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# “Peak car” effects on scheme appraisal

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# Abstract

The phenomenon of peak car has been introduced among transport professionals and academics during the past decade. It is based on the analysis of a series of indicators related to car use and travel behaviour. It implies that the use of car, that has been increasing since its first appearance, will either drop or increase at a significantly decreased rate. The basic indicator examined behind this theory is the average distance travelled by car that has dropped in combination with a decreased number of driving licenses among young adults, mainly men. These trends have been observed to be similar in different countries of the world, implying a universal trend.

Should peak car occur in the future, it will affect our current forecasting. This study focuses on the impact that peak car would have on scheme appraisal and specifically its economic impacts, should our current forecasts be proven to be wrong. It focuses on the example of an 80km section of the A12 that forms part of the strategic road network of the U.K. The official scheme appraisal guidelines and best practice methods followed in the U.K. have been used and combined with a methodology that assesses the economic impact of inaccuracies in traffic forecasting.

The results of this study reveal a significant additional cost if the current forecasting is proven to be wrong. A range of forecasting inaccuracies has been tested and it is shown that if they occur in the future, the basis on which decisions are done today will be out of date and the economic inaccuracies will be significant. It signifies the need to better investigate travel trends and incorporate a series of alternative scenarios in scheme appraisal to account for inaccuracies in the present forecasts.

# Εκτεταμένη περίληψη

Την τελευταία δεκαετία συγκοινωνιολόγοι και ακαδημαϊκοί έχουν εντοπίσει μια αλλαγή στη συμπεριφορά όσο αφορά στη χρήση του αυτοκινήτου: Η κατ' άτομο μέση διανυόμενη απόσταση με αυτοκίνητο  έχει μειωθεί και ο αριθμός των νέων άδειων οδήγησης από άτομα νεαρής ηλικίας έχει επίσης μειωθεί. Το φαινόμενο αυτό που υποδηλώνει μια συμπεριφοριστική μεταβολή ως προς την επιλογή μέσου μεταφοράς, έχει ονομαστεί peak car και απασχολεί ολοένα και περισσότερο την επιστημονική κοινότητα καθώς επηρεάζει όποιο είδος προβλέψεων γίνονται για τη μελλοντική συμπεριφορά των μετακινούμενων.

Οι τάσεις αυτές έχουν παρατηρηθεί με μικρές διακυμάνσεις σε διαφορετικές χώρες. Το φαινόμενο του peak car ισχυρίζεται ότι η χρήση του αυτοκινήτου, η οποία είναι σε ανοδική πορεία από την αρχή της χρήσης του, είτε θα μειωθεί είτε θα συνεχίσει να αυξάνεται αλλά με σημαντικά μειωμένους ρυθμούς. Παρόλαυτά δεν είναι ακόμα ξεκάθαρο εάν πρόκειται για μια νέα τάση η οποία θα συνεχιστεί ή θα σταματήσει.

Έχει αποδειχτεί μέσω πολυάριθμων μελετών ότι οι προβλέψεις ζήτησης που έχουν γίνει για έργα υποδομής είναι συνήθως ανακριβείς. Οι προβλέψεις αυτές χρησιμοποιούνται σε μελέτες σκοπιμότητας οι οποίες στη συνέχεια χρησιμοποιούνται για λήψη αποφάσεων. Οι αποφάσεις που σχετίζονται με έργα υποδομής σχετικά με τις μεταφορές αποτελούν ένα σημαντικό μέρος του προϋπολογισμού κάθε χώρας. Κατ' επέκταση, εάν το peak car ισχύσει και οι προβλέψεις που χρησιμοποιούμε τώρα αποδειχτούν λάθος, οι οικονομικές επιπτώσεις των τωρινών αποφάσεων θα είναι σημαντικές.

Θεωρήθηκε σκόπιμο να μελετηθεί μια μεθοδολογία που να βοηθάει στην λήψη τέτοιου είδους αποφάσεων. Εάν οι αρμόδιες αρχές είναι ενημερωμένες για το περιθώριο λάθους των προβλέψεων και το πώς αυτό μεταφράζεται σε χρηματικές τιμές, θα ήταν πιο ξεκάθαρα τα ρίσκα που παίρνουν, ειδικά όταν πρόκειται για μεγάλα έργα με μεγάλο χρονικό ορίζοντα. Ουσιαστικά, η μεθοδολογία που μελετάται είναι μια μελέτη ευαισθησίας που δοκιμάζει διαφορετικά σενάρια για διαφορετικές συμπεριφορές και προτιμήσεις ως προς τη χρήση του αυτοκινήτου.

Η μεθοδολογία για τη μελέτη των οικονομικών επιπτώσεων του φαινομένου υπό μελέτη απαρτίζεται από τέσσερις ομάδες βημάτων που έχουν ως εξής:

**Ομάδα βημάτων 1**

Έναρξη επιλέγοντας το έργο που θα αξιολογηθεί. Μπορεί να είναι έργο οδικής υποδομής, ανάπτυξη σχεδίου κινητικότητας μιας πόλης, προώθηση «πράσινων» μέσων μεταφοράς κλπ. Αφού επιλεχθεί το έργο, γίνεται η συλλογή δεδομένων.

Το δεύτερο βήμα είναι η εφαρμογή πολλαπλασιαστών ανάπτυξης ώστε να υπολογιστεί η μελλοντική ζήτηση στην περιοχή.

Τα επόμενα βήματα είναι παρόμοια και πρόκειται για εφαρμογή πολλαπλασιαστών ανάπτυξης ώστε να υπολογιστεί η μελλοντική ζήτηση για τα διάφορα σενάρια της μελέτης ευαισθησίας.

**Ομάδα βημάτων 2**

Το πρώτο βήμα είναι η χρήση ενός υπολογιστικού εργαλείου ώστε να εισαχθούν όλα τα δεδομένα που συλλέχθηκαν στην ομάδα βημάτων 1 και να παραχθούν τιμές για τους δείκτες υπό μελέτη. Σε αυτό το βήμα επίσης επιλέγονται οι δείκτες που θα χρησιμοποιηθούν, λαμβάνοντας υπόψη τα διαθέσιμα δεδομένα. Οι δείκτες αυτοί μπορεί να ανήκουν σε διάφορες κατηγορίες. Ενδεικτικά, μπορεί να είναι δείκτες κυκλοφοριακής κατάστασης (φόρτοι, μήκος ουρών, καθυστερήσεις), περιβαλλοντικοί (επίπεδα $CO_2$, επίπεδα θορύβου), οδικής ασφάλειας (αριθμός και είδος ατυχημάτων).

Το επόμενο βήμα είναι ο υπολογισμός των δεικτών για το βασικό σενάριο μελλοντικών συνθηκών και τα σενάρια ευαισθησίας. Το επιλεγμένο εργαλείο χρησιμοποιείται πάλι σε αυτό το βήμα. Θα πρέπει να ληφθεί υπόψη ότι μελετώντας το peak car ο βασικός δείκτης που μπορεί να αλλάξει είναι η χρήση του αυτοκινήτου. Ως εκ τούτου ο καταμερισμός στα μέσα μπορεί επίσης να αλλάξει και το επιλεγμένο εργαλείο θα πρέπει να υπολογίσει αυτές τις επιπτώσεις.

**Ομάδα βημάτων 3**

Τα βήματα αυτής της ομάδας είναι παρόμοια. Σε αυτό το στάδιο της μεθοδολογίας οι δείκτες που προηγουμένως επιλέχθηκαν για την παρούσα κατάσταση, τη μελλοντική κατάσταση και τα σενάρια ευαισθησίας μεταφράζονται σε οικονομικούς δείκτες. Μια αξία αντιστοιχίζεται για κάθε μονάδα των δεικτών. Για παράδειγμα, οι καθυστερήσεις στο οδικό δίκτυο μπορούν να μεταφραστούν σε οικονομικούς δείκτες πολλαπλασιάζοντας με την αξία του χρόνου ανά σκοπό ταξιδιού και είδος οχήματος.

**Ομάδα βημάτων 4**

Σε αυτό το στάδιο υπολογίζεται το γενικευμένο κόστος όλων των δεικτών και γίνεται σύγκριση ανάμεσα στα επιλεγμένα σενάρια.

Το έργο που επιλέχθηκε για μελέτη είναι ένας οδικός άξονας που είναι μέρος του στρατηγικού οδικού δικτύου της Αγγλίας (A12). Το κομμάτι που μελετήθηκε βρίσκεται εξολοκλήρου στα όρια μιας διοικητικής μονάδας (Essex county) ώστε να υπάρχει αντιστοίχηση με τις συνθήκες μιας πραγματικής μελέτη. Το μήκος του οδικού άξονα είναι 80km και έχει ειπωθεί σε πολυάριθμες μελέτες ότι πρόκειται για ένα προβληματικό κομμάτι που χρησιμοποιείται από ένα μείγμα είδος μεταφορών.

Η συλλογή των δεδομένων έγινε εξολοκλήρου από επίσημες πηγές δεδομένων που είναι διαθέσιμες στο κοινό. Μπόρεσαν να συλλεχθούν οι φόρτοι για τον δρόμο ο οποίος είναι καταμερισμένος σε δέκα τμήματα. Το Υπουργείο μεταφορών (DfT) συντηρεί μια βάση δεδομένων η οποίος χρησιμοποιήθηκε στην προκειμένη περίπτωση. Επιπλέον των φόρτων συλλέχθηκε η πληροφορία για το μήκος των δέκα τμημάτων και τη μέση ταχύτητα διαδρομής. Χρησιμοποιώντας το μήκος του κάθε τμήματος και την επιτρεπόμενη ταχύτητα υπολογίστηκε ο χρόνος ελεύθερης ροής. και η καθυστέρηση σε κάθε τμήμα ως η διαφορά του χρόνου ταξιδιού με τον χρόνο ελεύθερης ροής. Τα δεδομένα και οι υπολογισμοί έγιναν για την πρωινή και απογευματινή ώρα αιχμής. Οι πολλαπλασιαστές ανάπτυξης που χρησιμοποιήθηκαν αντιστοιχούν στις επίσημες κρατικές προβλέψεις και αντιστοιχούν σε 28,4% αύξηση φόρτων για την πρωινή ώρα αιχμής και 29,4% για την απογευματινή. Ως εκ τούτου οι μελλοντικοί φόρτοι υπολογίστηκαν. Ως έτος βάσης επιλέχθηκε το 2013 και έτος πρόβλεψης το 2031. Επιλέχθηκε να δοκιμαστούν 20 σενάρια για διαφορετικούς παράγοντες ανάπτυξης που να διαφέρουν από τις επίσημες προβλέψεις -1% έως -20%. Το βήμα που επιλέχθηκε να δοκιμαστεί είναι 1%. Δεν ήταν ξεκάθαρο πώς η ιδιοκτησία και χρήση αυτοκινήτου εμπλέκεται στους παράγοντες πρόβλεψης, επομένως έγινε η επιλογή που αναφέρθηκε για τη δοκιμή διαφορετικών σεναρίων για τη μελέτη ευαισθησίας.

Ως δείκτες για την αξιολόγηση των οικονομικών επιπτώσεων του peak car επιλέχθηκαν οι καθυστερήσεις στον δρόμο. Η απλή μέθοδος που περιγράφηκε ακολουθήθηκε και στην περίπτωση της παρούσας κατάστασης και για τη μελλοντική κατάσταση χρησιμοποιήθηκε μια συνάρτηση φόρτου-καθυστερήσεων (VDF του BPR). Η συνάρτηση βαθμονομήθηκε για κάθε ένα από τα δέκα τμήματα ξεχωριστά και υπολογίστηκαν οι βασικές παράμετροι a και b. Έτσι μπόρεσαν να υπολογιστούν οι καθυστερήσεις για το βασικό μελλοντικό σενάριο και για τα σενάρια ευαισθησίας. Στις περιπτώσεις όπου ο φόρτος ήταν μεγαλύτερος της χωρητικότητας και συνθήκες συμφόρησης θα επικρατούσαν, υποτεθηκε μια ελάχιστη ταχύτητα 15km/h και έτσι υπολογίστηκαν οι χρόνοι διαδρομής και οι καθυστερήσεις.

Η καθυστερήσεις μεταφράστηκαν σε χρηματικά ποσά πολλαπλασιάζοντας με την αξία του χρόνου. Η τιμές για την αξία του χρόνου που χρησιμοποιήθηκαν είναι μέρος της επίσημης κρατικής μεθοδολογίας και είναι διαχωρισμένες ως προς τον σκοπό της μετακίνησης και το είδος του οχήματος. Όλες οι τιμές έχουν αναχθεί στο 2013 που είναι το έτος των δεδομένων για την παρούσα κατάσταση.

Συγκρίνοντας τα γενικευμένα κόστη, βρέθηκε ότι το κόστος των καθυστερήσεων στο μέλλον αυξάνεται σημαντικά κυρίως εξ’ αιτίας των καθυστερήσεων λόγω κυκλοφοριακής συμφόρησης και της υπόθεσης για ελάχιστη ταχύτητα 15 km/h. Το ετήσιο κόστος των καθυστερήσεων για το έτος βάσης υπολογίστηκε £22,795,222 και το αντίστοιχο για το σενάριο μελλοντικών συνθηκών υπολογίστηκε £155,546,846. Η μελέτη ευαισθησίας έδειξε ότι το κόστος των μελλοντικών καθυστερήσεων εάν ο παράγοντας ανάπτυξης είναι 1% μικρότερος θα είναι £154,126,746 και εάν είναι 10% μικρότερος το αντίστοιχο κόστος θα είναι £120,481,007

Η εφαρμογή που παρουσιάζεται αδυνατεί εξ’ αιτίας των περιορισμένων δεδομένων που δεν επέτρεψαν τη δημιουργία ενός λεπτομερούς μοντέλου. Βασίζεται σε μια σειρά υποθέσεων, παρόλαυτά είναι αρκετή για να δείξει ότι οι οικονομικές επιπτώσεις του peak car και των επακόλουθων ανακριβειών στις προβλέψεις των παραγόντων ανάπτυξης θα ήταν σημαντικές. Στο μέλλον η εφαρμογή της μεθοδολογίας, έχοντας στη διάθεση όλα τα απαραίτητα δεδομένα, θα μπορούσε να χρησιμοποιηθεί από τους μελετητές ώστε να αναδείξει το περιθώριο λάθους των μελετών και να χρησιμοποιηθεί από τις αρμόδιες αρχές στη διαδικασία λήψης αποφάσεων. Η λήψη αποφάσεων θα έγκειται πάντα σε ένα περιθώριο λάθους και η μεθοδολογία αυτή θα μπορούσε να ελαχιστοποιήσει τις οικονομικές επιπτώσεις μιας λάθος απόφασης. Ένα επιπλέον μέτρο που θα μπορούσε να ληφθεί είναι η σταδιακή λήψη αποφάσεων ανά τακτά χρονικά διαστήματα. Έτσι οι προβλέψεις θα είναι πιο βραχυπρόθεσμες και πιο ακριβείς.

# 1. Introduction

## 1.1 Introduction

Demand forecasting among the first stages of scheme appraisal and strategic infrastructure decision making: Decision makers are based on socio economic studies when considering proposed major infrastructure projects. Attention has been drawn several times on assessing the accuracy of forecasts for existing projects: an EU study by the European Court of Auditors (2014), Spycer (2006), Halkias and Tyrogianni (2008), McCray et al (2012) and many more have studied the before and after traffic demand of infrastructure projects of different scales. The studies have been carried out across different countries and different types of projects. Road schemes like the Birmingham M6 toll road have attracted less passengers that predicted whereas others like the Manchester Metrolink have attracted more passengers than predicted and have revealed a change in modal share. Though in some cases road scheme demand predictions have been found to be more accurate than rail scheme demand predictions.

Governments each year decide on their spending and transport infrastructure projects are among the highest share of budget. An amount between 3% and 11% is spent for the transportation sector at the U.S.A, U.K., Saudi Arabia and China. According to EU studies the Gross Domestic Product (GDP) within the member states is predicted to grow between 2006 and 2031 due to the infrastructure developments that will take place in the EU countries. Therefore decision making related to transportation infrastructure development and transportation related schemes is crucial for a country's economic welfare and development. Since forecasting plays an important role in appraising such schemes, the related inaccuracies can be translated to economic inaccuracies if a decision is made that turns out to have less significantly less demand than predicted.

The reasons why forecasts fail have been studied by a number of researchers such as Wegener (2010), Flyvjberg (2005), Edwards and Mackett (1996) and Tal and Cohen-Blankshstain (2011) . They conclude that there is a combination of factors affecting forecasting, varying from the researcher's personal beliefs and national background, to politics and favoured strategies at the time of the appraisal. Researchers like Metz (2014) and Antoniou et al (2011) draw the attention to parallel growth and changes in behaviour due to infrastructure projects: technologies that can change travel speed patterns can also change the modes travel available that will transfer people further in the same time; a new motorway may create induced traffic and urban sprawl and development by improving the access to previously isolated areas. These side effects of infrastructure projects should be accounted for and an appropriate means to do so is the suggested land Use Transport Interaction Modelling (LUTI). Shiftan (2007) and Wegener and Fürst (1999) have further investigated the application of such models and their fit for purpose of assessing the effects of transportation infrastructure developments to land use developments and vice versa.

All the above evidence signifies the importance of having as sound and accurate forecasting methodologies as possible in order to minimise the financial consequences of wrong decision making, when it comes to transportation infrastructure schemes. Building up on the accuracy of our forecasts, there has been significant research during the past couple of decades on a behavioural shift in demand of transportation mode. Goodwin (2012) was among the first to observe a drop in the average distance travelled per capita in different countries of the world. Following that Metz (2014), Le Vine S. (2014b) and numerous other researchers have observed that the car ownership rate has started falling and that young adults are less eager to learn how to drive, especially men. The term "peak car" describes exactly those trends and implies that the average distance travelled by car as well as the related car ownership will either drop in the future or continue to increase but in a decreased rate.

Goodwin (2012) summarised a number of socio-economic reasons for that behavioural shift. Melia (2012) presents a synopsis of the attention drawn to peak car by different researchers. Goodwin and Dender (2013) review seven papers on the topic on peak car. In May 2014 U.K. transport experts gathered to discuss about peak car, following the New Zealand's Ministry of Transport request. Figuoera et al. (2014) compared the travel patterns of the older and younger generation of Danish. The list on research related to peak car continues and it is evident that there is a behavioural change that concerns contemporary researchers and professionals.

Although the amount of research on the topic reveals its importance and implication to decision making, it is not yet clear whether this phenomenon will continue to occur or cease after a few years. Lovallo and Kahneman (2003) have suggested a method of dealing with forecasting inaccuracies related to optimism bias, that is known as reference class forecasting. It suggest comparing the current project to similar past projects, examining their accuracy in forecasting based on ex-ante studies and adjusting the forecasting of the current project in question accordingly. This thesis also suggests via its application to run a sensitivity testing during scheme appraisal in order to assess the range of economic impact of different traffic growth factors. Specifically, focusing on the attributes related to car ownership and modal share and their implication to calculating the growth factors, to define the range of the sensitivity testing to cover different scenarios related to peak car.

## 1.2 Thesis contributions

The peak car theory is still under development and whether it will occur or not in the future is still arguable. There is discussion around the scheme appraisal methods we are using and whether they reflect in the best way future conditions. Stakeholders use the outputs of such methods in order to make decisions, based on the comparison between present and future conditions and the economic benefits of different schemes.

This methodology aims at testing the economic impact of peak car and the related forecasting inaccuracies. It tests different growth factors related to different car ownership and modal share and measures the monetary values of the different results. Since it is not clear whether peak car will continue to occur or not, it was found useful to have a tool to assess different forecasting scenarios, so that decision makers can be informed of the different economic impacts of their decisions in case of different growth scenarios. It should not be seen a tool of questioning the current forecasting methodology, but as an additional precautious measure that adds information to current scheme appraisal methods.

This methodology is different than a simple sensitivity testing as it aims at identifying the factors that are related to peak car and their implication to traffic growth forecasting. Then the different scenarios applied are related to different choices of car use and car ownership, revealing a testing of different behavioural scenarios. It may be used by transport appraisal practitioners and decision makers, as well as by academics wishing to investigate further the effects of peak car.

## 1.3 Application

This application consists of  a sensitivity testing aiming at examining the economic impact of different of traffic growth factors, in the appraisal process. An 80 km section of a road that forms part of U.K.'s strategic road network has been examined (A12, within the boundary of Essex County). Available data open to the public has been gathered an analysed to produce an image of the road's current traffic performance. The road has been analysed broken down to ten sections, as per Highways Agency's segmentation.

Due to lack of  detailed data from junction to junction a model was not feasible to be built and Bureau of Public Road's Volume Delay Function (VDF) were used instead in order to calculate the travel times on the links, according to the traffic travelling on them. Due to data inconsistency between travel time and traffic flows a set of parameters a and b was estimated for the CDF each of the ten links. Traffic forecasts were estimated applying the traffic growth factors and a range of those for the sensitivity testing, varying from -20% to 1% change, in order to account for reduced traffic flows due to peak car.

Traffic was split according to peak hour (AM and PM), vehicle type (car, LGV, HGV) and trip purpose (work, non-work) and the respective values of time were applied to the delays and the amount of traffic experiencing those delays. Therefore the annual cost of delays was calculated for the AM and PM peak hours. A similar procedure was followed to calculate the cost of the delays for the basic forecast scenario and the sensitivity testing forecast scenarios. The comparison revealed a significant additional cost for the delays expected in 2031 as well as significant variances on that cost for the different growth factors assumed at the sensitivity testing.

