7 would impact on statutory designated sites, SSSIs or SPZs although the Huntingdon Southern Bypass would result in some loss of habitat. Both options would cross flood zone 3 at three main rivers

## Preferred highway option (tolled)

### Description

13.51. As described in the previous chapter, the preferred tolled highway option adopts the same design as Option 7, namely: a three-lane Huntingdon Southern Bypass with junctions with the existing A14 near Ellington and Trinity Foot and with the A1 and A1198, dual two-lane Local Access Roads between Trinity Foot and Girton, enhancements to Girton interchange to provide for free-flow movement between the north and west of the junction; widening of the Cambridge Northern Bypass to dual three-lane between Girton and Milton; and lengthening of the west-facing slip roads at Histon and Milton.

13.52. Whilst further work is required to examine the exact nature of the tolling regime in more detail, the testing undertaken during this study suggests that a tolling regime can be designed which delivers significant economic benefits and which generates revenue from tolling. This therefore represents the preferred tolling regime at the time of writing. A £1 toll for cars and LGVs and £2 toll for HGVs (2011 prices) would be applied to each journey made on any part of the tolled section of the A1 (between the A1 and Girton). The toll would apply all day, every day with no multiple-use discounts and limited exemptions (to be determined).

### Forecast impacts

13.53. Tolling in the way described above is forecast to have only a moderate effect on traffic patterns (and related impacts) compared to an un-tolled Option 7 and would have virtually no effect on traffic levels either side of the tolled section, suggesting that strategic diversion is small. Traffic levels in the morning peak hour on the tolled Huntingdon Southern Bypass are forecast to fall by only 2%. The main effects of the toll would be to divert traffic from the (tolled) mainline A14 to the (un-tolled) Local Access Roads (LARs) between Trinity Foot and Girton (approximately 400 PCUs in the peak hour); and to reduce the combined flow on the mainline and LARs by 700 PCUs (suggesting some localised diversion via the A428 corridor and local roads).

13.54. The additional traffic on the LARs would have the effect of increasing delays on them to four minutes eastbound in the morning peak (Trinity Foot to Girton) compared to the free-flow time, although by consequence of the reduction in traffic on the main carriageway, average end-to-end journey times would fall by one minute.

13.55. The forecast diversionary effects are shown in the flow difference plots in Appendix G, Figure G7. This shows that some diversion onto alternative strategic routes (such as the A428/A1), the A1198, A1123 and local roads, particularly to the north-east of the A14. As a consequence, network stress levels would increase to over 85% on the A1 (southbound between Brampton Hut Interchange and St. Neots), on the A1132 (Between Huntingdon and St. Ives) and on unclassified roads between Willingham and Cottenham and between Swavesey and Longstanton. Some diversion onto the local road network in Huntingdon is also forecast, but at lower levels than in the £2/£4 toll tests, whilst the toll is forecast to have minimal effects on the Cambridge local network at the £1/£2 level. Further work is required to understand and mitigate these unwanted diversionary effects.

13.56. Tolling would have no appreciable effect on accident savings, emissions or the local environment.

## Conclusions

13.57. This study identified a multi-modal public transport, freight and highway package which is forecast to address the challenges of delays, poor resilience and accidents identified in the core study area. The package would achieve this by providing improved public transport connectivity to reduce the share of personal travel by car; improved rail freight capability to reduce the share of freight carried by road and; for trips where car, van or lorry is the only realistic option, by improving the capacity of the A14 where it is most constrained and under pressure.

13.58. The nature of the existing transport networks, and disparate trip patterns in the study area do however limit the degree to which improving public transport can reduce demand for travel by car on the A14. Having examined all realistic and affordable opportunities to improve bus, park & ride and rail connectivity, the public transport package in isolation would not resolve the problems on the A14 identified in Output 1 of this study. However, this is not to say that the individual elements of the public transport package do not necessarily have merit in themselves, for example in improving public transport accessibility, although the modest additional patronage forecast suggests that these benefits are limited.

13.59. In comparison, there appears to be much greater scope to transfer freight from road to rail both in the core study area and beyond. The preferred freight package is forecast to remove approximately 1,300 HGVs from the road network travelling to/from the Haven Ports area during an average 24 hour period in 2031 (this effect is due to both elements of the freight package – enhancements to the F2N corridor and expansion of Strategic Rail Freight Interchanges nationally). On the A14, the package of rail freight measures could cut HGV traffic by 11% compared to a Do-Minimum scenario, which would offset 60 to 80% of the forecast growth in HGV traffic which would otherwise have occurred between 2011 and 2031. In so doing, the numerous problems resulting from the large share of HGVs currently using the A14 would be alleviated.

13.60. Following a systematic process of option identification, assessment and refinement, a preferred highway package was identified which would comprise a dual two or three lane Huntingdon Southern Bypass between the A1 and Trinity Foot, dual two-lane Local Access Roads to provide capacity for local traffic parallel to the A14 between Trinity Foot and Girton, an enhanced interchange at Girton; and online widening to three lanes of the A14 Cambridge Northern Bypass between Girton and Milton.

13.61. However, the appraisal offered less of a steer on the issue of retention or downgrading of the existing A14 alignment adjacent to Huntingdon. Whilst the monetised elements of the appraisal tend to support retaining the existing route, most of the non-monetised elements point towards downgrading. Two options perform well: one of which would retain the existing route and provide a two-lane Huntingdon Southern Bypass (Option 5) and one which would downgrade the existing A14, remove the Huntingdon Southern Viaduct and provide a three-lane Huntingdon Southern Bypass with additional junctions with the A1 and A1198 (Option 7). Option 5 has the potential to generate a Benefit to Cost Ratio (BCR) of up to 3.66 whilst Option 7 (un-tolled) could generate a BCR of 2.14 (noting that the latter option tends to have more non-monetised benefits).

13.62. The Project Board agreed that examination of the impacts of tolling should use Option 7 as a basis because it combined:

- the positive characteristics of options that downgraded the existing A14 around Huntingdon (Option 3), which would thus be likely to attract most if not all of the strategic traffic to the new bypass; and
- the Local Access Roads in Option 5 which, in conjunction with the downgraded section, would offer a free route for local traffic.

13.63. The Project Board agreed that examination of the impacts of tolling should use Option 7 as a basis because, unlike Option 5, the current A14 past Huntingdon would be downgraded meaning that that route would offer a less attractive free alternative to the tolled Huntingdon Southern Bypass for strategic trips.

13.64. The examination of tolling was fairly broad. However, it was sufficient to conclude that there is a tolling regime with tariffs of £1 for cars and LGVs and £2 for HGVs (2011 prices) applied to a section between Ellington and Girton, which could deliver much of the economic benefit of the un-tolled scheme and generate a revenue which could offset some of the capital cost of the scheme. With this tolling regime, a tolled Option 7 offers a BCR of up to 2.1. The modelling also suggested that, for Option 7, at these tariff levels, and with some representation of measures to discourage use of local roads, diversion away from the tolled route onto the local road network could be largely mitigated. At higher tariff levels, this becomes increasingly difficult.

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