## 1.4 Thesis Outline

This thesis is structured as follows:

- *Chapter* 2 *- Background*

  *This chapter studies the existing literature related to the importance traffic forecasting, forecasting inaccuracies and why they occur, Land Use and Transport Modelling Interaction (LUTI).*

- *Chapter* 3 *- Peak Car*

  *This chapter presents the Peak Car theory and the related evidence base as well as the implication of car ownership in traffic growth factors estimation in the U.K.*

- *Chapter* 4 - *Methodology*

  *This chapter explains the rationale behind the methodology for the application of this study.*

- *Chapter 5 – Application*

  *This chapter presents a sensitivity testing that aims to test the effects of peak car on economic figures used in appraisal methods.*

- *Chapter* 6 - *Recommendations / Conclusions*

  *This chapter summarises the main findings of this study.*

# 2. Background

## 2.1 The importance of forecasting

Demand forecasting is a core part of strategic infrastructure decision making: Decision makers are based on socio economic studies when considering proposed major infrastructure projects. Such studies are based on estimated values of demand for the development under consideration. Therefore, planning for the future is based on demand forecasts. Should a forecast be inaccurate or, the possibility and the severity of the financial and social losses is increased, thus the risk of investing in a project that will underperform is higher. There are numerous examples of projects that have either surpassed the demand forecasts or failed to meet them:

The EU study by the European Court of Auditors (2014) reveals that two thirds of European funded Transport Projects underperform. The audit studied 26 projects in 11 member states. They were all found to be meeting user standards, but were used by fewer passengers than predicted.

Spycer (2006) presents the case of Bangkok's US$2 billion Skytrain, a 23km elevated heavy rail mass transit system with 22 stations in downtown Bangkok started operating in 1995. The demand estimates were provided by four independent international companies and varied from 788.000 to 600.000 (adjusted after the crisis in 1997) daily users for 2000. The actual demand when the train operated was 150.000 passengers daily that rose to 350.000 in 2006.

Halkias and Tyrogianni (2008) refer to the road scheme "Attiki Odos", a 65km interurban motorway in Greece that was completed in 2004 and aimed at connecting numerous municipalities of Greece with the rest of the strategic road network. Actual traffic exceeded the forecasts, as it was estimated to be used by 240.000 users daily on 2010, but on 2007 it was already used by almost 300.000 vehicles per day.

McCray et al (2012) carried out a case study and analysed forecast socioeconomic variables for Lynchbourg, Virginia. The forecast was done in 1980 with a horizon of 20 years. The case study compared the predicted figures with the actual ones on 2000. The variables that were examined were population, households, employment and vehicle ownership. Methodologically, the region of Lynchburg was divided into 68 smaller zones and the "regional/zonal percentage error" was the difference between predicted and actual data. It was also found that some planned developments that failed to be implemented in certain zones, affected the forecast accuracy of the whole region. Both the average errors for the entire region and the average errors for the smaller zones were examined. It was found that the spatial distribution of errors is systematic and that the individual zones errors are bigger that the regional errors. They also suggested that adjustment factors should be used by modellers in order to assess different scenarios. Therefore, all possible outcomes of forecast accuracies would be covered. They suggested factors, as summarized in Table 2-1 below, based on the findings of the specific study.

| | Regional forecast errors (%) | | Average of forecast errors of the 68 zones | Suggested adjustment forecast | |
|---|---|---|---|---|---|
| | All zones included (68) | Excluding outlier zones | | Region | Zone |
| Vehicles | <10% | | 45% | ± 28 | ± 45 |
| Employment | <10% | | 136% | ± 12 | ± 136 |
| Population | 48% | 10% | 39% | ± 10 | ± 39 |
| Households | 14% | 1% | 48% | ± 1 | ± 48 |

**Table 2-1 Inaccuracies in the study of McCray et al (2012)**

Omega Centre's project profile report (2007) presented the M6 toll road in Birmingham, the first and only road scheme under UK's private Finance initiative. It is a 3-lane motorway of 43km length that was initially planned as a relief road. After a lot of policy changes, public inquiries and controversial opinions, it opened in December 2003 and its cost was £1.68 bn. The forecast daily usage was estimated to 70.000 vehicles per day (different scenarios were run) and the actual daily usage in the summer of 2004 was 55.000 vehicles. A revised tolling strategy was applied in 2007 in order to address this loss of expected revenue. The M6 toll road is identified as being used by "hard core drivers" who are willing to pay for their journey and their choice is not affected by changes in the toll pricing.

The Manchester Metrolink is a Light Rail Technology (LTR) train that was constructed under Public Private Partnership (PPP) with a 15 year concession period and was opened in 1992. Knowles (1999) conducted "before" and "after" surveys to measure the impact of Metrolink Phase One and observed that the Scheme attracted more passengers that forecasted, especially during off-peak periods. During peak period, demand was slightly less than forecast though still higher than the previous rail service. Metz (2013) refers to the change in modal share of means of transportation in Manchester that is illustrated in Figure 2-1 below.

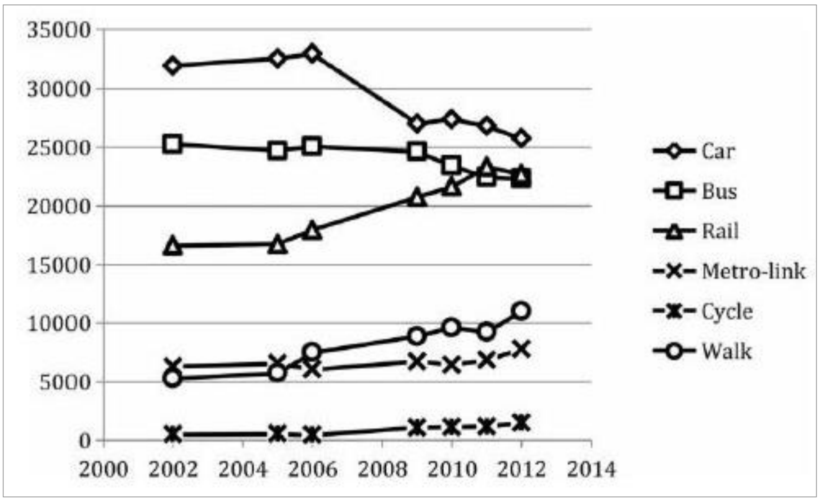


**Figure 2-1 Manchester modal share temporal comparison for inbound trips per day (2002-2012)**
*Source: Metz (2013)*

Omega Centre's project profile report (2011) examines the Arlandabanan rail link, constructed in Sweden in order to connect the city's rail network with the Stockholm Arlanda airport. It is a PPP project with 60 years concession period that suffered from changes in the government. It was constructed on time and on budget, opened in 1999 and so far the passenger traffic has been less that forecasted.

Crozet (2013) in his presentation prepared for the Roundtable on The Economics of Investment in High Speed Rail (2013, New Delhi), mentions that *“Since 1982, France has had a legal instrument which requires the administration, for all major infrastructure projects, to carry out an ex-post assessment in order to compare traffic and socio-economic viability with forecasts.”* Additionally, when presenting the variations of passenger demand on entry into services (MES) and in fully operational mode (Croisiere) the actual demand was found to be up to 50% less than predicted for the TGV nord and 35% less for the Sud-Est link, situated east of Paris.

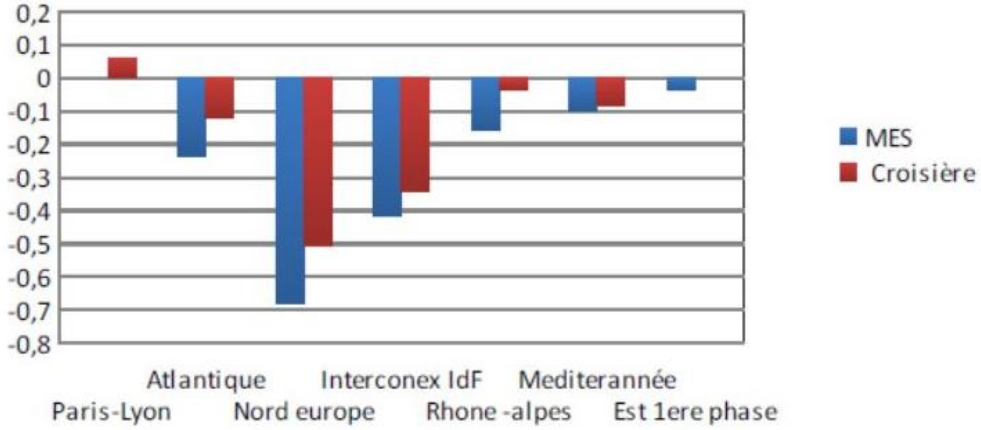


**Figure 2-2** **Variations between predicted and observed traffic**
*Source: Crozet, 2013*

The literature review reveals an ongoing discussion about forecasting accuracy methods used for decision making. Both ex ante and ex post studies assess implemented and proposed projects and the accuracy of the forecasts:

Parthasarathi and Levinson (2010) researched the accuracy of forecasts that were used for decision making in road infrastructure projects, by the Minnesota Department of Transportation, since 1970. The estimated demand was tested against the actual demand and the results revealed that demand was underestimated in 47% of projects and it was overestimated in 49% of projects.

Welde and Odeck (2011) analyzed the traffic forecast accuracy among Norwegian road projects. In particular, they studied toll road schemes against toll free road schemes. They concluded that the toll free road traffic forecasts are more prone to inaccuracies due to a combination of factors: underestimation of induced traffic and low traffic growth factors provided by the national database. They also noticed that when it comes to toll road projects, planners are more meticulous therefore optimism bias is limited. As a possible solution, they suggest independent consultants to provide forecasts.

Bain (2009) presents the results from a study of toll road forecasting performance in a range of 100 privately funded projects internationally. By gaining access to commercial documentation and datasets related to project finances and spending four years compiling the results and comparing predicted with actual traffic volumes he concludes that toll traffic forecasts are characterised by large errors and optimism bias.

Nobuhiro et al (2013) realised a case study for the evaluation for the Tokdai line rail service in the suburb of Nagoya in Japan that operated in 1991. They compared five factors and investigated their forecast accuracy: target area (the usage of the line was underestimated), overnight population (the usage was overestimated), modal split (the demand was overestimated), consideration of the effects of a competitive railway (the demand was overestimated), selection of modal split model (the demand was overestimated) and incomplete network (the network completion and fare reduction led to increased demand). This reveals that the methods we are using are not accurate enough to plan for the future.

Chatterjee and Gordon (2006) were commissioned by the British Department for Transport (DfT) to undertake a study where they described five alternatives scenarios for the Great Britain of 2030 and studied their implications in travel demand and traffic provision. They compared the scenarios with a reference scenario of the National Transport Model (NTM). Their main challenge was to quantify the aspects of the different scenarios they examined. They studied the outcomes with greater interest to the uncertainty on the inputs of the model rather than the specifications and parameters of the model. They found that changes in policy could lead to changes in traffic and congestion levels: The introduction of congestion charging in the urban network was found effective in limiting traffic growth within the urban area. The oil price assumed for the NTM was found to be higher than when the NTM was built and this might have an impact in traffic demand. Should current policies continue to be applied and comparing 2000 to 2030, traffic is forecasted to increase by 51% and congestion by 68%. Under the improvement of vehicle efficiency scenario, respectively, traffic is forecasted to increase by 36%, congestion by 43% and carbon emissions to decrease by 19%.

Vuk and Hansen (2006) validated the passenger traffic model of Copenhagen (OTM), "[...] that consists of *an operative model of Copenhagen often used for generating 10 - 20 year forecasts".* The accuracies and weaknesses of the model were identified in order to be used later as an input to model updates. The OTM is calibrated to its 1992 base year and in the study the model is validated for the period 2000 - 2004. They pointed out the importance of validating models that is often neglected in the model development phase. The 1992 model was found to behave satisfyingly in terms of overall demand, however the metro passenger flows were over-predicted by 11% for 2001 and 50% for 2005.

Ülengin et al. (2013) realised an ex ante study in order to estimate the demand for 13 committed major road infrastructure projects in Turkey. They built an integrated gravity-based model and assessed scenarios so as to predict the demand in 2020. The Gross Domestic Product's (GDP) estimation by the World Bank was taken as a fact and it was assumed that that the Gross Value Added (GVA) to the origin and destination areas of the road projects would also have a similar pattern of growth. Based on the growth rates of the GDP and GVA, the demand projection was calculated. They concluded that among the sample only one seemed promising in terms of both passenger and freight demand in 2020.

De Jong et al. (2007) reviewed the literature about quantifying traffic forecasting uncertainty and also realised a case study where they examined both the input and the model uncertainty. The literature on the topic was found limited. They used a combination of methods to quantify the uncertainty of the Dutch national model. They concluded that their method could be used in assessments of projects that are using the specific model, but it is too computer-intensive to be used for smaller projects.

The need to establish solid forecast methodologies is vital in strategic planning and infrastructure policy. However, the assumptions and the input parameters to the forecasts define the outcomes. These assumptions are closely related to social behaviour and the changes in the structure and collective beliefs are widely contributing to the future conditions. As Chatterjee and Gordon (2006) mention: "*The scenarios considered involve in some cases quite significant changes to society. Taking the concept of paradigm shifts introduced by Kuhn (1962) in 'the structure of scientific revolutions' (1962) such changes to society will not happen instantaneously (they are dependent on changes to human values and attitudes amongst other factors) and will typically require at least 20 years to come about"*. There is a deeper connection between society trends and the forecast for transport planning.

In the Executive Summary of the U.K. National Audit Office's (NAO) report on Planning for Economic Infrastructure (2013), it is mentioned that the areas of particular risks related to economic performance of infrastructure projects include:

- Novel infrastructure projects for which there is no precedent comparable dataset to predict demand.
- Forecasts on how fast the effects of the economic recession will fade away
- Infrastructure investment may form new patterns of demand

Demand forecasting is used in the assessment process of infrastructure projects and strategies. The importance of it being accurate may be revealed by studying the financial outcome of a bad decision. The amount of GDP and budgeting countries spend in infrastructure investment shows that this money is well valued and they should be wisely spent. The Economist mentions that, worldwide, never before has infrastructure investment used such a big GDP percentage before ("Building BRICs of growth" - 2008). Errors in decision making would lead to errors in governmental spending. An indicator of the financial gravity of spending related to transport infrastructure is the proportion of budgeting that invested in this sector. In Figure 2-3 below is presented the percentage of budget allocated to Health, Education, Defence and Transport & Infrastructure by four of the wealthiest countries worldwide. Transportation and related infrastructure investment take an average of 6.1% of governmental spending.

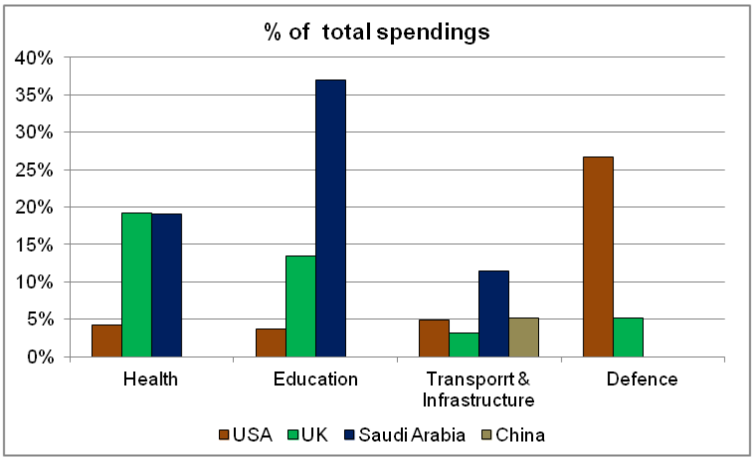


**Figure 2-3** **Budget allocate to four most costly sectors by four wealthy countries**
*Sources: USA - Fiscal year 2015 - BUDGET OF THE U.S. GOVERNMENT*
*UK - Office for Budget Responsibility, 2014-15 estimates. Allocations to functions are based on HM Treasury analysis. http://www.ukpublicspending.co.uk*
*Saudi Arabia - http://www.us- bc.org/custom/news/details.cfm?id=1541#.U4DSHnZGRVI*
*China - 2014 budget*

According to the U.S.A.'s Department of Transportation (DoT) and deriving from the Fiscal Year 2015 Budget: "[...] *The FY 2015 President's Budget request includes a $302 billion four-year surface transportation reauthorization proposal that will improve the operation and condition of the Nation's surface transportation systems. By targeting funding and implementing innovative reforms, this proposal will improve the way government operates, will ensure resources reach areas of need, and will create opportunities for all Americans.* According to the draft 2014 budget announced by the Chinese Ministry of Finance, on March 3rd 2014, a percentage of 5.1% of the total expenditure will be allocated to transport.

For 2015 only, U.K's Department for Transportation (DfT) has been allocated $91 billion, equivalent to 5% of the total amounts allocated. This makes it the third financial priority, after Small Business Administration (related to generation of jobs and promotion of competitive markets) and the Department of Defence. According to the U.K. budget for 2014-2015, the spendings for Transport are £23 billion ($38.64 bi) and the Total Managed Expenditure is expected to be around £732 billion. It is specifically mentioned that "[...] *U.K. is committed to developing its transport infrastructure with major projects like CrossRail and HS2"* that are currently being designed and implemented. CrossRail is an innovative project crossing London east to west and extending to nearby cities. It has been impressive how the works have managed to take place and implement a new rail line in a city with millions of daily visitors, a complex overground and underground system. The amount of money and planning time that has been spent to ensure that Health and Safety requirements are kept while the tunnels are also built is an excellent indicator of the government's commitment to expand transportation networks and meet the capital's growing needs. HS2 is a controversial project planned to connect London with the north of England while providing high speed connections. There has been a lot of discussion around the need for it and its high cost, but the fact that it is going forward is another indicator of a commitment to provide good quality cross-country connection.

According to the EU study (2006) "*Strategic Evaluation on Transport Investment Priorities under Structural and Cohesion Funds for the Programming - Period 2007-2013"*, the GDP is predicted to grow between 2006 and 2031 due to the infrastructure developments that will take place in the EU countries. A model was developed to assess the impact of different scenarios of developments under the cohesion strategy that was applied after the increase of the EU member countries. Two scenarios were assessed, a "maximum" scenario assumed all the planned infrastructure projects will go forward and a balanced scenario that assumes budget restriction and selection of projects to go forward according to their Benefit Cost Ratio (BCR) and contribution to specific objectives and needs. The growth of the GDP varies according to the scenario applied and for each country, as presented in Table 2-2. However, the increase of GDP per capita is foreseen to be between 0.2% - 0.6%.

| | 2006 GDP | 2031 Reference GDP | Scenarios | | | |
|---|---|---|---|---|---|---|
| | | | Max Road | Max Rail | Max | Balanced |
| Lithuania | 2390 | 4361 | 0.20% | 1.90% | 1.90% | 1.80% |
| Cyprus | 18192 | 33670 | n/a | n/a | n/a | 0% |
| Latvia | 3108 | 6490 | 0% | 1.70% | 1.80% | 1.60% |
| Romania | 1693 | 3528 | 1.20% | 0.60% | 1.70% | 1.20% |
| Estonia | 4543 | 9003 | 0.10% | 1.60% | 1.70% | 0.10% |
| Portugal | 13814 | 28075 | 0.10% | 1.40% | 1.50% | 0.70% |
| Poland | 5258 | 14003 | 0.60% | 0.40% | 0.90% | 0.80% |
| Czech Republic | 6525 | 15180 | 0.30% | 0.40% | 0.70% | 0.70% |
| Hungary | 5263 | 14906 | 0.30% | 0.30% | 0.60% | 0.60% |
| Bulgaria | 2012 | 5344 | 0.40% | 0.30% | 0.60% | 0.10% |
| Spain | 18660 | 30914 | 0.10% | 0.40% | 0.50% | 0.30% |
| Greece | 13739 | 21548 | 0.20% | 0.20% | 0.40% | 0.40% |
| Malta | 10677 | 21657 | n/a | n/a | 0.40% | 0.40% |
| Slovakia | 4909 | 11952 | 0.20% | 0.10% | 0.20% | 0.30% |
| Slovenia | 14309 | 27276 | 0.10% | 0% | 0.10% | 0.10% |

**Table 2-2** **Different GDP growth scenarios according to an EU study**
*Data Source: Strategic Evaluation on Transport Investment Priorities under Structural and Cohesion Funds for the Programming - Period 2007-2013 No 2005.CE.16.AT.014 Synthesis Report Final, 2006*

So far, we have seen that the research on traffic forecast is wide and in many cases it is accompanied with case studies and alternative scenario analysis that produce some kind of sensitivity testing. The factors affecting forecasts are related to both the inputs, methodology and optimism bias. Additionally, forecasting is in the heart of decision making for infrastructure and given the fact that infrastructure is given among the highest percentages of leading nations' budgeting, it can be assumed that demand forecasting related to transport planning is of vital importance for any country's growth to be well targeted to accommodate the needs of future generations.

## 2.2 Sources of failure

Wegener (2010) presents a future transport situation where environmental and financial (mainly related to petrol price) constraints will lead to a change in urban mobility patterns and also questions the ability of today's models to adequately accommodate such changes. He argues that the majority of current models are not flexible enough to incorporate changes in transport cost, interaction with land use and changes in modal split. He presents an EU study (*EU 6th RTD Framework project STEPs - Scenarios for the Transport System and Energy Supply and their Potential Effects*) where different scenarios for a combination of oil price and environmental factors were used to assess the use of car and alternative modes of transportation until the year 2013. The study proved what was initially expected: an increase in oil price and environmental restrictions will lead to decreased car use and shifting to different means of transportation. Wegener concludes that future energy scarcity and climate change would lead to new urban planning policies and that transportation modelling would need to keep up with such changes. Current widely used techniques for urban modelling would have to consider including the above mentioned factors in order to be realistic and reliable in forecasting. He makes two lists regarding future models:

Weak points if future models fail to consider climate changes and changes in the cost of travelling:

- too much extrapolation of past trends
- too much extrapolation of past trends
- too much belief in equilibrium
- too much reliance on observed behaviour
- too much attention to preferences
- too much emphasis on calibration
- too much focus on incremental solution
- too much effort spent on detail

What needs to change in the philosophy and method of urban modelling:

- less extrapolation, more fundamental change
- less equilibrium, more dynamics
- less observed behaviour, more theory
- less preferences, more constraints
- less calibration, more plausibility analysis
- less detail, more basic essentials
- less forecasting, more backcasting

Tal and Cohen-Blankshstain (2011) studied the relation between forecast bias and the researcher's background, by focusing on forecasts done for two types of policies related to reduction of car use: telecommuting and car-sharing. They observed four characteristics for their contribution to forecasting biases:

- researcher's attitude and beliefs regarding the policy at stake

- researcher’s affiliation
- institute performing the study
- publication type

The study resulted in finding no association between the above mentioned characteristics and forecast bias. They believe that the researchers are not homogenous in their beliefs, therefore their biases are not homogenous either. Additionally, a mix of sceptic and optimistic researchers creates a mix of biases. With the sceptics being introduced later than the optimistics, biases have reduced but in a very slow rate.

Flyvjberg (2005) considers two sets of common arguments about the usual methodology for measuring the accuracy of project demand forecasts and concludes that the existing methods are fit for purpose. The first argument is that the basis for the comparison should not be the demand of the decision making year. The second argument supports that the actual implemented project demand should not be calculated by only the first year of operation’s demand but include a set of several years to cover “demand ramp-up”. As an example of non-successful operation year demand, the Eurotunnel (underwater tunnel connecting France and U.K.) is brought up, as its actual use during the first year of operations was not as high as expected. Many projects face start-up problems and it takes time for people to get accustomed to a new transport choice and respond to this by shifting demand toward it.

Flyvjberg (2005) agrees that using a year further down the project’s operation is good in principle but not in practice: Some studies take into consideration the ramp-up of demand and examine the demand after three or five years of operation. The error deriving from the ramp-up comparison has minor impact on the present value calculations, when compared to the error brought by the first year.

In the same work, Flyvjberg (2005) presents the scarcity of reliable data for researchers when executing N-studies (ie studies of a large number of projects) to calculate the accuracy of forecasts: The data available by the government or private sector is often biased, “cooked” or not available in an extend to allow for a reliable sample. Therefore, the researcher have to use techniques such as questionnaires, resulting in assumptions made in a basis of data that are far from ideal.

Flyvbjerg et al. (2006) investigated the forecasting accuracy of hundreds of projects worldwide, realised during a 30 year period (1968-1998) and the related reasons. Forecasts for rail projects were found less accurate when compared to those for road projects. The Project Managers and researchers linked to the projects were interviewed in order to define the reasons behind the inaccuracies in forecasting: the forecast demand for rail projects is more likely to be overestimated and the costs underestimated in order to favour positive decision making and promote governmental strategic commitments. Also, the forecasts were not found to have become more accurate over the years. Therefore, according to Flyvbjerg et al. (2006), if the methodology and the approach to forecasting does not change, the accuracies achieved will not change either.

Edwards and Mackett (1996) provide with an alternative approach to the rationality of strategic infrastructure decision making in the UK of the 1990’s, by challenging its base, hence the politics and legislation. They examined the process of decision making in the UK infrastructure and in particular, by studying 11 new and planned systems. They argued that the light rail projects, that were favoured at the time, would not be used to capacity. They challenged the legislation behind decision making, as they state that the bus schemes, being discriminated at the time, could consist of a cost-effective alternative to rail. They concluded that: *“although transport planners make rational decisions within the current political framework, the framework and therefore some of the decisions, are not rational”*.

Parthasarathi and Levinson (2010) researched the reasons affecting demand (in)accuracies for major infrastructure projects in Minnesota-USA, throughout the decades. The estimated demand was tested against the actual demand and the results revealed that demand was underestimated in 47% of projects and it was overestimated in 49% of projects. The accuracy varies according to the road type, the available counts and the year of the study. A qualitative study was also done and the modellers who had been involved in forecasting were interviewed by the authors in order to illustrate their perception of the reasons behind the abovementioned inaccuracies; the inability to predict social changes and to accommodate those in the forecasting was one of the key reasons to cause inaccuracies. Such changes may have been:

- Women coming into workforce

- Late retirement age

- Emerging technologies enabling work from home

This stresses the importance to include in current forecasts the possibility of new technologies and social changes, in addition to economic and population growth changes. Additionally, there are worldwide large scale events that cannot be predicted and affect travel patterns, such being economic recession, oil price variations, terrorists attacks etc. The interviewees pointed out that the numbers of the models should be used by decision makers as one of many tools in their task and that they should have a clear understanding of their meaning and their interpretation. The use of the correct scale of model is also vital: a macro-level model should not be used to assess the impacts of a project that need micro-level of detail. Finally, decision makers should bear in mind that the modelling results are best used to compare different scenarios rather than as absolute numbers.

Metz (2014) questions whether new technologies will lead to change travel speed and patterns. As such technologies are referred the new vehicle types (electric, automated), travel information systems, wide use of the internet allowing working from home and e-commerce. He states that such although emerging technologies will bring along incremental improvements to the way we travel, *the future of the car and of other transport technologies is likely to be rather unexciting* as *we get most of what we need from travel at current speeds*.

Antoniou et al (2011) present the problem of predicting the performance and inaccuracy of forecasts and specifically its ability to predict induced traffic. They focus on the factor of land-use-transport-interaction and use as an example the renovation of a motorway in Greece. They compare it with two similar Greek motorways. They review the literature and present a series of proposed solutions, like integrating land use with traffic modelling and forecasts, and they point out the need to bridge the gap between stat-of-the-art and state-of-the-practices.

Flyvbjerg et al. (2006) refer to a new forecast methodology, based on reduced cognitive bias and they call it "reference class forecasting". This method is based on theories introduced by the psychologist Daniel Kanhneman in the nobel-prize-winning work on bias on economic forecasting (Kahneman and Trevsky 1979 and Kahneman 1994). In this methodology, a series of past projects and their forecast accuracy levels (as calculated by ex-post studies) may be used to inform and adjust current forecasts.

Alkhorayef and Pearman (2013) researched the reasons behind major transport projects underperformance, mainly from a psychological point of view. They observed a recurring thread of projects underperforming due to poor management and focused of four cognitive biases:

- Optimism bias
- Escalation of commitment
- Illusion of control
- Planning Fallacy

They conducted interviews with 29 senior decision makers in major Saudi Arabia construction projects:

- 4 Project Observers – Members of Consultative Assembly of Saudi Arabia (PO)
- 12 Project Managers (PM)
- 3 Key Decision Makers – Ministers (KDM)
- 4 Project Consultants (PC-Cons)
- 3 Project Contractors (PC-Cont)
- 3 Project Sponsors - Ministry of Finance (PS)

They listed the interviewees' opinions on the general causes of project failure as well as the psychological causes of project issues at the planning stage. The results of this study are presented in Table 2-3 and Table 2-4 below.

| | PM | PC | PS | PO | KDM | All [29] | % |
|---|---|---|---|---|---|---|---|
| Lack of accountability | 50% | 57% | 67% | 50% | 67% | 16 | 55% |
| Incomplete Information | 50% | 43% | 67% | 50% | 67% | 15 | 52% |
| Urgency | 42% | 57% | 67% | 0% | 67% | 13 | 45% |
| Out-dated forecasting techniques | 42% | 57% | 100% | 0% | 0% | 12 | 41% |
| PM's poor technical ability | 33% | 29% | 67% | 50% | 33% | 11 | 38% |
| Lack of cooperation between stakeholders | 25% | 14% | 0% | 25% | 33% | 6 | 21% |
| Ignorance of project management best practices | 17% | 43% | 0% | 25% | 0% | 6 | 21% |
| Unpredicted issues | 33% | 0% | 0% | 0% | 0% | 4 | 14% |
| Delays in decision (long process) | 8% | 0% | 0% | 0% | 67% | 3 | 10% |
| Too optimistic forecasting | 58% | 86% | 67% | 50% | 67% | 19 | 66% |
| Too confident in forecasting | 33% | 57% | 33% | 25% | 33% | 11 | 38% |
| Personality | 8% | 43% | 67% | 50% | 67% | 10 | 34% |
| Seeking quick success | 33% | 0% | 0% | 75% | 33% | 8 | 28% |
| Role of thumb forecasting | 8% | 43% | 33% | 0% | 33% | 6 | 21% |
| Self-justification bias | 8% | 0% | 33% | 75% | 0% | 5 | 17% |

**Table 2-3** **A psychological perspective on large project issues at the Planning** *Stage Data Source: Alkhorayef and Pearman(2013)*

| | All [29] | % |
|---|---|---|
| Poor business Case (poor estimates, poor documentation etc) | 21 | 72% |
| Urgency (Public complain, head of state pressure etc) | 19 | 66% |
| Project Contractor's technical ability (ill qualified employees, workload etc) | 18 | 62% |
| External Factors (price changes, shortage row materials, busy environment etc) | 17 | 59% |
| Project Manager's Employees poor performance (ill qualified employees, workload etc) | 16 | 55% |
| Project Manager's delays (approvals, payments, site handover, bureaucracy etc) | 15 | 52% |
| Lack of accountability | 15 | 52% |
| Poor project design | 14 | 48% |
| Project Contractor's financial ability | 14 | 48% |
| Poor coordination and cooperation between government bodies | 14 | 48% |

**Table 2-4** **General Causes of transport projects underperformance**
*Data Source: Alkhorayef and Pearman (2013)*

## 2.3 Land use transport interaction modelling (LUTI)

The two way interaction of land use and transport choices has been studied for decades. The use of the effects of land use to inform and update transport models, and vice versa, is broadly known as Land Use Transport Interaction (LUTI) modelling. It takes into consideration the effects that land use has on people's travel choices and analyses the ways in which travellers interact with their surroundings. It has been considered a relatively safe and accurate way of calculating trip distribution, as it considers the source of travelling, namely the visit to different places/land use. The integration of land use and transport has been given special attention by different governmental bodies in countries such as Germany, the Netherlands and Austria.

Shiftan (2007) presents the need to include land use policies when studying travel behaviour. He supports that activity-based modelling is a suitable approach to achieve this, as it is able to capture changes in land use and people's reactions to them, as opposed with trip-based modelling that is not equally adaptable. As a case study, Shiftan uses an activity based model of Portland that also includes a stated preference residential choice model: A package of land use policies is introduced and its effects on travel distribution are examined. In this case, the residential choice model reveals great changes in the urban environment: 16% increase of households in the urban centre and 13% increase in the urban growth area. However, the application of the activity based model both to the base scenario and to the urban growth scenario shows only marginal effects regional travel patterns.

Wegener and Fürst (1999) present three groups of the theoretical approaches to LUTI:

- Technical theories ( urban mobility systems)
- Economic theories (cities as markets)
- Social theories (society and urban space)

In Figure 2-4 below is shown the continuous interaction between land use and transport, their link to accessibility and activities as well as the intermediate steps, decisions and factors affecting this interaction.

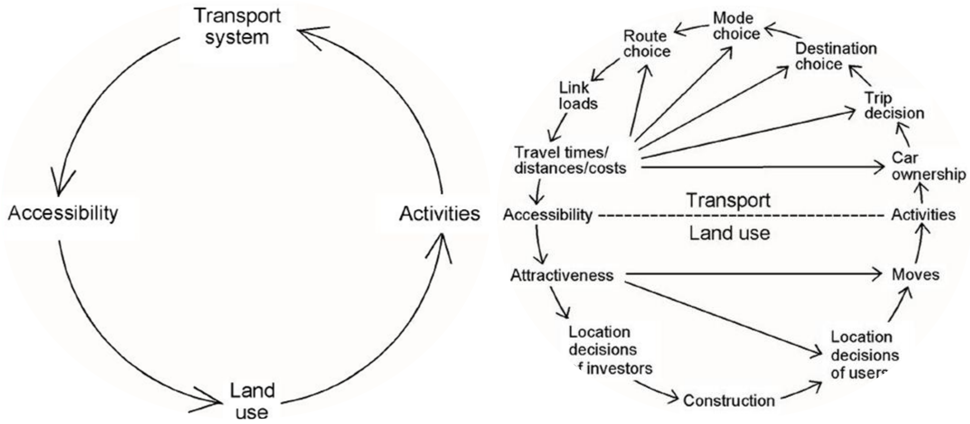


**Figure 2-4** **LUTI explanatory diagrams**
Source: Wegener and Fürst (1999)

Wegener and Fürst (1999) present the land use characteristics that influence transport choices: residential density, employment density, neighbourhood design, location and city size. They also present the influence of transport in land use, by presenting the findings of a series of empirical studies. Consequently, there is correlation between these two spatial features and their interaction cannot be ignored. The use of model considering this interaction has been growing during the past decades and there are now various examples of such models and case studies:

Coppola et al. (2013) used LUTI in order to simulate the overall equilibrium for the city of Santander, Spain. They used a combination of random utility theory and hedonic regression in order to define the locations of population, economic activities and average real estate prices within the zones of the city and their interaction with accessibility means. The model was used for the base year and also to predict the impacts of different future transport infrastructure scenarios. It was consistently found that accessibility was a major factor affecting the sensitivity of the location for the three above mentioned aspects. The travel times from home to work were found to have an explanatory role in house location. It was found that accessibility of sites was an important factor in the location of economic activities. Aspects like property prices and prestige value of housing was sensitive to income levels. Finally, it was concluded that the fit for purpose of the model could be improved by disaggregating the types of households and economic sectors as well as by having a data collection range to allow for more complex specifications of the utility theory.

Guzman et al. (2013) suggested an alternative approach to decision making for long term transport infrastructure planning. They tested a combination of forecasting, assessment and optimisation by using LUTI modelling for the long term evaluation of different scenarios. The social welfare of the different policies studied was measured using cost benefit analysis (CBA) and maximised using an optimisation process. A toll ring road scheme was used for the purposes of the study, the base year was considered to be 2004 and the planning horizon was 30 years. It was found that certain pricing policies could be useful for the city in a long term basis: the social welfare Net Present Value (NPV) due to the scheme would drop in the short term but increase steadily after 2012 and the toll value during peak hour would increase from 0 to 1 on 2009 and then continue to increase with a smaller rate throughout the study period.  Car usage of the priced road would drop by 9% at the end of the 30 year study period and modal shift revealed an increased PT use by 3%. This shift would produce a PT fare revenue of 22M€ and general benefits for both road users (e.g. greater speeds) and PT users. However the destination pattern for 6% of car users changed and loss of trips to the Central Business District was observed. Additionally, environmental impacts of the scheme were studied. Therefore, the integration of LUTI models with existing socio-economic assessments methods for mobility planning is proved to be helpful and considering a broader variety of objectives and interlinked factors like mobility and travel patterns. Wegener and Fürst (1999) state that there are three methods to predict the impacts of land use and transport policies: stated preference, revealed preference and mathematical methods. The latter being the only one with the ability to forecast unknown conditions and make assumptions for changing only one constant and keeping everything else stable.

The interaction of transport infrastructure and urban development is evident in the area of Canary Wharf in London. It used to be a Dockland and plans to redevelop it led to a newly emerged financial and commercial centre with lots of world leading banks and financial institutions having their headquarters there. The development was accompanied by an extension to London's tube and excellent connections to the city. Additionally, as Metz (2014) mentions in Canary Wharf there are only 3.000 parking spaces for 100.000 staff, thus indicating the minimised use of car in an area that some of the capital's highest earners visit daily. Moreover, the Shard in London is the tallest building in the European Union but only has 48 parking spaces. This is balanced by its central location and excellent connectivity via public transport.

# 3. Peak Car

## 3.1 Introduction

The term “Peak Car” was introduced by Goodwin (2012), formerly Professor of Transport Policy at the Centre for Transport Studies, University College London, and currently Emeritus Professor. The theory explains that the use of car and the car ownership as revealed by the distance travelled per capita that has been increasing since its first appearance, has reached a maximum and either will decrease or increase at significantly decreased rates. The indicator under study is the distance travelled per capita which seems to have been increasing in a decreased rate or even stayed stable in seven countries, as presented in the International Transport Forum’s graph in Figure 3-1 below.

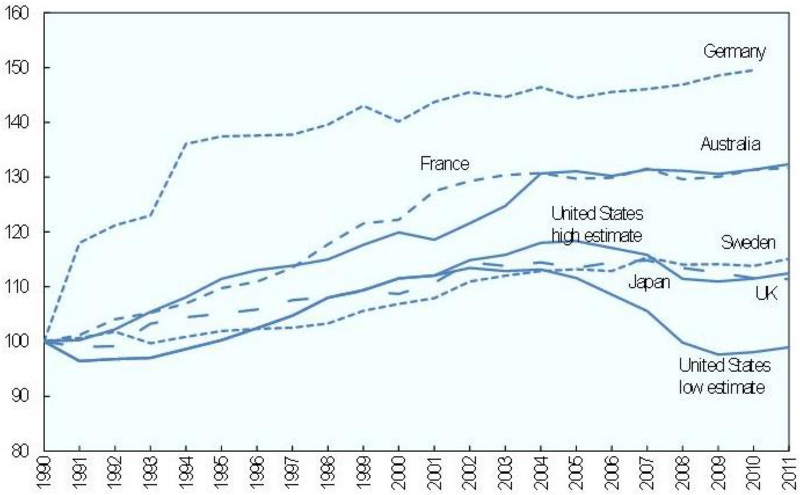


**Figure 3-1** **Passenger kilometres by private car (1990=100)**
*Source: International Transport Forum. The Federal Highway Administration estimate of vehicle occupancy in the US has been revised for 2009 based on the 2009 National Household Travel Survey (NHTS), resulting in a lower occupancy rate than previously. High estimate applies the vehicle occupancy based on 2001 NHTS while low estimate is based on a gradual decline from 2001 rate to 2009 rate*

This phenomenon studies a combination of factors and indicators that reveal similar trends over the world. Metz (2014) shows the decoupling of income and car use, revealing that high earners, especially men, use their car in a decreasing rate. Additionally, the number of new driving licences in the U.K. has decreased and the car is becoming less attractive means of transportation among young people, especially men. Wegener (2010) outlines a number of new trends that could be related to the phenomenon of peak car. Such trends are the technological innovations, finite fossil fuel reserves, environment-protecting policies set out at country or world level. The list of possible contributing factors goes on, including on-line shopping, working from home, consumers’ interest shift to technological gadgets, health initiatives.

Goodwin (2012) summarises a series of factors that may be related to this change in the use of the car and separates them into two categories: the first one being based on economic and governmentally driven factors such as GDP changes, buyer’ s purchasing power, fuel prices or cost of use; the second one being a less tangible one that is driven by cultural, social and policy factors. They are presented in Table 3-1 below:

| |
|---|
| **Traditional 'economic' factors of prices and incomes** |
| • General economic conditions<br>• Fuel prices<br>• cost of learning to drive<br>• acquire and run cars<br>• congestion charging<br>• insurance costs<br>• parking costs<br>• Fares subsidies on public transport<br>• Changes in regulation<br>• taxing and funding of company cars<br>• Decoupling of income growth from travel growth |
| **Changes to the relative quality and reliability of travel** |
| • Improvements in public transport, due to priority access to infrastructure and better operations<br>• Congestion Provision of cycle lanes and other support<br>• Pedestrianisation of town centres and traffic calming in residential areas<br>• Development of urban rail systems with consequential impacts on property values and attractiveness of locations well served by public transport<br>• Reallocation of road capacity from car to wider pavements, priority lanes, etc<br>• Parking conditions and policy<br>• Increased availability and lower (relative) prices of alternative long distance mode (rail, air) which may lead to substitution for given destinations but perhaps more importantly<br>• substitution of destinations and modes |
| **Developments in land use planning** |
| • Redevelopment of brown-field sites and inner city areas with high densities<br>• Retail and service development favouring urban localities rather than out-of-town sites<br>• Inner city development of a type which becomes preferred by higher income groups and opinion formers, changing fashions away from suburbs<br>• Better understanding of economic benefits of public realm improvements |
| **New social/technical patterns and preferences seen as influences on behaviour** |
| • Travel time budgets, especially in the context of natural saturation level<br>• Application of 'smarter choices' programmes<br>• Cultural and psychological shifts including a cooling or disappearance of the 'love affair with the car'<br>• Concern with motivations less favourable to the car (notably environmental impacts and personal health)<br>• Various different forms of e-commerce (tele-commuting, on-line shopping, virtual conferences and meetings) and e-leisure (social networks, virtual worlds) especially associated with mobile commuting (which in turn is more favourable to public transport use than car driving)<br>• Social changes such that the driving license as a key rite of passage into adulthood no longer has the universality it had seemed to be acquiring, especially among young men whose propensity to learn to drive and buy a car has reduced in many countries<br>• Decline of the status, fashion, social esteem, implicit sexuality and 'buzz' of car ownership and use, and their replacement by other products and icons<br>• Changing demographic structures and lifestyles, including those which affect the longevity of particular life-cycle stages and the locations where people prefer to spend them, for example shifts from inner cities to suburbs of young couples, returning to cities when their children leave home<br>• Growth of immigrant numbers (in the broadest sense) who bring different cultural attitudes and habits of travel to their new homes, whose effects may go in either direction depending on the specific two cultures concerned<br>• Shift in the direction of transmission of attitudes, i.e. from children to parents<br>• Complex balance of aging and gender effects, such that women are catching up with the car access of men, men are catching up towards the longevity of women, both are living longer with a tendency to keep on with car use in the early years of retirement but then to have a longer period of life when it is less easy to sustain car use and the skills which go with it. |
| **New patterns of work, shopping, entertainment and leisure** |
| • Shift of certain categories of what has traditionally been considered as 'personal' travel to 'commercial' travel, notably in home delivery of some goods previously been transported by car<br>• Telecommuting, high-technical versions of home working shifts of some travel from car to air, and from air to train<br>• Reduction in traditional forms of car dependence, including by development of new patterns of car use moving away from traditional ownership to various sharing, leasing or renting schemes |
| **Direct and indirect effects of technologies providing mobile internet access** |
| • Opportunities for entertainment, social contact and productive work during travel, tending to favour public transport more than car use.<br>• Better travel planning, including recovery from disruption |

**Table 3-1 Comprehensive list of causes of reduced car use in developed countries**
*Source: Goodwin (2012)*

Peak car has been related to energy consumption and the term peak oil. Peak oil theory implies that there has been a maximum rate of oil extraction around 2000 and that thereafter the oil consumption will continue to decrease. Nick Butler mentions in the Financial Times (2013) that the US transport sector oil demand is falling and that this phenomenon is due to social changes rather than the economic downturn. He compares the “peak car” term with “peak oil” term that has been used for several years. Using current technologies and with the non-oil powered car market still rising, the level of car use affects the demand for oil. As Sheikh Zaki Yamani, a Saudi Arabian ex-oil Minister has stated *“The Stone Age did not end for lack of stone and the Oil Age will end long before the world runs out of oil*”. This might be the case with car ownership and usage, considering all the new trends of young people preferring public transport, getting less driving licenses and generally preferring to acquire new technological gadgets rather that a new car.

## 3.2 Evidence and data

The main indicator change that was noticed and fired the peak car discussion is the distance travelled per capita that has not increased as expected a few years ago and has been presented in Figure 3-1. Goodwin (2013) presents a series of similar analyses for more countries, forecasting and estimated trends regarding the future use of car per person as well as comparative analysed between previously estimated traffic growth factors and traffic actual growth.

Le Vine S. (2014b) sifts the attention to “Generation Next”, namely the demographic group of pre-driving age teenagers and states that they are less economically vibrant and less economically active than their predecessors. Another point that is noted is that as a result of the economic recession, less young people are now working and the purchasing power of those who are working has not yet reached the level seen in 2001. Therefore, suggesting that the phenomenon of young people in the U.K. driving less may be linked to personal economic strength of the individuals.

In May 2014 U.K. transport experts gathered to discuss about peak car, following the New Zealand’s Ministry of Transport request. New Zealand is currently considering reviewing its own transport strategy. Lyons and Goodwin (2014) summarise the discussed topics. They make a distinction between miles travelled per capita and total miles travelled. The first that has declined reveals a shift in behaviour and is an indicator of peak car whereas the second may have increased as a result of population growth. As far as policy makers are concerned distinction between the two is not significant as it is the forecast total amount of traffic on the roads that they are concerned about when making decisions.

> There is great interest in the appearance of some common features in many countries, notably including changes in the propensity to get driving licenses among young adults (especially teenage men), an apparent weakening of the association between income and mobility, a greater influence of public transport, walking and cycling to economic prosperity in some of the most successful cities, and the development of e-commerce, telecommuting, and social networks.
> *Source: Goodwin (2013)*

The Institute for Mobility Research (IFMO) (2013) has carried out a research gathering data from six developed countries: Germany, France, Great Britain, Norway, Japan and the USA in order to analyse the mobility of Generation Y, namely the generation of children born between 1980 and 2000. Their findings are supportive of the peak car theory:

- While **licence-holding** among young adults has stagnated at a high level in recent years in France, Germany and Norway, it has decreased in Great Britain, the USA and Japan.
- **Car availability** – measured in terms of personal licence-holding coinciding with household car ownership – fell among young adults in all study countries except Japan.
- The **modal share of the car** among trips made by young adults has decreased in all study countries except the USA and Japan; this trend was particularly strong in Germany.
- A decrease in average **annual distance travelled by car** by young adults, in all study countries, is the result of these behavioural changes.
- Across all study countries, the trend towards **lower automobility** was more pronounced among men than among women.

The research lists a number of possible reasons related to this behavioural change of young adults in the countries studied:

- Increasing prevalence of life situations which do not engender car use: increase of people attending tertiary education, increase of the age at which people have family etc.
- Changes in transport supply: policies that favour the use of public transport/bicycle and discourage the use of car etc.
- The rise of Information and Communication Technology (ICT): The rise of technological gadgets that are used while travelling and limit the ability to use a car or the fact that they may now be the new status measure. Though they were found to have a negligible impact in the context of the research.
- Other factors and country-specific developments: environmental awareness, cost of mobility, unemployment and income levels etc.

The behavioural changes they observed in the UK and Germany were the most noteworthy, thus they examined the two countries as a more detailed case study.

Le Vine (2014a) in his latest research on young adults mobility concludes that there remain evidence gaps in the backing up of the peak car theory and that current evidence suggest that environmental sensitivity and on-line activity have not played a significant role. Though it is definite that economic growth has shifted to older ages and that the process of driving license acquisition, at least in the UK, has added to the barriers of travelling by car. Lastly, concludes that we do not yet fully understand the drop in distance travelled by car among young drivers and that it is unlikely that it is related to the drop of number of young drivers.

Figuoera et al. (2014) compared the travel patterns of two age groups of the Danish population: the older generation (64-84 years old) and the younger generation (18-64 years old). They conclude that there are significant changes in the travel behaviour, with the older generation less likely to sift to alternative means of transportation in high density and well areas served by public transportation. This may be attributed to the older group's choice to use the car as a compensatory tool for physical loses and maintain mobility, as well as to the extended hours of availability to drive due to not working.

Kuhmnihof et al. (2012) examined the temporal change in travel patterns among adults between 19-28 years old in Germany. They used four datasets in order to achieve their goal:

two German national household surveys, serving as main sources of travel data (1976 and 1995-2009 datasets) and two German income and expenditure surveys serving as a source of car ownership data (1998 and 2008 datasets). They concluded that young adults in Germany have reduced their use of automobiles and related this to increased multi-modality among car owners and decrease in car ownership.

Kuhnimhof et al. (2011) studied the travel pattern trends among young adults in both Germany and the U.K. They used data deriving from national travel surveys starting from the 1970s. They concluded that young adults have decreased their travel with automobiles during the past decade, as illustrated in Figure 3-2 below. This was found to be occurred due to a combination of factors: car ownership has decreased; modal sift is evident with decreasing use of the car; long-distance travelling has become longer, therefore air travel is preferred; men have reduced their automobile travelling more significantly than women. They point out that similar trends were found in both Germany and U.K. implying that this may be a trend that is also evident in other countries.

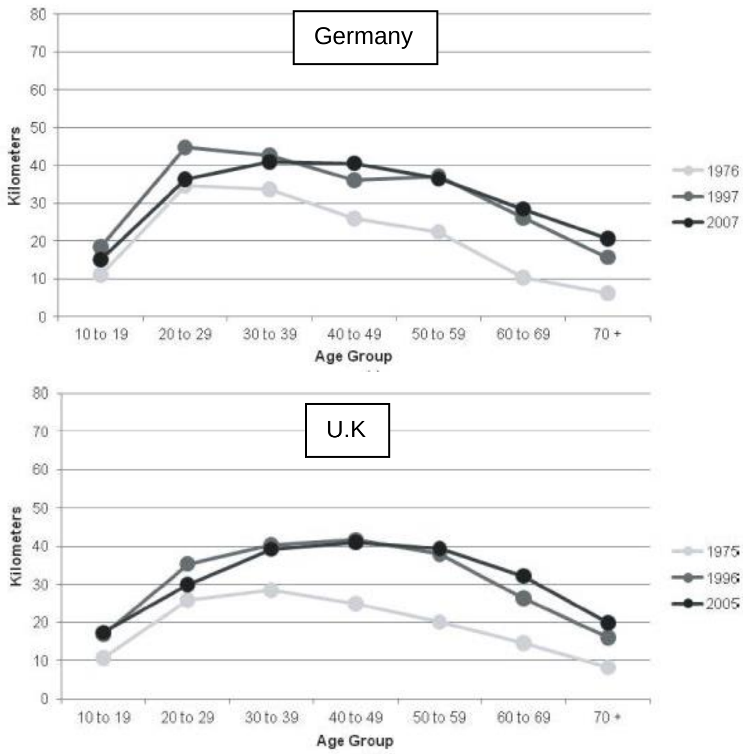


**Figure 3-2** **Distance by motorized modes per trip maker and day, by age, (1976 – 2007) kilometres travelled by car (driver and passenger).**
*Source: Kuhnimhof et al. (2011)*

Metz (2013) mentions the three first eras of travel, namely the first (60.000 years ago) when humans started walking and hunting, the second (10000 years ago) when domestication started and humans gathered around plantations and the third ($19^{th}$ century) when the railway was invented and suggests that we have now entered the fourth era marked by the phenomenon of peak car when the average per capita growth of daily travel has ceased to increase. He examines a number of factors and trends related to peak car such as demographics, technology and modal share. He suggests that the main factors driving the choice of transportation mode in the future will be demographic, namely population growth, urbanisation and increasing longevity.

Newman and Kenworthy (2011) examined data related to the existence of peak car for the USA, Australia and eight nations. The data consists of trends in distance travelled per capita as summarised in Figure 3-3, modal share, fuel prices, urban density and car use, trends among different age groups. They conclude that peak car has indeed started to apply in big cities and is caused by a combination of factors: inability of the car to support urban sprawl and serve within a desired time frame; improved and increased existence of transit options in the cities; unattractiveness of the car among the older generation and the younger adult generation. The result of peak car is a paradigm shift for planners, engineers and economists.

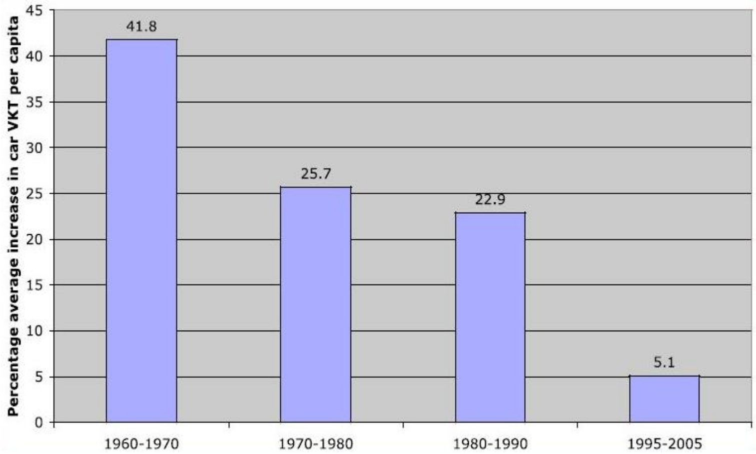


**Figure 3-3** **Car use growth trends in developed cities[1] from 1960 to 2005 using Global Cities Database.**
*Source: Newman and Kenworthy (2011)*

Lee and Senior (2011) examined the effects of four light rail schemes on travel mode in four cities in the U.K. Specifically, the examined before and after conditions using census data for the following schemes: Greater Manchester Metrolink, South Yorkshire Supertram, Midland Metro and Croydon Tramlink. They concluded that the new schemes did not affect car modal share significantly but mainly the bus modal share.

Goodwin and Dender (2013) review seven papers[2] on themes related to peak car and summarised their findings: young adults drive less than their predecessors but it is not predictable how they will behave in the future; the location and density of an area affects significantly the use of car; regarding the economics side, elasticities related to income and price are falling and finally with respect to policy making they suggest that instead of deciding

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[1] **US cities**: Boston, Chicago, Denver, Houston, Los Angeles, New York, Phoenix, Portland, San Francisco. **Canadian cities:** Calgary, Winnipeg. **Australian cities**: Adelaide, Brisbane, Melbourne, Perth, Sydney. **European cities**: Amsterdam, Brussels, Copenhagen, Frankfurt, Hamburg, London, Munich, Paris, Stockholm.

[2] The **seven papers** reviewed:

- Metz, D. (2010). Saturation of demand for daily travel. Transport Reviews, 30(5), 659–674.
- Metz, D. (2012). Demographic determinants of daily travel demand. Transport Policy, 21(1), 20–25
- Schipper, L. (2011). Automobile use, fuel economy and CO2 emissions in industrialized countries: Encouraging trends through 2008? Transport Policy, 18(2011), 358–372.
- Newman, P., & Kenworthy, J. (2011). Peak car use: Understanding the demise of automobile dependence. World Transport Policy and Practice, 17(2), 31–42.
- Goodwin, P. (2011). Three views on 'Peak Car', special issue on 'A future beyond the car', guest editor S. Melia. World Transport Policy and Practice, 17(4), 8–17.
- Kuhnimhof, T., Armoogum, J., Buehler, R., Dargay, J., Denstadli, J. M., & Yamamoto, T. (2012). Men shape downward trend in car use among young adults—Evidence from six industrialised countries. Transport Reviews, 32(6), 761–780.
- ITF (2011). Transport outlook — Meeting the needs of 9 billion people. Paris: ITF.

based on one forecast scenario, there should be a range of possible scenarios to base decision making on.

In the U.K., as stated by the Parliamentary Office of Science and Technology (POST) and JMP's Beswick A., the key definition for "peak car" in the UK assumes that the annual car miles per person have been flattening or decreasing since the early 1990s and that they will continue to decline or stay static. This is contradictory with the NTM where the prediction is that they will begin to grow alongside economic recovery, but at a declining rate. The NTM is used in forecast planning, therefore all the strategic infrastructure cases supported by the Government, are assessed based on growth factors provided by the NTM. It is important to understand the contradiction and the related the risk taking of using data that may differentiate with official behavioural forecasts. Concerns about the forecasting methodology used in the U.K. and its relevance to the latest research in travelling trends was raised by 32 renown academics and two professional societies, in their open letter to the Secretary of State that was published on January 22nd 2013.

> **"Peak Car"** [...] Whether this hypothesis turns out to be true has huge consequences for the future of London's transport network, and attempting to unpick the factors that may contribute to it or act against it is central to our ability to plan and invest for London's long-term future.
> *Source: TFL (2012)*

Metz (2014) examines the example of the U.K. and puts the average distance travelled under the spotlight. He explains how it has increased over the past centuries and that the innovations in travelling modes, let it be new road infrastructure, rail lines, advancing complex networks, has affected the distance people have been travelling and the possibilities for urban sprawl and inter urban connectivity. He argues that given the fact that the time we are willing to spend at daily travelling is definite, improving transportation speed can help people reach further therefore assisting urban sprawl. Transport-related infrastructure development has led to urban development and the two should always be seen in conjunction rather that separately.

Changes in car usage have been attributed to a combination of environmental, planning and socio-economic factors: A sample capturing a global perspective is the synopsis of Melia (2012) of five opinions related to the new era of car use:

- the three views on Peak Car, as stated by Goodwin (2012), that the car use has reached a peak, is in decline or will start growing after the economic downturn
- the need for sustainable travel, as outlined by Hillman (2012)
- the movement towards more walkable cities worldwide with a specific example for Australia, as presented by Matan and Newman (2012)
- a possible movement towards a car-free York (U.K.), as investigated by and the study on the delivery of freight in car-free cities, by Crawford (2012).

New technologies and more sustainable modes of transportation may influence the use of car in the U.K., especially when combined with large scale rail infrastructure projects that are on the way. Though the NTM report states that the impact these developments would have on the use of car in total, is negligible and that this risk has been incorporated in the appropriate sensitivity testing.
According to the U.K.'s Office for National Statistics (ONS), the population of England is due to increase by 2040 by an average of 20%. Additionally, according to the Office for Budget responsibility (OBR) the GDP per capita is predicted to rise by an average of 66% by 2040.

The fuel cost for cars and LGVs is predicted to fall around 24% and 7% respectively. The extreme highs and lows of those figures create a number of combinations that lead to different growth factors. The NTM's "Road Transport Forecasts 2013" clearly states that its forecasts are an approximation of what will happen on the roads up to 2040, based on current understanding of travel patterns, key factors affecting demand (micro and macro factors) and assuming no change in government policy. The assumptions and methodology of the NTM are constantly monitored in order to provide with "[...] *robust results and fit for purpose as a high level strategic model"*.

Lovallo and Kahneman (2003) explain how optimism may affect decision making at a business and financial level. When a business decision needs to be made, forecasting is used for the indicators related to the decision under consideration in order to define whether it is financially worth proceeding with or not. It is said that people tend to be optimistic about their forecasts due to their own nature (most people are optimistic as persons), anchoring (insisting on the initial business proposal and not taking into consideration dynamic changes in budgeting), competitor neglect (not considering the competition as an influential factor) or organisational pressure (need to deliver a successful proposal in a limited time-frame and a competitive environment that leads to using optimistic and favouring forecasts). They state that for most people *the tendency towards optimism is unavoidable* and that most companies indeed use this as motivation to their staff and as a means to keep them resilient to changes and difficult situations. They suggest a method to minimise this optimism bias and call it "**reference class forecasting**" It consists of establishing an "outside view" that means, completely ignoring the details of the project at hand and instead ***"examine the experiences of a class of similar projects, lay out a rough distribution of outcomes for this reference class, and then position the current project in that distribution. The resulting forecast is much more accurate."***

This theory has been mentioned by Flyvbjerg et al. (2006) and it could be used in the transport related forecasting and specifically in identifying the optimism in forecasting and bringing it down to a realistic level. In order to take this "Outside View", Lovallo and Kahneman (2003) suggest the following certain steps:

1. Select a reference class: Carefully select the relative projects to reflect the conditions of our current problem.
2. Assess the distribution of outcomes: *Document the outcomes of the prior projects and arrange them as distribution, showing the extremes, the median and any clusters*.
3. Make an intuitive prediction of your project's position in the distribution: This step is highly likely to be biased; therefore the following two steps will assist in a more realistic forecast.
4. Assess the reliability of your prediction: Base the current choice on past choices' accuracy and historical data in order to assess its reliability. In the absence of such information, make an effort to statistically rank the reliability of the current prediction according to other types of predictions. It may be useful to recruit an experienced statistician at this stage.
5. Correct the intuitive estimates: Adjust the initial estimate towards the average, based on the analysis of predictability from Step 4.

# 3.3 Car ownership and traffic forecasting in U.K.

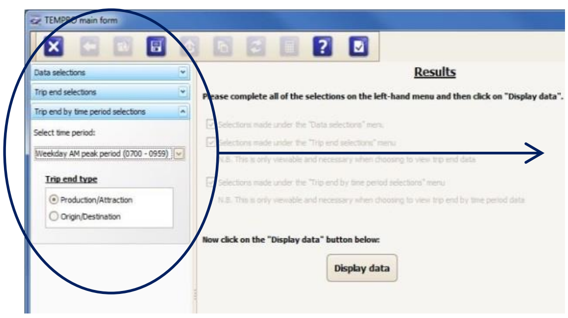
## 3.3.1 Introduction

This section as well as some parts of the application and the methodology refer to U.K. specific processes. Table 3-2 includes some useful information about the abbreviations and documentation names that are used later on in the methodology.

| | Full Name | Description |
|---|---|---|
| DfT | Department for Transport | |
| HA | Highways Agency | |
| WEB TAG | DfT's Transport Analysis Guidance | Contains guidance on the conduct of transport studies. The guidance includes or provides links to advice on how to:<br>- set objectives and identify problems<br>- develop potential solutions<br>- create a transport model for the appraisal of the alternative solutions<br>- how to conduct an appraisal which meets the department's requirements |
| NTEM | National Trip End Model (U.K.) | The National Trip End Model (NTEM) forecasts and the TEMPRO (Trip End Model Presentation Program) software are used for transport planning purposes. The forecasts include:<br>- population<br>- employment<br>- households by car ownership<br>- trip ends<br>- traffic growth factors based on data from the National Transport Model (NTM). The data and software are available for free, for anyone to use. |
| TEMPRO | Trip End Model Presentation Program | |

**Table 3-2 Abbreviations and description of U.K. specific terms**

In the U.K. the growth factors related to traffic forecasts are provided by the DfT via the Trip TEMPRO. This section examines the methodology behind the growth factors estimation: TEMPRO uses as underlying data the NTEM and provides with results for a combination of categories that may be defined by the user, as presented in Table 3-3. Car ownership is implicated in this method via the NTEM that is using the National Car Ownership Model.




| Data selections | Trip end selections | Trip end by time period selections |
|---|---|---|
| Dataset version | Trip purpose definition | Trip end type:<br>- Production/attraction<br>- origin/destination |
| Results type:<br>- Trip ends by time period<br>- Trip ends by car availability<br>- Car ownership data<br>- Planning data | Transport mode:<br>- Walk<br>- Cycle<br>- Car driver<br>- Car passenger<br>- Bus/coach<br>- Rail/underground | Time period:<br>- Weekday AM peak period<br>- Weekday PM peak period<br>- Weekday interpeak<br>- Weekday off-peak<br>- Saturdays<br>- Sundays<br>- Average weekday<br>- Average day |
| Definition of base year and future year | | |

**Table 3-3 TEMPRO screenshot: Initial set of options**

## 3.3.2 National Trip End Model (NTEM)

In the U.K. the DfT is responsible for supervising and maintaining traffic forecasting methodologies. The NTEM is the underlying information of the TEMPRO software that gives the growth factors used in planning schemes. This section examines the information included in the latest version of the NTEM (v 6.2) and how car ownership is involved in the growth factors estimation. The previous version of the NTEM (v 5.4) was released in 2008.

The U.K. is divided into zones based on the 2001 Census output areas “[...] *to give a good representation of urbanicity and rurality at a defined geographical level”.* The U.K. is divided in 2,496 NTEM zones. The process followed by the NTEM is summarised in Figure 3-4 below: A scenario generator is run and creates planning data forecasts that are used for input to the Car Ownership Model and the National Trip Ends Model. The scenario generator reads projections for population, households and employment as well as Expected Growth Factors (EGFs) that represent the level of growth that is expected in each zone taking into consideration the area type or the observed changes in employment. The software used base year (2001) demographics for each zone.

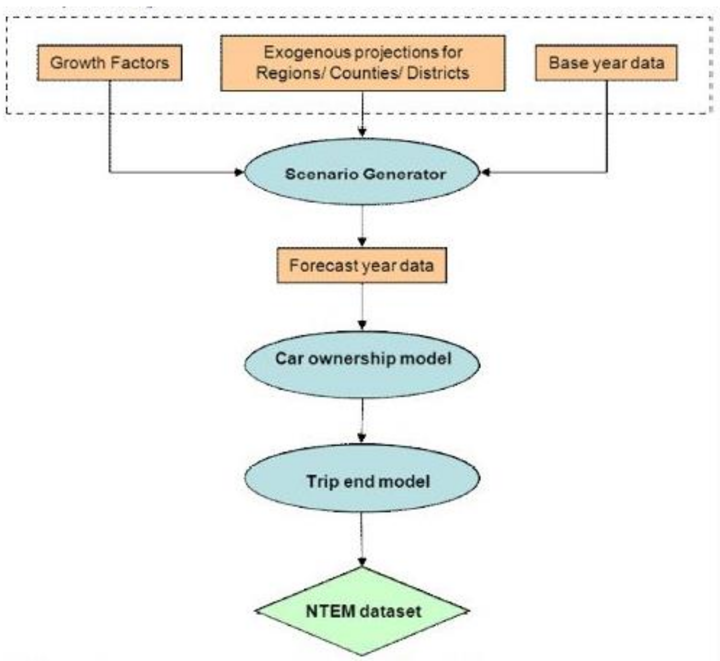



**Figure 3-4** **Basic steps in generating the NTEM 6.2 dataset**
*Source: NTEM Planning Data Version 6.2 – Guidance note – DfT*

The structure of a possible series of forecast runs is presented in Figure 3-5 below. Each set of forecast is run for a 5 year interval.

The main input data that in the forecasting process are households, population and employment. These inputs are generally government provided trend projections and may be modified in the process of producing a set of planning led forecasts. Households are examined by size in the study area. Population is examined by gender and age. Employment is examined by sector, gender and working status.

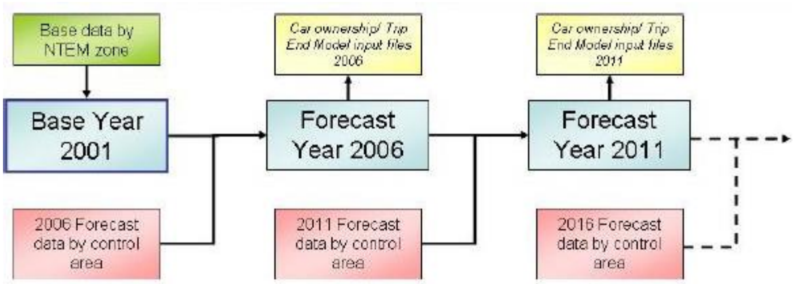



**Figure 3-5** **Structure of a possible series of scenario tests using Scenario Generator**
*Source: NTEM Planning Data Version 6.2 – Guidance note – DfT*

As far as the forecasts are concerned, they are done in different ways for each data category: Population forecasts are produced by the ONS. Each county (administration unit) is responsible for the projections of households. The dwelling stock is extracted from published data from the ONS and it is combined with the projected annual averages of housing. The employment forecasts are produced by the DfT using:

- Office for Budget Responsibility Employment growth and the treasury employment forecasts for the national level
- Experian business studies for the local authority/district level
- Historic data at a national level
- The DfT employment forecasting model

The scenario generator uses the EGFs and they influence how much the employment and household development from a zone is distributed to its constituents. The EGF methodology is essential in the absence of a complete set of specific data on housing and employment sites. The newest version of the NTEM has incorporated differences related to the car ownership model. Though these differences are not significant are related to purchase costs and GDP. The new NTEM version has a slightly lower proportion of households without a car and greater proportion of one-car households. The differences in the projection of car ownership in the previous and the new version of the NTEM are presented in Figure Figure 3-6 below.

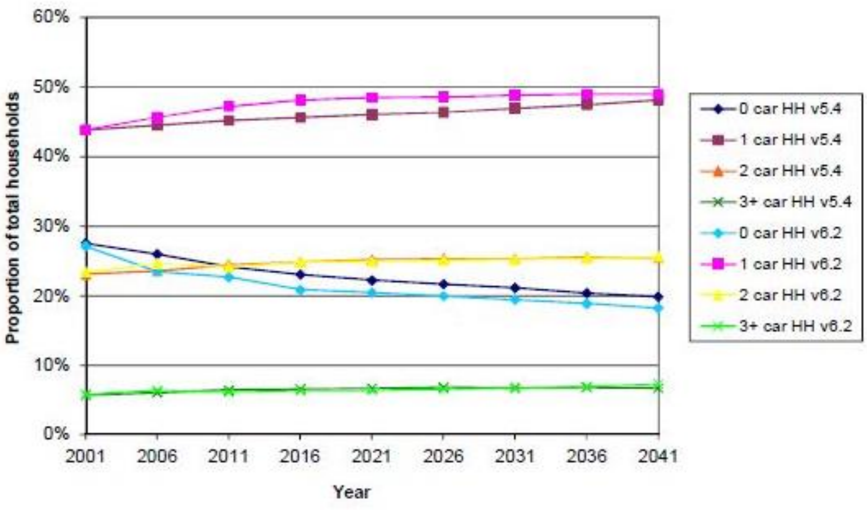



**Figure 3-6** **NTEM: Car ownership through time – comparison of version (6.2) with version (5.4)**
*Source: NTEM Planning Data Version 6.2 – Guidance note – DfT*

### 3.3.3 National Car Ownership Model

The DfT has for many years been responsible for maintaining the national car ownership model and has had a number of reports related to the underlying methodology:

In the 1960s and 1970s National Road Traffic Forecast (NRTF) car ownership forecasting model was aggregate and based on trend extrapolation techniques developed by the Road Research Laboratory. Later on discrete choice models gathered pace they also got adopted by the DfT' s forecasting methodology. The model maintained its aggregate nature as it had been previously developed but augmented its forecasts at a local level using a partially disaggregate ownership model. This model showed the proportion of houses with zero, one and two or more cars in each model zone based on estimates of market saturation, household, income and the proportion of adults holding a full driving license. The methodology was slightly altered later on in 1989.

A disaggregate approach was first implemented in the 1997 NRTF and it involved the calibration of two household choice models showing the probability of owing at least one car or at least two cars if one was already owned. In 1999 DfT wanted to develop the model in order to be used for policy analysis and made recommendation for a number of improvements to its car ownership forecasting methodology (NATCOP). The study was carried out in 2001 (Wheelan et al. 2001) and aimed to work on two key areas: Improve the structure of the previous 1997 model to include a number of policy sensitive variables and use the newest calibration techniques; introduce a new car ownership forecasting methodology to generate local forecasts across all regions of Great Britain. These improvements took into account a number of factors:

- increase in multiple-vehicle households
- assess the impact of company cars on ownership levels
- identify market saturation
- assess the impact of employment levels on car ownership
- test the sensitivity of the model to purchase and use costs

**Prototypical Sampling**

The most obvious way to produce samples representative of future conditions is to generate an artificial population which has, as far as is known, the characteristics of the future population. However, the forecasts that are generally available - e.g. from planning authorities - typically refer to aggregate statistics such as age-sex population distribution, rather than the composition of individual households. A method is therefore required for generating a sample of households that is internally consistent, i.e. that it 'looks like' a typical population, while also achieving consistency with such aggregate statistics as are available.

The objective of the method is thus to use an existing household sample to produce a sample that is or will be representative of one or more target areas. The key method used for adjusting the samples is the adjustment of the expansion weights present on the survey records (the FES does not include expansion weights all households are weighted by the total population divided by the sample size).

*Source: Wheelan et al. (2001)*

The latest updated report regarding the National Car Ownership Model is the DfT' s 2007 report conducted by MVA consultancy. It aimed at updating some of the demographic data to include the latest updates; update the model to run for a 2001 base year; recalibrate the model to TEMPRO 5 data; provide a brief reporting on the updates carried out and the model's performance.

The model assesses the possibility of a household owing zero, one, two or more vehicles by applying three binary logit models. The mathematical expression for this probability assessment is presented in Equation 1 below. All three models estimated draw data from the Family Expenditure Survey and the National Travel Survey and relate the number of cars owned to the utility of ownership which is related to a number of socio-economic characteristics of the household, its geographic location, purchase cost and license holding.

The results of the models estimation is a number of estimated model coefficients. As far as the model's application is concerned it is mentioned that: "[...] *the most practical way to generate unbiased forecasts from a choice model is by a technique known as sample enumeration. This approach rests on the assumption that the sample (usually the sample on which the model is calibrated) is representative of the population and that the forecast demand for each alternative can be estimated"*.

$$P_{1+} = \frac{S_{1ah}}{[1+exp(-U_{1+})]}$$

$$P_{2+|1+} = \frac{S_{2ah}}{[1+exp(-U_{2+|1+})]}$$

$$P_{3+|2+} = \frac{S_{3ah}}{[1+exp(-U_{3+|2+})]}$$

For model estimation we have assembled data from the Family Expenditure Survey (now the Expenditure and Food Survey), National Travel Survey, CACI Income data and constructed indices for car ownership costs, car running costs and general prices (RPI), together with data showing historical trends in the average number of driving licences per adult.

*Source: Updating National Car Ownership Model, DfT, 2007*

**Equation 1** **Car Ownership Model mathematical specification**
*Source: Updating National Car Ownership Model, DfT, 2007*

where:

$S$ : Saturation level by area (a) and household type (h)

$U$ : Utility of ownership, specified as follows:

$$U_{1+} = ASC_1 + b_1 LPA + (c_1 + c_{h1} D_h + c_{a1} D_{a1})Y + d_1 E + e_1 O + f_1 R$$

$$U_{2+|1+} = ASC_2 + b_2 LPA + (c_2 + c_{h2} D_h + c_{a2} D_{a2})Y + d_2 E + e_2 O + f_2 R + g_{21} CC_1$$

$$U_{3+|2+} = ASC_3 + b_3 LPA + (c_3 + c_{h3} D_h + c_{a3} D_{a3})Y + d_3 E + e_3 O + f_3 R + g_{31} CC_1 + g_{32} CC_2$$

where:

| | |
|---|---|
| LPA | is the number of driving licences per adult for Great Britain as a whole |
| Y | is household income |
| $D_h$ | is a vector od household type dummy variables |
| $D_a$ | is a vector of area type dummy variables |
| E | is the number of adults employed |
| O | is an index of purchase costs |
| R | is an index of vehicle use costs |
| $CC_1$ | is a dummy variable if there is one company car in the household |
| $CC_2$ | is a dummy variable if there are two company cars in the household |
| ASC | is a vector of alternative specific constants |

a,b,c,d,e,f,g are parameter vectors to be estimated

The models with their estimated coefficients and using the enumeration technique may be used to generate ownership forecasts for each of the 2,496 forecast zones in a six stage application method:

Stage 1: Base sample definition

Stage 2: Target area definition

Stage 3: Forecasting period definition

Stage 4: Target variable definition

Stage 5: Household category definition

Stage 6: Adjusting the constants

# 4. Methodology

## 4.1 Introduction

Peak car theory is related to the use of car and it is implicated in passenger demand and traffic forecasts, as it has been explained in the literature review. Whether peak car happens or not, our forecasts have been proven to be inaccurate in many cases and when this comes to infrastructure investment, the financial loss of such inaccuracies is significant. This methodology focuses on the impacts of the peak car theory in order to strengthen the need for more attention to the theory and for new methods to come to place for dealing with the inaccuracies in forecasting.

It was considered useful to have a tool that calculates the financial implications of forecasting inaccuracies. That tool may be used by stakeholders and decision maker to assess the financial impact of their decisions in case the forecasts that have been used for scheme appraisal have been inaccurate.

This methodology provides with a holistic approach that aims at identifying the monetary value of forecasting inaccuracies by examining a variety of factors. In Figure 4-1 below is a general outline of the methodology. The rationale behind the methodology is based on assessing road schemes but it can also be applied at any kind of infrastructure scheme, provided that the base year and forecast key factors can be calculated and translated into monetary values.

The general concept is that once the scheme under study has been selected and all the present year data has been gathered, it can be input to a tool (e.g. a model) that analyses them. Therefore, a number of externalities (examined factors) may be extracted from the tool. Those externalities may be translated into monetary values by applying a function or just multiplying with a value of cost for each of them. Therefore the base year generalised cost of the externalities is calculated.

The basic forecasting values are applied to the base year data, thus the forecast values are input to the tool that calculates the forecast values for the externalities. The steps mentioned above are then repeated to calculate the generalised cost for the forecast values of the externalities. The difference between base year and forecast year cost of the externalities is the cost of the future year conditions.

The next step is to run the sensitivity test in order to assess the financial impacts of forecasting inaccuracies. The basic change is the growth factors applied to the base year values in order to calculate the sensitivity testing input data for the tool. Therefore the sensitivity testing forecast values of the externalities are calculated alongside the related generalised cost. The difference between forecast year cost of the externalities and the sensitivity testing cost of the externalities is the cost of forecasting inaccuracies.

This procedure may be repeated as many times as the application considers useful in order to produce a satisfying dataset of generalised costs for the sensitivity testing. The steps of the methodology are explained more in detail later on in this chapter.

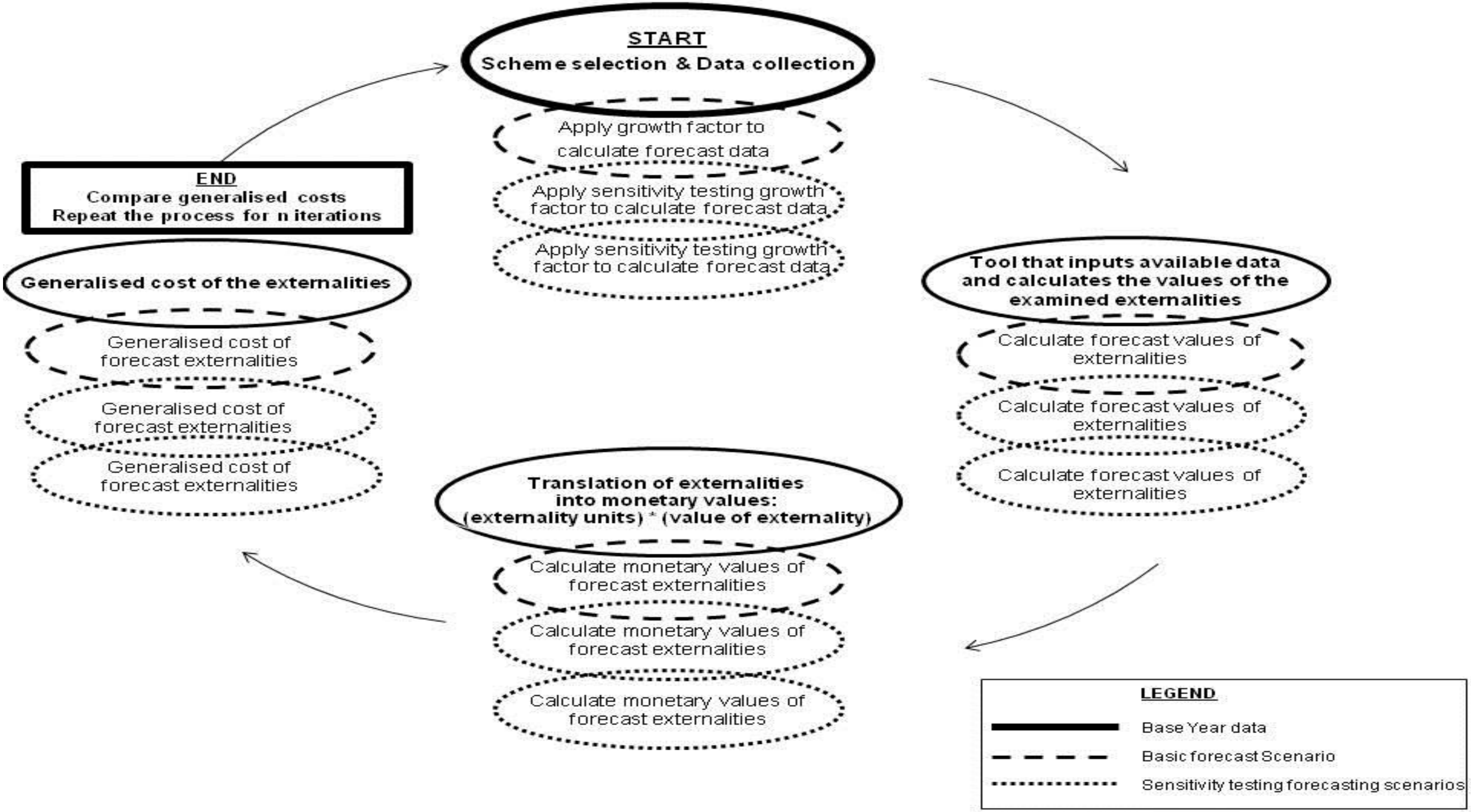



**Figure 4-1 Methodology Outline**

## 4.2 Group Step 1

This section describes the first group of steps in this methodology as shown in Figure 4-2 below.

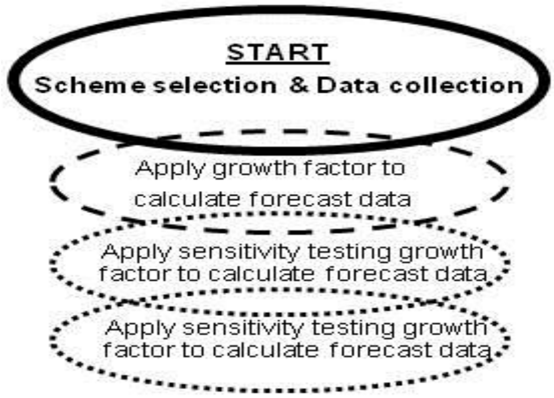



**Figure 4-2 Group step 1 of the methodology**

### <u>START</u> - Scheme selection and data collection

This is the first sub-step and it does not differ to the initial approach to most scheme appraisal projects. The scheme that will be assessed is selected in this step and all the relevant available data is gathered. The scheme under consideration could be any kind of infrastructure scheme that is related to transport management and mobility: it may be a transport strategy, a road improvement, a relief road implementation, a new railway, a bus scheme etc. The data that is collected is also relevant to the nature of the scheme. Generally it may consist of traffic demand data, passenger demand data, modal share, composition of traffic, geometrical characteristics of the network etc.

### Apply growth factors to calculate forecast data

This is the second sub-step and does not differ to the initial approach to most scheme appraisal projects. The base year conditions will have to be compared to forecast conditions, therefore a growth factor is usually applied to the base year demand data. This sub-step applies the officially given growth factors to the base year data in order to produce a forecast dataset to be input to the tool at the next step.

### Apply sensitivity testing growth factor to calculate forecast data

In this sub-step is decided the alternative growth factors that should be applied to the base year demand data in order to produce the sensitivity testing forecasting values. This third sub-step and it may be repeated several times according to the sensitivity testing requirements. There may be a need to run only 5-10 alternative scenarios or hundreds of different combinations. This number relates to the nature of the scheme, the importance of it and the gravity of the inaccuracies in case they occur.

The official growth factors are usually given by a governmental body and the goal of this methodology is to use those and compare with a set of different scenarios of growth, in case peak car becomes more evident in the future. The official forecasting methodology and the implication of car ownership in it are questioned here. In some countries there may be enough data as to how the forecasts are done and in some other countries it is hard to clarify that. In the first case it may be possible to calculate the sensitivity testing growth factors to assess the impacts of different combinations car ownership and distance travelled per capita. In the second case a set of assumptions may be made as to what the step of the sensitivity testing will be. In both cases the purpose of this methodology is served: the implication of the forecasting inaccuracies is made evident.

## 4.3 Group Step 2

This section describes the second group of steps in this methodology as shown in Figure 4-3 below.

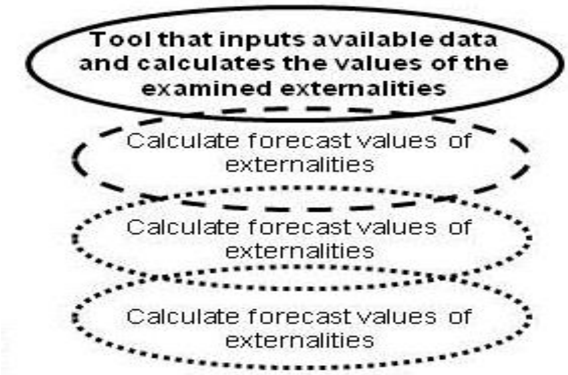



**Figure 4-3 Group step 2 of the methodology**

### Tool that inputs available data and calculates the values of the examined externalities

This is the first sub-step and it involves a calculative procedure that will convert the input data to a set of outputs that consist of the externalities to be examined. The decisions that are made in this step are relevant to the tool that will be used and the set of externalities that will be used. The two decisions are also related to each other as the one may impose constraints on the other.

As far as the tool is considered, ideally it is a model that includes the network under consideration and can adequately calculate the interaction of the input data and produce results for the selected externalities. The externalities are the factors that will be used later on in this methodology to assess the impact of peak car. It is important to include a wide range of factors that are similar to those used for scheme appraisal. Ideally, the externalities include a series of factors as listed below:

- Traffic performance indicators such as: traffic demand volumes, delays on the links, queuing levels, fuel consumption.
- Environmental assessment indicators such as: $CO_2$ emissions, noise levels.
- Safety indicators such as: number of incidents, number of accidents, casualties.

### Calculate forecast values of externalities

This is the second sub-step and it is the same with the third sub-step and all the iterations run after that for the sensitivity testing. It consists of changing the inputs to the calculation tool in order to accommodate forecast demand conditions and extracting the values for the externalities.

It should be noted that peak car, should it occur in the future, it will affect the distance travelled per capita and possibly the number of vehicles on the roads. The tool used in this step would ideally calculate the demand sift and assess the above mentioned indicators accordingly. For example, should car be used less and demand sifts to walking and cycling, the number of incidents and accidents may increase. Therefore, while the change in our input is related to traffic volumes (as described in Group Step 1), the modal share of this change should also be considered as it will affect the image on the network in the future.

## 4.4 Group Step 3

This section describes the third group of steps in this methodology as shown in Figure 4-4 below.

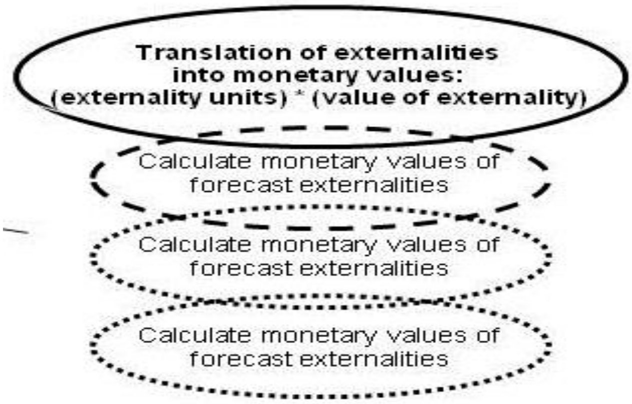



**Figure 4-4 Group step 3 of the methodology**

This step calculates the monetary values of the externalities that have been extracted at Group Step 3. The procedure is the same for all sub-steps and only two factors are changing between the first sub-step and the rest:

- The inputs, thus the values of the externalities
- The values (cost) of the externalities for the forecast year(s) have to be adjusted to represent current values. This is a correction that is done to account for changes in GDP or inflation. Therefore, all the monetary values may be compared on the same basis.

In order to translate the externalities to monetary values, a cost should be assigned to each unit of the externality. According to what the externality represents, the cost is calculated differently. Below is described the methodology for each group of externalities described in the previous section:

Traffic performance indicators

The delays on the links can be translated in monetary values by multiplying with the value of time. The value of time is different for drivers and passengers, different according to the purpose of the trip (work, leisure etc.) and according to the vehicle type (car, LGV, HGV). Therefore the above mentioned factors should have been defined so that the delays have been broken down to categories and they are multiplied with the correct value of time for each category.

The queuing may be translated into time lost and increased greenhouse gasses emission and therefore will fall under the category of delays or $CO_2$ emissions. A fuel consumption externality may be used and multiplied with the value of fuel in order to calculate the difference in the cost for fuel demand.

Environmental assessment indicators

The units of $CO_2$ emissions and the change in noise levels is multiplied by a cost for the two indicators. Therefore, the cost of environmentally related externalities is calculated.

Safety indicators

Once the number of accidents and casualties has been calculated they should be multiplied with the cost per accident/casualty in order to provide with the cost for the two externalities. The accidents should be classified for their severance and the location where they happened in order to apply different costs to them. The cost of an accident should not only include the cost of the physical damages but also the cost of the emergency units and time of the staff involved.

## 4.5 Group Step 4

This section describes the fourth group of steps in this methodology as shown in Figure 4-5 below.


**Figure 4-5 Group step 4 of the methodology**

The first sub-step sums all the previously calculated costs of the externalities and calculates the generalised cost for the current conditions. The process is simple and the same for all sub-steps.

The final step of this methodology is to compare the generalised costs and if necessary proceed to an additional iteration. The comparison of the generalised costs is done between the base year and all forecast generalised costs. Thus, the increased/decreased cost for the official forecasts can be compared with a range of costs for the sensitivity testing scenarios.

**Comparison methodology**

$GC_{FY} - GC_{BY}$ → compare with

$GC_{ST1} - GC_{BY}$

$GC_{ST2} - GC_{BY}$

$GC_{ST3} - GC_{BY}$

$GC_{STn} - GC_{BY}$

where:

| | |
|---|---|
| $GC$ | is the Generalised Cost |
| $BY$ | is the Base Year |
| $FY$ | is the Forecast Year with the official forecast growth factors |
| $ST_i$ | is the Forecast Year with the (i) iteration sensitivity testing growth factors |

# 5. Application

## 5.1 Introduction

Discussion about peak car comes down to what means of transport people will choose in the future and how accurate our predictions are. It is still uncertain how to make accurate predictions and as it has been shown that there are a few methods on minimising forecasting errors by using back-casting. The purpose of this application is to explore in the best possible way the effect of peak car on scheme appraisal. Specifically, it aims in observing the sensitivity of cost parameters - widely used in scheme appraisal - to the change in car ownership and the subsequent traffic forecasts. The methodology has been adjusted to better reflect the limited data availability and constraints.

It was chosen to run a sensitivity test to the outcomes of the national traffic forecasting system of the U.K. The U.K. was selected as there is plenty of traffic data that is frequently updated and open to the public. Moreover, the author lives and works in the U.K. and is familiar with the processes and data collection there. Road traffic forecasts have been selected to be examined: A great amount of infrastructure scheme appraisal is based on strategic planning studies. A strategy for a road or a road network may imply the need for improvements on the road itself, improvements on the public transport network and measures that do not directly relate to the road but may contribute to enhancing future conditions. Such studies are used to strengthen the case for infrastructure developments. Of course there is a number of factors that is considered when developing a strategy (environmental issues, highway design issues, safety concerns, public rights of way etc.). Therefore, it was found useful to examine how peak car could affect that part of the evidence base for a road based strategy.

In this section is presented the study area and its characteristics, the methodology that has been adjusted for this application and results of the sensitivity testing.

## 5.2 Group Step 1 – Data collection and forecasting

This section describes the application of Group Step 1 of the methodology.

### 5.2.1 Data Sources

The selection of the facility is usually related to the needs of the study. If it is a strategic planning study, then the local authorities decide on the route that should be examined. In the case of this application, an 80km section of an “A-road” has been selected. The section falls within the boundaries of a county in order to make the application related to an administration unit. Any route could be examined and the level of detail and the accuracy of the results would depend on the available data and the application of the methodology.

The basic data that is required is the traffic flows on the road and the associated delays. The level of detail depends on data availability and defines the accuracy and reliability of the results. The data ideally should be available on every link, from junction to junction in order to capture conditions on a set of “closed” systems.

Traffic data sources in the U.K. include the HA and DfT. The central authorities run a systematic program of traffic data collection that is available online for general use. This methodology is based on easily accessible information that can be found free of charge. The most reliable sources of traffic information are the DfT’s traffic counts and the HA’s traffic databases. Though should there be additional data available, this could only add to the accuracy of the outcomes.

The DfT Traffic Counts “[...] *provides street-level traffic data for every junction-to-junction link on the 'A' road and motorway network in Great Britain”.* Though in practice, traffic data are not necessarily always available for all the links from junction to junction and the Interactive map/regions search (see Figure 5-1) can be used to show if data is available and their date/type. Available data include estimated Average Annual Daily Flows (AADF) and raw manual counts data.

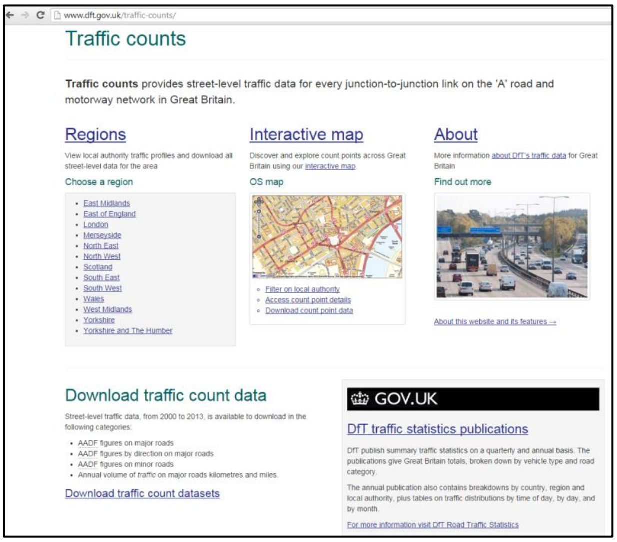



**Figure 5-1 DfT’s website for traffic counts downloading**

The HA “[...] *currently maintains, operates and develops three traffic databases and associated applications. The Traffic Flow Data System (TRADS) holds information on traffic flows at sites on the network. The Journey Time Database (JTDB) system holds information on journey times and traffic flows for links of the network. These two databases are known collectively as the HA Traffic Information System (HATRIS)”.* Data for both databases are collected from a variety of sources and collated by the HA before given to the public. It is not clear as to where each dataset derives from but there is not a way to clarify that. The TRADS data are usually given from link to link though the JTDB data are given for bigger link sections, according to the data available to the HA.

Other data required for this methodology are related to the geometry of the links examined and consist of the type of the link (urban, sub-urban, connector etc), the number of lanes, the lane width and all data required to define the link capacity.

In the U.K. the capacity of a link can be defined using the Design Manual for Road and Bridges (DMRB) Volume 5 Section1: the link is categorised according to its features (see

Figure 5-2) and then the capacity is defined according to the number of lanes and lane width (see Figure 5-3). In the same document, there is also provision in case of great flows of heavy vehicles reaching up to 15%-25% of the traffic flows.

**Volume 5 Section 1** — **Chapter 2**
**Part 3 TA 79/99 Amendment No 1** — **General Principles**

| Feature | ROAD TYPE | | | | |
|---|---|---|---|---|---|
| | Urban Motorway | Urban All-purpose | | | |
| | UM | UAP1 | UAP2 | UAP3 | UAP4 |
| **General Description** | Through route with grade separated junctions, hardshoulders or hardstrips, and motorway restrictions. | High standard single/dual carriageway road carrying predominantly through traffic with limited access. | Good standard single/dual carriageway road with frontage access and more than two side roads per km. | Variable standard road carrying mixed traffic with frontage access, side roads, bus stops and at-grade pedestrian crossings. | Busy high street carrying predominantly local traffic with frontage activity including loading and unloading. |
| **Speed Limit** | 60mph or less | 40 to 60 mph for dual, & generally 40mph for single carriageway | Generally 40 mph | 30 mph to 40 mph | 30mph |
| **Side Roads** | None | 0 to 2 per km | more than 2 per km | more than 2 per km | more than 2 per km |
| **Access to roadside development** | None. Grade separated for major only. | limited access | access to residential properties | frontage access | unlimited access to houses, shops & businesses |
| **Parking and loading** | none | restricted | restricted | unrestricted | unrestricted |
| **Pedestrian crossings** | grade separated | mostly grade separated | some at-grade | some at-grade | frequent at-grade |
| **Bus stops** | none | in lay-bys | at kerbside | at kerbside | at kerbside |

**Table 1 Types of Urban roads**
**and the features that distinguish them**

**Figure 5-2 DMRB – Defining link capacity Step 1 of 2**
*Source: DMRB – available online*

**Volume 5 Section 1** — **Chapter 3**
**Part 3 TA 79/99 Amendment No 1** — **Determination of Urban Road Capacity**

| | | Two-way Single Carriageway- Busiest direction flow (Assumes a 60/40 directional split) | | | | | | | | | Dual Carriageway | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number of Lanes | | | | | | | | | Number of Lanes in each direction | | | |
| | | 2 | | | | 2-3 | 3 | 3-4 | 4 | 4+ | 2 | | 3 | 4 |
| **Carriageway width** | | 6.1m | 6.75m | 7.3m | 9.0m | 10.0m | 12.3m | 13.5m | 14.6m | 18.0m | 6.75m | 7.3m | 11.0m | 14.6m |
| **Road type** | **UM** | **Not applicable** | | | | | | | | | | 4000 | 5600 | 7200 |
| | **UAP1** | 1020 | 1320 | 1590 | 1860 | 2010 | 2550 | 2800 | 3050 | 3300 | 3350 | 3600 | 5200 | * |
| | **UAP2** | 1020 | 1260 | 1470 | 1550 | 1650 | 1700 | 1900 | 2100 | 2700 | 2950 | 3200 | 4800 | * |
| | **UAP3** | 900 | 1110 | 1300 | 1530 | 1620 | * | * | * | * | 2300 | 2600 | 3300 | * |
| | **UAP4** | 750 | 900 | 1140 | 1320 | 1410 | * | * | * | * | * | * | * | * |

**Table 2 Capacities of Urban Roads**
**One-way hourly flows in each direction**

Notes
1. Capacities are in vehicles per hour.
2. HGV ≤ 15%
3. (*) Capacities are excluded where the road width is not appropriate for the road type and where there are too few examples to give reliable figures.

**Figure 5-3 DMRB – Defining link capacity Step 2 of 2**
*Source: DMRB – available online*

### 5.2.2 Study Area

For the purpose of this study the road that has been selected is the A12 trunk road in the U.K. It is a strategic road link at the East of the UK, starting from the Docklands area in London, crossing the M25 London ring road and reaching up to Great Yarmouth on its northern end. It has a total length of approximately 205km. Apart from London, it runs through the towns of Chelmsford, Colchester, Ipswick and Great Yarmouth, providing with an almost unique connecting main road network link between those towns. The A12 also serves a great amount of freight traffic, as it intersects and overlaps at some point with the A120 that connects the Haven ports with Stansted airport and the rest of UK' s road network. Haven ports (Felixstove and Harwick) are two of the most heavily trafficked ports of the U.K., where almost 40% of all UK freight transport takes place. In general, the A12 is known to serve a combination of commuting, freight, tourist and leisure traffic. The section of the road that has been studied and will from now on be mentioned as "A12" is the part from the Junction with the M25 (J11) until the junction with the A14 (J33) and covers a length of approximately 80km, as shown in Figure 5-4 below.


**Figure 5-4** **The section of the A12 under study**

The A12 has repeatedly been identified as being part of UK's strategic road network that suffers from congestion during peak hours and congestion due to incident management. It is an important link to transfer people and goods and contributing to the economy and general welfare. The section that is studied is within Essex County and during the next decades there is planned growth in the area, in terms of both housing and jobs. There is also a planned upgrading of Haven ports that would bring in more freight traffic to the distributing roads. Therefore, the A12 that has been identified as problematic at present would have to accommodate additional future traffic. There are concerns as to how the road should be managed in order to assist in the general growth locally, regionally and nationally. In this study, the present traffic conditions are analysed and a variety of future growth scenarios are tested for their economic impacts. The focus is on the road itself and the indicator that is used is the value of lost time in terms of delays for the total number of road users during peak hours.

Below is presented the analysis of the available data for the Base Year and the calculated growth factors according to the standard forecasting method. The selected base year is 2013, due to data availability. Most frequently, Strategic Planning in the UK uses a time horizon of approximately 20 years. In order to have a realistic and comparable basis of data, 2031 has been selected as "forecast" year. The available data for the road consist of data issued by the DfT, JTDB and HATRIS.

### 5.2.3 Data availability and set-up

**Traffic Data – Base Year (2013)**

The HA's JTDB provides with data of traffic volumes, journey times and delays on segments of the road network. The A12 section that under study is broken down to 10 sections as shown in Figure 5-5 below. For those segments the JTDB data has been analysed in order to provide with base year conditions. The data availability for the specific road led to selecting June 2013 as a representative base year month for this analysis.

Each segment may include a number of junctions; therefore the actual number of vehicles travelling on each link of the road may not be calculated accurately when using this dataset. The alternative would be to use HATRIS volume data that is more detailed and include information for each link from junction to junction. Thought HATRIS data does not include information about travel time and delays, which is essential for the purpose of this study. HATRIS data would be useful if a model was built but due to lack of additional information on traffic distribution, an estimated OD matrix would need to be calculated and a static model would be used. The model would not be any more accurate that its inputs available. In this study the delays and the traffic volumes are under examination. Therefore a model would not add up to the existing methodology. Nevertheless, HATRIS data has been analysed in order to reinforce the case of present conditions and to ensure that the problematic areas have been accurately identified.

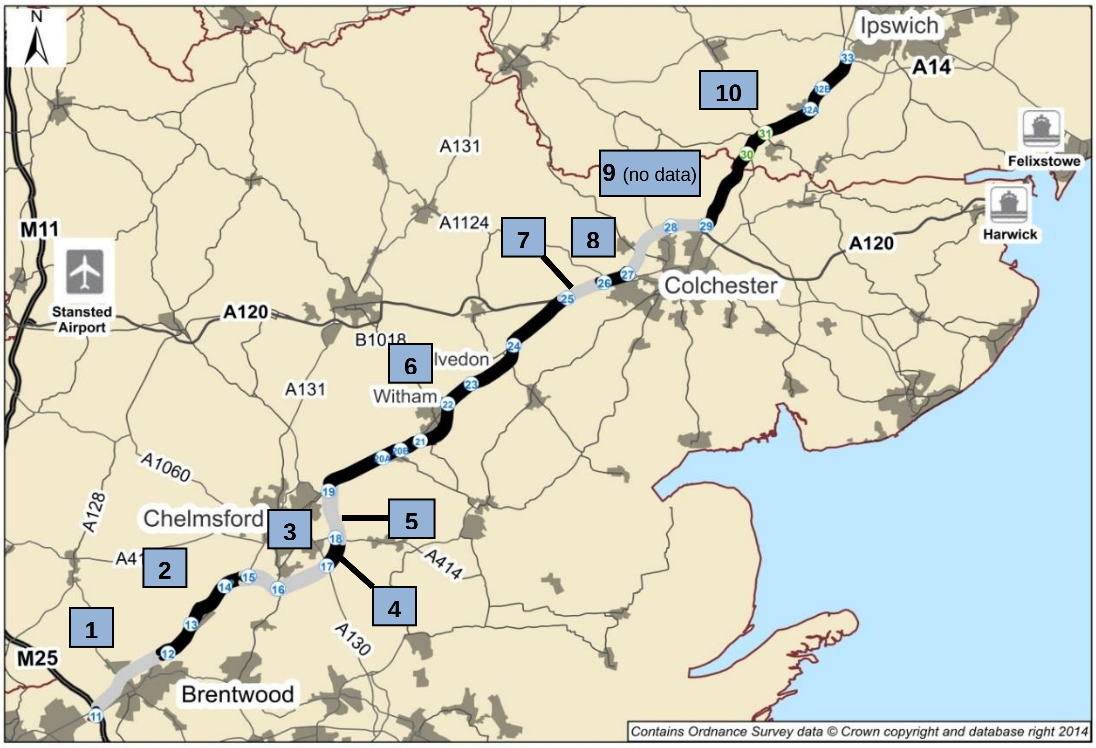



**Figure 5-5** **A12 broken down in 10 segments, as per JTDB**
*Data source: HATRIS*

The JTDB available data that has been analysed for the A12 refers to both AM and PM peak hour data and is presented in Table 5-1. It consist of:

- Link Length (km)
- Average Travel Times (sec)
- Total Flows (vehicles)

The speed limit for the area is known. The theoretical capacity of the road is calculated using the Design Manual for Roads and Bridges (DMRB) and considers the geometric characteristics of the road. For the studied area it varies between 3200 and 5200 veh/hour for a 2-lane or a 3-lane link accordingly. Therefore the Free Flow Travel Time (To) and the Total Hourly Delays (vehicle sec) have been calculated as per Equation 2 and Equation 3 below.

$$T_o = \frac{Link\ Length}{Speed}$$

**Equation 2** **Free Flow Travel Time (sec)**

$$D = (Travel\ Time - To) * Total\ Flow$$

**Equation 3** **Total Hourly Delay (vehicle sec)**

| | | | | | HATRIS – JTDB | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | AM peak hour | | PM peak hour | |
| Link Name in the analysis | Link Length (km) | Speed limit (kph) | To (sec) | Capacity | Travel Time (secs) | Total Flow (vehicles) | Travel Time (secs) | Total Flow (vehicles) |
| 1 – NB | 7.22 | 112 | 232 | 3600 | 261 | 2330 | 323 | 3370 |
| 1 – SB | 7.28 | 112 | 234 | 3600 | 285 | 2889 | 345 | 2145 |
| 2– NB | 8.3 | 112 | 267 | 3600 | 242 | 2490 | 353 | 3469 |
| 2– SB | 8.22 | 112 | 264 | 3600 | 86 | 3063 | 523 | 2379 |
| 3– NB | 7.16 | 112 | 230 | 3600 | 191 | 1996 | 1140 | 3205 |
| 3– SB | 7.2 | 112 | 231 | 3600 | 820 | 2879 | 5683 | 2018 |
| 4– NB | 2.18 | 112 | 70 | 3600 | 108 | 2913 | 117 | 3705 |
| 4– SB | 2.18 | 112 | 70 | 3600 | 79 | 2879 | 80 | 2018 |
| 5– NB | 4.76 | 112 | 153 | 3600 | 777 | 3020 | 751 | 3698 |
| 5– SB | 4.74 | 112 | 152 | 3600 | 321 | 3420 | 283 | 3282 |
| 6– NB | 23.66 | 112 | 761 | 3600 | 295 | 3065 | 276 | 4137 |
| 6– SB | 23.7 | 112 | 762 | 3600 | 262 | 3379 | 242 | 2690 |
| 7– NB | 3.14 | 112 | 101 | 5200 | 86 | 3286 | 83 | 3886 |
| 7– SB | 3.18 | 112 | 102 | 5200 | 190 | 3677 | 164 | 3265 |
| 8– NB | 2.06 | 112 | 66 | 5200 | 880 | 4157 | 797 | 4642 |
| 8– SB | 2.02 | 112 | 65 | 5200 | 114 | 3982 | 111 | 3911 |
| 10– NB | 18.4 | 112 | 591 | 3600 | 79 | 2253 | 84 | 2343 |
| 10– SB | 18.22 | 112 | 586 | 3600 | 669 | 2322 | 619 | 2289 |

**Table 5-1 Available and analysed data for the base Year (2013)**

**<u>Traffic Data – Forecast year (2031)</u>**

The national forecasting methodology that is used in order to assess schemes uses the NTEM via the software TEMPRO that is being maintained and updated under the DfT' s supervision. The relation between the growth factors and car ownership has been explained earlier: Growth factors are calculated as a combination of demographic, housing and employment forecast data. Though it is not clear how exactly car ownership enters the equation of forecasting and planners may only access the results of the forecasting.

The national forecasting methodology that is used in order to assess schemes uses the NTEM via the software TEMPRO that is being maintained and updated under the DfT' s supervision. For the A12 and a time horizon of 2031, TEMPRO gives a traffic growth factor of **28.4%** for the **AM** period and **29.4%** for the **PM** period. This traffic growth is associated with:

- New land use developments
- Changes in fuel price and income affecting travel choices
- Demographic factors including population age profiles which affect timing and purpose of travel

Using the traffic growth factors as described above and the calculations described in Equation 2 and Equation 3 the data that has been calculated for 2031 is presented in Table 5-2 below.

| | | | | | HATRIS – JTDB | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | AM peak hour | | PM peak hour | |
| Link Name in the analysis | Link Length (km) | Speed limit (kph) | To (sec) | Capacity | Travel Time (secs) | Total Flow (vehicles) | Travel Time (secs) | Total Flow (vehicles) |
| 1 – NB | 7.22 | 112 | 232 | 3600 | 310 | 2992 | 1740 | 4361 |
| 1 – SB | 7.28 | 112 | 234 | 3600 | 317 | 3197 | 1982 | 4489 |
| 2– NB | 8.3 | 112 | 267 | 3600 | 263 | 2563 | 1723 | 4147 |
| 2– SB | 8.22 | 112 | 264 | 3600 | 523 | 3740 | 523 | 4794 |
| 3– NB | 7.16 | 112 | 230 | 3600 | 1140 | 3877 | 1140 | 4786 |
| 3– SB | 7.2 | 112 | 231 | 3600 | 5683 | 3935 | 5683 | 5354 |
| 4– NB | 2.18 | 112 | 70 | 3600 | 121 | 4220 | 147 | 5028 |
| 4– SB | 2.18 | 112 | 70 | 3600 | 490 | 5338 | 490 | 6007 |
| 5– NB | 4.76 | 112 | 153 | 3600 | 1097 | 2892 | 1038 | 3032 |
| 5– SB | 4.74 | 112 | 152 | 3600 | 1740 | 3709 | 370 | 2775 |
| 6– NB | 23.66 | 112 | 761 | 3600 | 1982 | 3933 | 296 | 3079 |
| 6– SB | 23.7 | 112 | 762 | 3600 | 1723 | 3697 | 260 | 2611 |
| 7– NB | 3.14 | 112 | 101 | 5200 | 523 | 3697 | 107 | 2611 |
| 7– SB | 3.18 | 112 | 102 | 5200 | 1140 | 4391 | 1140 | 4247 |
| 8– NB | 2.06 | 112 | 66 | 5200 | 5683 | 4339 | 862 | 3481 |
| 8– SB | 2.02 | 112 | 65 | 5200 | 135 | 4722 | 127 | 4225 |
| 10– NB | 18.4 | 112 | 591 | 3600 | 103 | 5113 | 117 | 5061 |
| 10– SB | 18.22 | 112 | 586 | 3600 | 813 | 2982 | 680 | 2962 |

**Table 5-2 Available and analysed data for the Basic Forecast Scenario (2031)**

## General trends

The DfT provides with data for the Average Annual Daily Traffic (AADF) and a temporal analysis for the A12 for both directions from 2000 until 2013 is presented in Figure 5-6 below. Traffic has been growing since 2000 and is currently 16% more. There has been a drop after 2009 due to recession but since 2011 traffic has started to grow again. It is evident that the increase between 2011 and 2012 was bigger that between 2012 and 2013 and it is arguable how it will behave in the future. Currently, traffic levels on the A12 are almost similar to pre-recession period.

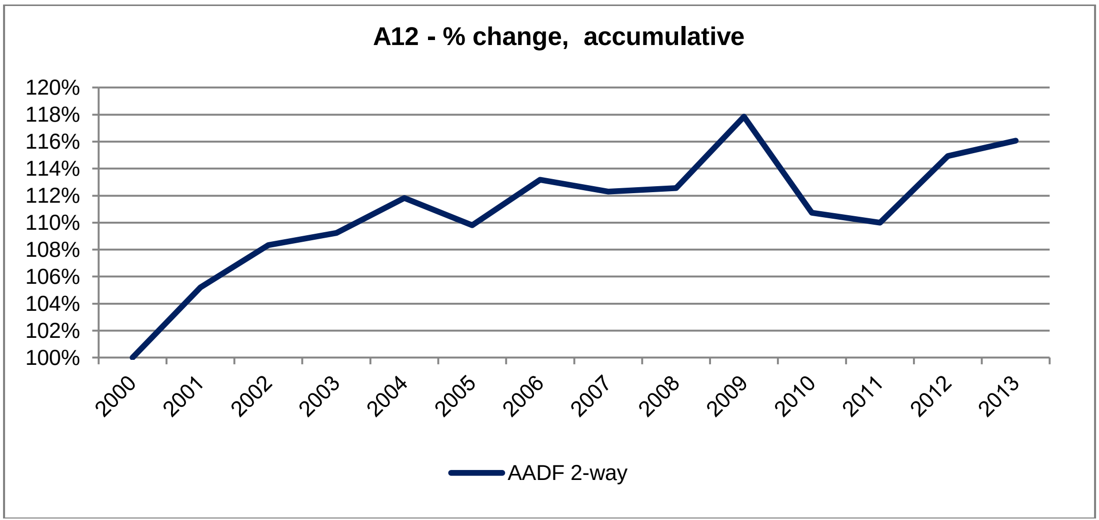



**Figure 5-6** **AADF analysis on the A12 (both directions)**
*Data source: DfT*

The above analysis has been broken down to vehicle types and is presented in Figure 5-7. During the recession period there was a significant drop in LGVs that has been reversed after 2010. The increased use of LGVs may be related to the increase of e-commerce and use of small vehicles to carry goods from the shop to the consumer's door.

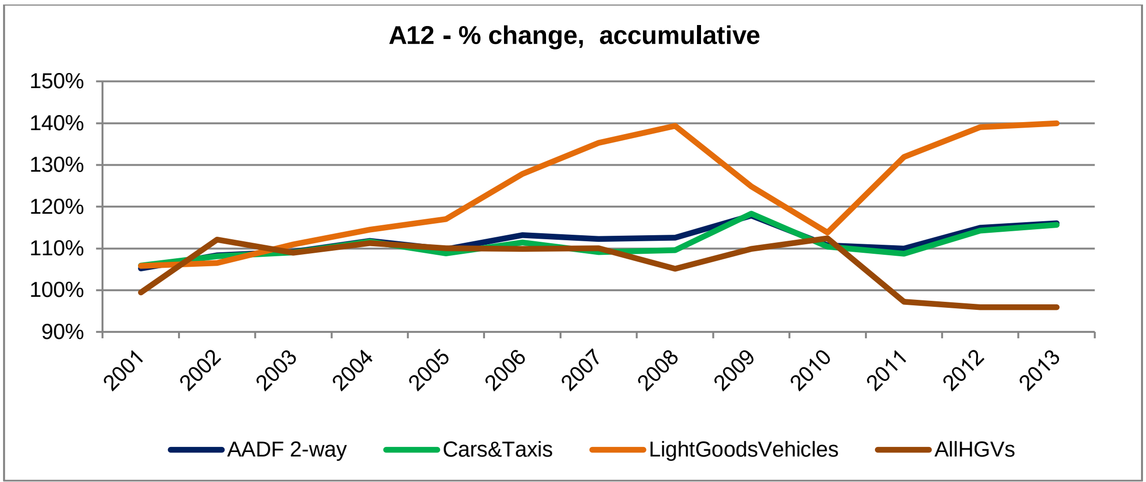



**Figure 5-7** **AADF analysis on the A12 (both directions) by vehicle type**
*Data source: DfT*

The underlying data for the above graphs is presented in matrices in **Error! Reference source not found.**.

## 5.3 Group Step 2 – Calculation of externalities

This section describes the application of the second step of this methodology. In this step a tool is used where all the input data is analysed and produces outcomes for the externalities that are later on analysed. Due to the lack of available data for every link of the network, setting up a traffic model would not be an accurate method of calculating outputs. Therefore, it should be noted that this application cannot account for delays caused at junctions. But, the general methodology has been adjusted in the best possible way so that the cost of over estimating future demand if peak car is established and car usage does not increase as predicted by governmental forecasting can be calculated.

### 5.3.1 Tool that calculates the externalities

**Selection of Volume Delay Function as a tool**

In this application, the measure of the economic effects of the route conditions is the delays experienced by the road users and how these are translated into monetary values. As described in the methodology chapter, the generic process is to multiply the traffic volumes (split per trip purpose, vehicle type etc.) with the delays and use this value to multiply with a VoT. Therefore, three components are substantial:

- traffic volumes (split in vehicle type and trip purpose per peak hour)
- delays experienced by that traffic (present, basic forecast, sensitivity testing forecast)
- VoT (per vehicle type and trip purpose)

Once the forecast traffic and future VoT have been calculated it remains to calculate the delays caused by that level of traffic. The volume Delay Functions (VDF) are widely used to calculate the delays related to a certain amount of traffic. They do not account for delays caused on the junctions but this has been identified as a weakness of this application.

The VDF that has been selected is that of the Bureau of Public Roads (BPR) that is widely used and accepted as a reliable function when calculating delays. The general concept is that the function is calibrated to the sample and then it may be used to produce results. The values that need to be defined in Equation 4 are the parameters a and b. As a starting point for the calibration the values of a=0.15 and b=4 are usually used. The data required for the calibration is a large sample of sets of journey time and traffic volumes on the link examined.

$$T = T_0 * \left[1 + \alpha \left(\frac{V}{C}\right)^{\beta}\right]$$

$T : Journey\ time$

$T_0 : Free\ flow\ time$

$\alpha, \beta : parameters$

**Equation 4 BPR's VDF**

The delays do not change in a linear way as traffic flow changes; they increase with a faster pace as the link approaches capacity. A sample of VDF is presented in Figure 5-8.

Therefore, it is not accurate to use the same function/parameters when the link is under and over capacity. There simple option is to recalibrate the function to values when the link is over capacity. Thus there will be two sets of parameters a and b that should be used to produce travel times on the link when the traffic flow is under or over the capacity limit.

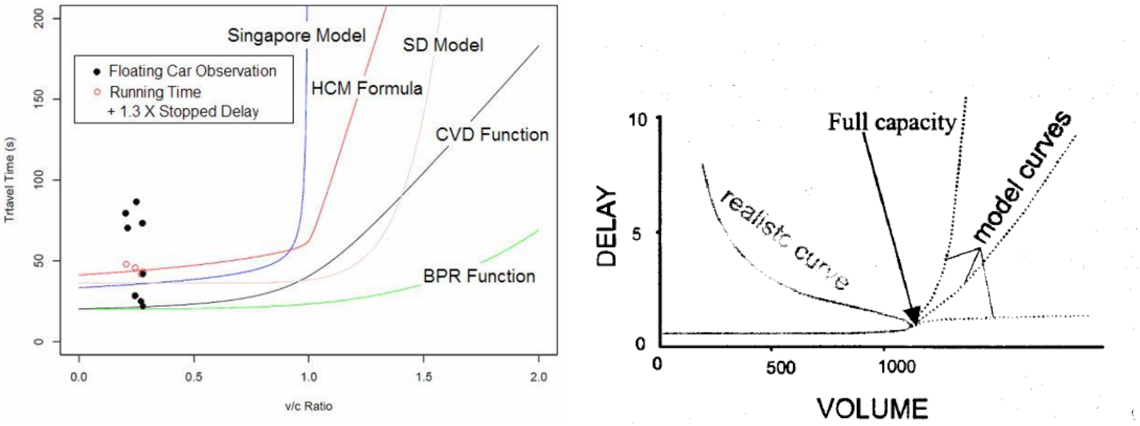



**Figure 5-8** **Example of VDF Graphs**
*Sources: (a) Davis A.G and Xiong H. (2007)*
*(b) Jastrzebski P. W. (2000)*

Jastrzebski P. W. (2000) studied an alternative VDF and run a set of tests to compare it with other widely used VDFs. This study resulted from the need to prepare a traffic model for Warsaw and they needed a reliable VDF to use during the assignment and the calibration/validation process. The main problem they face with existing VDFs is that they would assign traffic even after the break point (link capacity), also known as over-assignment. They concluded that:

- *The new function allows assigning bigger trip matrices without over-assignment*
- *The new function needs more iteration to reach an equilibrium state in the network*

Therefore, the method used is determined by the size of the network and the availability of data. The BPR can be easily used and provide with reliable results, provided that its calibration is done both for under and over capacity conditions.

## <u>Data Constraints and VDF calibration</u>

This application calculates the delays related to the traffic volumes and tests different scenarios according to different growth factors, therefore test the "peak car" effects on the forecasts. The VDF are widely used in order to create such results. As it has been mentioned in the methodology, the BPR's VDF is a reliable function to calculate delays, as long as it has been calibrated to the data for both under and over capacity traffic conditions.

The data available for this application is not enough to produce a sound calibration. The correlation between saturation (V/C) and delays has been tested and the $R^2$ was used as a measure. The $R^2$ varies between 0.033 and 0.287 for the four sets of data available, namely Northbound AM and PM and Southbound AM and PM data. The available data consists of a combination of traffic data for 9 sections of the A12 and it is not a big or consistent enough sample to create a reliable calibration. Therefore it was considered more appropriate to define sets of values for a and b for all 9 sections and for each direction and peak hour separately. Namely, 36 sets of parameters have been calculated for a and b.

A calibration process has been followed for each one of the 36 sets of data where the value of a was altered by a step of 0.025 initially that was changed if necessary. The value of b was kept constant. An example of the calibration process is presented in Table 5-3 below, as it was done for Section 1 of the road NB direction and PM peak hour:

| Iteration | a | b | To | T (VDF) | T actual | % difference |
|---|---|---|---|---|---|---|
| 1 | 0.15 | 4 | 232 | 259 | 324 | -25% |
| 2 | 0.17 | 4 | 232 | 262 | 324 | -23% |
| 3 | 0.19 | 4 | 232 | 266 | 324 | -22% |
| 4 | 0.21 | 4 | 232 | 269 | 324 | -20% |
| 5 | 0.23 | 4 | 232 | 273 | 324 | -19% |
| 6 | 0.25 | 4 | 232 | 277 | 324 | -17% |
| 7 | 0.27 | 4 | 232 | 280 | 324 | -16% |
| 8 | 0.29 | 4 | 232 | 284 | 324 | -14% |
| 9 | 0.31 | 4 | 232 | 287 | 324 | -13% |
| 10 | 0.33 | 4 | 232 | 291 | 324 | -11% |
| 11 | 0.35 | 4 | 232 | 294 | 324 | -10% |
| 12 | 0.37 | 4 | 232 | 298 | 324 | -9% |
| 13 | 0.39 | 4 | 232 | 302 | 324 | -7% |
| 14 | 0.41 | 4 | 232 | 305 | 324 | -6% |
| 15 | 0.43 | 4 | 232 | 309 | 324 | -5% |
| 16 | 0.45 | 4 | 232 | 312 | 324 | -4% |
| 17 | 0.47 | 4 | 232 | 316 | 324 | -3% |
| 18 | 0.49 | 4 | 232 | 319 | 324 | -1% |
| **19** | **0.51** | **4** | **232** | **323** | **324** | **0%** |
| 20 | 0.53 | 4 | 232 | 327 | 324 | 1% |
| 21 | 0.55 | 4 | 232 | 330 | 324 | 2% |
| 22 | 0.57 | 4 | 232 | 334 | 324 | 3% |
| 23 | 0.59 | 4 | 232 | 337 | 324 | 4% |
| 24 | 0.61 | 4 | 232 | 341 | 324 | 5% |
| 25 | 0.63 | 4 | 232 | 344 | 324 | 6% |
| 26 | 0.65 | 4 | 232 | 348 | 324 | 7% |
| 27 | 0.67 | 4 | 232 | 351 | 324 | 8% |
| 28 | 0.69 | 4 | 232 | 355 | 324 | 9% |
| 29 | 0.71 | 4 | 232 | 359 | 324 | 10% |
| 30 | 0.73 | 4 | 232 | 362 | 324 | 11% |
| 31 | 0.75 | 4 | 232 | 366 | 324 | 11% |
| 32 | 0.77 | 4 | 232 | 369 | 324 | 12% |
| 33 | 0.79 | 4 | 232 | 373 | 324 | 13% |
| 34 | 0.81 | 4 | 232 | 376 | 324 | 14% |
| 35 | 0.83 | 4 | 232 | 380 | 324 | 15% |
| 36 | 0.85 | 4 | 232 | 384 | 324 | 16% |
| 37 | 0.87 | 4 | 232 | 387 | 324 | 16% |
| 38 | 0.89 | 4 | 232 | 391 | 324 | 17% |
| 39 | 0.91 | 4 | 232 | 394 | 324 | 18% |
| 40 | 0.93 | 4 | 232 | 398 | 324 | 19% |

**Table 5-3 Calibration process for Section 1 NB PM**

A similar process has been followed for all 36 sets of data and the values for the parameters a and b for all of them is presented in Table 5-4 below. Using these parameters and the VDF described in Equation 4 it was possible to calculate the travel time for each section of the road given a different traffic volume input. In some cases the link would be over capacity (V/C > 1) which means that travel time does not increase according to the CDF. In those cases a maximum travel time for the link was calculated, assuming that all vehicles would be travelling at a minimum speed of 15kmph which corresponds to approximately 10% of the speed limit on the road. Therefore, the maximum travel time on every link was calculated and is presented in Table 5-4 below.

| | **a** | | **b** | **Max Travel time (sec) Speed = 15 km/h** |
|---|---|---|---|---|
| **Road Section** | **AM** | **PM** | | |
| 1 – NB | 0.7 | 0.51 | 4 | 1733 |
| 2 - NB | 0.3 | 0.34 | 4 | 1747 |
| 3- NB | 0.55 | 0.85 | 4 | 1992 |
| 4- NB | 0.525 | 0.61 | 4 | 1973 |
| 5- NB | 0.5 | 0.34 | 4 | 1718 |
| 6- NB | 0.15 | 0.225 | 4 | 1728 |
| 7- NB | 0.45 | 0.525 | 4 | 523 |
| 8- NB | 0.475 | 0.33 | 4 | 523 |
| 10- NB | 2.05 | 1.5 | 4 | 1142 |
| 1 - SB | 0.9 | 1.65 | 4 | 1138 |
| 2- SB | 0.225 | 0.225 | 4 | 5678 |
| 3- SB | 0.325 | 0.45 | 4 | 5688 |
| 4- SB | 0.55 | 1.9 | 4 | 754 |
| 5- SB | 0.3 | 0.11 | 4 | 763 |
| 6- SB | 0.2 | 0.15 | 4 | 494 |
| 7- SB | 0.475 | 0.55 | 4 | 485 |
| 8- SB | 0.625 | 0.9 | 4 | 4416 |
| 10- SB | 0.825 | 0.35 | 4 | 4373 |

**Table 5-4 Parameters a and b for all sets of data and Max Travel time on the links**

This application examines the economic effects of peak car phenomenon on the appraisal of schemes. Specifically it tests different growth factors and examines the economic effect they have in relation to the change they imply for traffic volumes and delays. It is considered that a testing of a range of growth factor between -20% and 0% and a step of 1% would be sufficient to examine the above mentioned economic changes. Therefore, the sensitivity testing growth factors were applied to produce the traffic volumes on the link and using the VDF and the parameters mentioned above, it was possible to calculate the travel time on the links for each scenario. Whenever the V/C was greater than 1, the maximum travel times were applied, as described in Table 5-4. The delays were calculated according to Equation 3. In Table 5-5 to Table 5-10 below are summarised the travel times and delays for all Base, Basic Forecast and Sensitivity Testing Forecast Scenarios.

| | | Base Year | | | | Basic Forecast Scenario | | | | Sensitivity Testing Scenario -1% Growth | | | | Sensitivity Testing Scenario -2% Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | | PM | | AM | | PM | | AM | | PM | | AM | | PM | |
| **Road Section** | To (sec) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) |
| 1 – NB | 232 | 261 | 0.008 | 323 | 0.025 | 310 | 0.022 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 |
| 2 - NB | 234 | 285 | 0.005 | 345 | 0.022 | 317 | 0.014 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 |
| 3- NB | 267 | 242 | 0.003 | 353 | 0.034 | 263 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 |
| 4- NB | 264 | 86 | 0.004 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 |
| 5- NB | 230 | 191 | 0.011 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- NB | 231 | 820 | 0.017 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 |
| 7- NB | 70 | 108 | 0.002 | 117 | 0.005 | 121 | 0.005 | 147 | 0.013 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 |
| 8- NB | 70 | 79 | 0.004 | 80 | 0.004 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 |
| 10- NB | 153 | 777 | 0.052 | 751 | 0.044 | 1097 | 0.140 | 1038 | 0.124 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 |
| 1 - SB | 152 | 321 | 0.024 | 283 | 0.014 | 1740 | 0.418 | 370 | 0.038 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 |
| 2- SB | 761 | 295 | 0.009 | 276 | 0.003 | 1982 | 0.477 | 296 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 |
| 3- SB | 762 | 262 | 0.009 | 242 | 0.003 | 1723 | 0.414 | 260 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 |
| 4- SB | 101 | 86 | 0.004 | 83 | 0.004 | 523 | 0.126 | 107 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 |
| 5- SB | 102 | 190 | 0.010 | 164 | 0.003 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- SB | 66 | 880 | 0.033 | 797 | 0.010 | 5683 | 1.367 | 862 | 0.028 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 |
| 7- SB | 65 | 114 | 0.003 | 111 | 0.002 | 135 | 0.009 | 127 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 |
| 8- SB | 591 | 79 | 0.004 | 84 | 0.005 | 103 | 0.011 | 117 | 0.015 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 |
| 10- SB | 586 | 669 | 0.023 | 619 | 0.009 | 813 | 0.063 | 680 | 0.026 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 |

**Table 5-5 (1 out of 6) Travel Times and Delays as calculated for Base Year, Basic Forecasting Scenario and Sensitivity Testing Forecasting Scenarios**

| | | Sensitivity Testing Scenario -3% Growth | | | | Sensitivity Testing Scenario -4% Growth | | | | Sensitivity Testing Scenario -5% Growth | | | | Sensitivity Testing Scenario -6% Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | | PM | | AM | | PM | | AM | | PM | | AM | | PM | |
| **Road Section** | To (sec) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) |
| 1 – NB | 232 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 |
| 2 - NB | 234 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 |
| 3- NB | 267 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 |
| 4- NB | 264 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 |
| 5- NB | 230 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- NB | 231 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 |
| 7- NB | 70 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 |
| 8- NB | 70 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 |
| 10- NB | 153 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 |
| 1 - SB | 152 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 |
| 2- SB | 761 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 |
| 3- SB | 762 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 |
| 4- SB | 101 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 |
| 5- SB | 102 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- SB | 66 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 |
| 7- SB | 65 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 |
| 8- SB | 591 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 |
| 10- SB | 586 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 |

**Table 5-6 (2 out of 6) Travel Times and Delays as calculated for Base Year, Basic Forecasting Scenario and Sensitivity Testing Forecasting Scenarios**

| | | Sensitivity Testing Scenario -7% Growth | | | | Sensitivity Testing Scenario -8% Growth | | | | Sensitivity Testing Scenario -9% Growth | | | | Sensitivity Testing Scenario -10% Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | | PM | | AM | | PM | | AM | | PM | | AM | | PM | |
| **Road Section** | To (sec) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) |
| 1 – NB | 232 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 |
| 2 - NB | 234 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 |
| 3- NB | 267 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 |
| 4- NB | 264 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 |
| 5- NB | 230 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- NB | 231 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 |
| 7- NB | 70 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 |
| 8- NB | 70 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 |
| 10- NB | 153 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 |
| 1 - SB | 152 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 |
| 2- SB | 761 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 |
| 3- SB | 762 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 |
| 4- SB | 101 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 |
| 5- SB | 102 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- SB | 66 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 |
| 7- SB | 65 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 |
| 8- SB | 591 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 |
| 10- SB | 586 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 |

**Table 5-7 (3 out of 6) Travel Times and Delays as calculated for Base Year, Basic Forecasting Scenario and Sensitivity Testing Forecasting Scenarios**

| | | Sensitivity Testing Scenario -11% Growth | | | | Sensitivity Testing Scenario -12% Growth | | | | Sensitivity Testing Scenario -13% Growth | | | | Sensitivity Testing Scenario -14% Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | | PM | | AM | | PM | | AM | | PM | | AM | | PM | |
| **Road Section** | To (sec) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) |
| 1 – NB | 232 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 |
| 2 - NB | 234 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 |
| 3- NB | 267 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 |
| 4- NB | 264 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 |
| 5- NB | 230 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- NB | 231 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 |
| 7- NB | 70 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 |
| 8- NB | 70 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 |
| 10- NB | 153 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 |
| 1 - SB | 152 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 |
| 2- SB | 761 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 |
| 3- SB | 762 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 |
| 4- SB | 101 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 |
| 5- SB | 102 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- SB | 66 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 |
| 7- SB | 65 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 |
| 8- SB | 591 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 |
| 10- SB | 586 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 |

**Table 5-8 (4 out of 6) Travel Times and Delays as calculated for Base Year, Basic Forecasting Scenario and Sensitivity Testing Forecasting Scenarios**

| | | Sensitivity Testing Scenario -15% Growth | | | | Sensitivity Testing Scenario -16% Growth | | | | Sensitivity Testing Scenario -17% Growth | | | | Sensitivity Testing Scenario -18% Growth | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AM | | PM | | AM | | PM | | AM | | PM | | AM | | PM | |
| **Road Section** | To (sec) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) |
| 1 – NB | 232 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 |
| 2 - NB | 234 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 |
| 3- NB | 267 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 |
| 4- NB | 264 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 |
| 5- NB | 230 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- NB | 231 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 |
| 7- NB | 70 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 |
| 8- NB | 70 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 |
| 10- NB | 153 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 |
| 1 - SB | 152 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 |
| 2- SB | 761 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 |
| 3- SB | 762 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 |
| 4- SB | 101 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 |
| 5- SB | 102 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- SB | 66 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 |
| 7- SB | 65 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 |
| 8- SB | 591 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 |
| 10- SB | 586 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 |

**Table 5-9 (5 out of 6) Travel Times and Delays as calculated for Base Year, Basic Forecasting Scenario and Sensitivity Testing Forecasting Scenarios**

| | | Sensitivity Testing Scenario -19% Growth | | | | Sensitivity Testing Scenario -20% Growth | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | AM | | PM | | AM | | PM | |
| **Road Section** | To (sec) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) | Travel Time | Delay per vehicle (h) |
| 1 – NB | 232 | 307 | 0.021 | 1740 | 0.419 | 307 | 0.021 | 1740 | 0.419 |
| 2 - NB | 234 | 315 | 0.013 | 1982 | 0.477 | 315 | 0.013 | 1982 | 0.477 |
| 3- NB | 267 | 262 | 0.009 | 1723 | 0.415 | 262 | 0.009 | 1723 | 0.415 |
| 4- NB | 264 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 | 523 | 0.126 |
| 5- NB | 230 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- NB | 231 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 | 5683 | 1.367 |
| 7- NB | 70 | 120 | 0.005 | 146 | 0.012 | 120 | 0.005 | 146 | 0.012 |
| 8- NB | 70 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 | 490 | 0.118 |
| 10- NB | 153 | 1081 | 0.136 | 1024 | 0.120 | 1081 | 0.136 | 1024 | 0.120 |
| 1 - SB | 152 | 1740 | 0.418 | 366 | 0.037 | 1740 | 0.418 | 366 | 0.037 |
| 2- SB | 761 | 1982 | 0.477 | 295 | 0.009 | 1982 | 0.477 | 295 | 0.009 |
| 3- SB | 762 | 1723 | 0.414 | 259 | 0.008 | 1723 | 0.414 | 259 | 0.008 |
| 4- SB | 101 | 523 | 0.126 | 106 | 0.010 | 523 | 0.126 | 106 | 0.010 |
| 5- SB | 102 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 | 1140 | 0.274 |
| 6- SB | 66 | 5683 | 1.367 | 859 | 0.027 | 5683 | 1.367 | 859 | 0.027 |
| 7- SB | 65 | 134 | 0.009 | 126 | 0.007 | 134 | 0.009 | 126 | 0.007 |
| 8- SB | 591 | 102 | 0.010 | 116 | 0.014 | 102 | 0.010 | 116 | 0.014 |
| 10- SB | 586 | 806 | 0.061 | 677 | 0.025 | 806 | 0.061 | 677 | 0.025 |

**Table 5-10 (6 out of 6) Travel Times and Delays as calculated for Base Year, Basic Forecasting Scenario and Sensitivity Testing Forecasting Scenarios**

# 5.4 Group Step 3 – Economic Analysis

The DfT's WEB TAG and the TAG data book include all the information required for a cost benefit analysis. This methodology has been found sufficient for this application and also aligns with officially used methodology for scheme appraisal. The TAG Data book's table of content related to Cost Benefit Analysis is presented in Table 5-11. The TAG Data book used in this study is the latest version (May 2014), therefore all references and data are related to that. Though it is strongly advised to consult the latest version of the TAG Data Book (available online) as the table names and content may change.

| TAG Unit | Section Title | Unit Title | Worksheet | Table Title |
|---|---|---|---|---|
| | | | **Cover** | Department for Transport contact information |
| | | | **User Parameters** | User - defined price year and initial forecast year |
| | | | **Audit** | Version log |
| | | | **TAG1** | WebTAG1 table look-up |
| | | | **Annual Parameters** | Forecast annual economic and demographic parameters |
| A 1.1 | Cost Benefit Analysis | | **A 1.1.1** | Discount rates |
| A 1.3 | User & Provider Impacts | Values of time | **A 1.3.1** | Values of time per person (working and non-working) |
| | | | **A 1.3.2** | Forecast values of time per person (working and non-working) |
| | | | **A 1.3.3** | Car and vehicle occupancies (2000); Annual percentage change in car passenger occupancy up to 2036 |
| | | | **A 1.3.4** | Proportion of travel and trips in work and non-work time |
| | | | **A 1.3.5** | Market price values of time per vehicle based on distance travelled |
| | | | **A 1.3.6** | Forecast market price values of time per vehicle based on distance travelled |
| | | Operating costs | **A 1.3.7** | Fuel and electricity prices and components |
| | | | **A 1.3.8** | Fuel / energy consumption parameter values |
| | | | **A 1.3.9** | Forecast proportion of car, LGV and other vehicle kilometres using petrol / diesel / electricity |
| | | | **A 1.3.10** | Forecast assumed vehicle fuel efficiency improvements to 2035 |
| | | | **A 1.3.11** | Forecast fuel / energy consumption parameters |
| | | | **A 1.3.12** | Forecast vehicle fuel / energy cost formulae parameters (work) |
| | | | **A 1.3.13** | Forecast vehicle fuel / energy cost formulae parameters (non-work) |
| | | | **A 1.3.14** | Non-fuel resource vehicle operating costs |
| | | | **A 1.3.15** | Forecast non-fuel resource car operating costs to 2035 |
| | | Social Impact of buses | **A 1.3.16** | Proportion of bus trips by car ownership, trip purpose and concessionary travel pass status. |
| | | | **A 1.3.17** | Proportion of bus trips by that would "not go" if bus not available. |
| | | | **A 1.3.18** | Value of the social impact per return bus trip |

**Table 5-11 Table of contents related to Cost Benefit Analysis**
*Source: TAG Data Book (May 2014)*

Once the data has been collected and analysed for the base year, as per Group Steps 1 and 2, the next step is to translate the delays in monetary values. The same procedure is followed once the forecast traffic flows and the related delays have been calculated. Therefore a comparable base may be established and the values may be used for decision making by stakeholders. The general process is described in Figure 5-9 below.

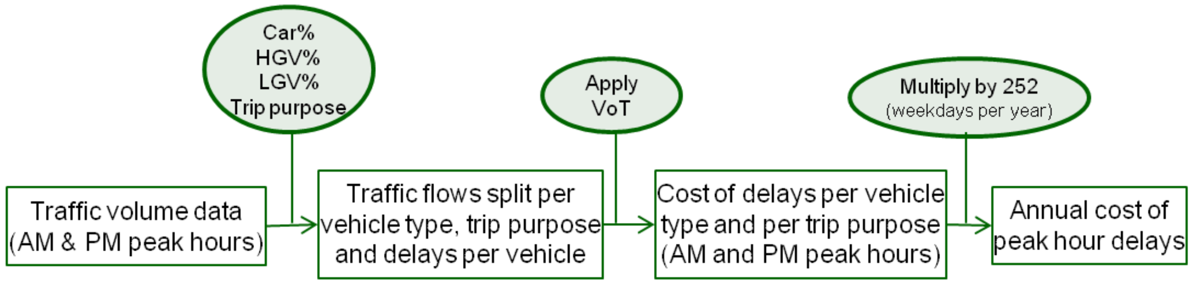



**Figure 5-9 Methodology steps for the economic analysis**

Traffic flows need to be split to different vehicle types, namely passenger cars (Car), Light Good Vehicles (LGV) and Heavy Good Vehicles (HGV). The percentages for this split depend on the data available. In this application they have been taken from the Highway Agency's "Route Base Strategy" for the A12.

| Car type percentages | | |
|---|---|---|
| Car | LGV | HGV |
| 0.74 | 0.16 | 0.1 |

**Table 5-12 Vehicle classification factors**
*Source: HA RBS for the A12*

After traffic has been split to vehicle types, it needs to be split according to trip purpose. Table A 1.3.4 of TAG data book (May 2014) that is presented in Figure 5-10 includes information for the proportion of travel in work and non-work time, split for different vehicle types according to national trends.

| Table A 1.3.4: | | Proportion of travel in work and non-work time | | | | | | | Proportion of trips made in work and non-work time | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mode / Vehicle Type & Journey Purpose | | Weekday | | | | | Weekend | All Week | Weekday | | | | | Weekend | All Week |
| | | 7am – 10am | 10am – 4pm | 4pm – 7pm | 7pm – 7am | Average | Average | Average | 7am – 10am | 10am – 4pm | 4pm – 7pm | 7pm – 7am | Average | Average | Average |
| | | Percentage of Distance Travelled by Vehicles | | | | | | | Percentage of Vehicle Trips | | | | | | |
| **Car** | Work | 18.1 | 19.9 | 13.0 | 12.3 | 16.4 | 3.2 | 13.1 | 6.8 | 8.3 | 5.5 | 3.6 | 6.5 | 1.7 | 5.0 |
| | Commuting | 46.0 | 11.4 | 40.8 | 36.2 | 31.0 | 8.5 | 25.3 | 40.6 | 11.6 | 32.3 | 26.4 | 25.4 | 9.1 | 20.3 |
| | Other | 35.9 | 68.7 | 46.2 | 51.5 | 52.5 | 88.3 | 61.6 | 52.7 | 80.1 | 62.2 | 70.0 | 68.1 | 89.3 | 74.7 |
| **LGV** | Work (freight) | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 | 88.0 |
| | Non – Work | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 |
| **OGV1** | Work | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| **OGV2** | Work | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | | Percentage of Distance Travelled by Occupants | | | | | | | Percentage of Person Trips | | | | | | |
| **Car** | Work | 15.4 | 13.8 | 10.2 | 9.9 | 12.6 | 2.0 | 9.2 | 5.2 | 2.2 | 4.1 | 1.2 | 4.7 | 1.1 | 3.4 |
| | Commuting | 38.3 | 8.1 | 32.2 | 29.1 | 23.9 | 5.1 | 18.0 | 33.3 | 15.6 | 25.8 | 10.9 | 20.0 | 6.4 | 15.2 |
| | Other | 46.4 | 78.1 | 57.6 | 61.0 | 63.5 | 92.9 | 72.7 | 61.5 | 82.2 | 70.1 | 87.9 | 75.3 | 92.5 | 81.4 |
| **PSV** | Work | 3.9 | 2.0 | 3.9 | 5.7 | 3.4 | 1.5 | 2.9 | 1.5 | 1.2 | 1.8 | 2.6 | 1.5 | 1.0 | 1.4 |
| | Commuting | 30.0 | 11.1 | 36.6 | 38.1 | 25.5 | 6.4 | 20.5 | 41.7 | 10.6 | 43.0 | 47.4 | 26.9 | 12.4 | 24.3 |
| | Other | 66.1 | 86.9 | 59.5 | 56.2 | 71.1 | 92.0 | 76.6 | 56.8 | 88.2 | 55.2 | 50.0 | 71.5 | 86.6 | 74.3 |
| **Heavy Rail** | Work | 14.1 | 22.4 | 16.4 | 23.2 | 18.3 | 6.3 | 16.5 | 6.7 | 13.6 | 6.7 | 8.8 | 8.3 | 2.8 | 7.6 |
| | Commuting | 51.9 | 10.2 | 55.9 | 53.1 | 43.7 | 4.3 | 37.8 | 71.7 | 14.9 | 68.0 | 60.4 | 58.2 | 11.1 | 52.2 |
| | Other | 34.1 | 67.4 | 27.7 | 23.7 | 38.1 | 89.5 | 45.7 | 21.6 | 71.5 | 25.4 | 30.8 | 33.5 | 86.1 | 40.3 |
| **Light Rail** | Work | 1.9 | 0.2 | 1.8 | 2.3 | 1.3 | 0.4 | 1.2 | 2.8 | 0.7 | 3.3 | 5.3 | 2.4 | 1.2 | 2.2 |
| | Commuting | 82.4 | 8.5 | 75.7 | 28.9 | 50.1 | 23.3 | 45.8 | 83.0 | 10.8 | 70.7 | 23.7 | 48.2 | 21.7 | 43.8 |
| | Other | 15.7 | 91.3 | 22.5 | 68.9 | 48.6 | 76.3 | 53.1 | 14.2 | 88.5 | 26.0 | 71.1 | 49.4 | 77.1 | 54.0 |

**Figure 5-10 Traffic split per trip purpose**
*Source: TAG Data Book (May 2014) – Table A1.3.4*

The information available is the percentage split according to the following four types:

- Percentage of Distance Travelled by Vehicles
- Percentage of Vehicle Trips
- Percentage of Distance Travelled by Occupants
- Percentage of Person Trips

The first category has been selected for this application, as there was no information for number of trips or number of occupants per vehicle.

| | Car | | | LGV | | HGV |
|---|---|---|---|---|---|---|
| | Work | Commuting | Other | Work | Non-work | |
| AM | 0.181 | 0.460 | 0.359 | 0.880 | 0.120 | 1 |
| PM | 0.130 | 0.408 | 0.462 | 0.880 | 0.120 | 1 |

**Table 5-13 Trip purpose split factors**
*Source: DFT – Web TAG data book – Table A1.3.4*

The delays that have been previously calculated for the total of traffic for AM and PM peak hours are now split by vehicle type and trip purpose. The next step is to apply a cost per time unit in order to calculate the cost of the delays per vehicle type and per trip purpose. The TAG data book includes tables with the value of time (VoT) and it is advised to use the type of VoT that is more suitable for the data available. Indicatively, Figure 5-11 presents the VoT per vehicle based on travelled distance as given by the TAG Data Book (May 2014).

**Table A 1.3.5: Market Price Values of Time per Vehicle based on distance travelled (£ per hour, 2010 prices and 2010 values)**

| Vehicle Type | Journey Purpose | Weekday 7am – 10am | Weekday 10am – 4pm | Weekday 4pm – 7pm | Weekday 7pm – 7am | Weekday Average | Weekend | All Week |
|---|---|---|---|---|---|---|---|---|
| Car | Work | 31.56 | 30.81 | 30.34 | 30.58 | 30.99 | 32.54 | 30.99 |
| | Commuting | 7.83 | 7.77 | 7.65 | 7.66 | 7.71 | 7.72 | 7.71 |
| | Other | 10.06 | 10.46 | 10.74 | 10.48 | 10.49 | 11.61 | 10.90 |
| | Average Car | 12.92 | 14.20 | 12.03 | 11.93 | 12.98 | 11.95 | 12.73 |
| LGV | Work (freight) | 14.62 | 14.62 | 14.62 | 14.62 | 14.62 | 15.35 | 14.62 |
| | Commuting & Other | 9.15 | 9.15 | 9.15 | 9.15 | 9.15 | 12.72 | 9.97 |
| | Average LGV | 13.96 | 13.96 | 13.96 | 13.96 | 13.96 | 15.03 | 14.06 |
| OGV1 | Working | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 |
| OGV2 | Working | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 | 14.35 |
| PSV (Occupants) | Work | 22.57 | 18.72 | 22.57 | 26.22 | 21.56 | 17.70 | 20.54 |
| | Commuting | 24.93 | 9.22 | 30.41 | 31.66 | 21.19 | 5.32 | 17.03 |
| | Other | 48.74 | 64.08 | 43.88 | 41.44 | 52.43 | 67.84 | 56.49 |
| | Total | 96.24 | 92.02 | 96.86 | 99.32 | 95.18 | 90.86 | 94.06 |

**Figure 5-11 Values of Time per journey purpose**
*Source: TAG Data Book (May 2014) – Table A1.3.5*

The cost of delay is calculated for each vehicle type and trip purpose, as outlined in the methodology. The total amount of cost for all the delays is calculated on a daily basis for the AM and PM peak hours. Multiplied by 252 (working days per year), it gives the total annual cost of delays.

The prices included in the TAG Data Book refer to 2010 values. Therefore, they should be factored to reflect GDP conditions during the year of study. The method to do this is described in the TAG Unit A11 – *Cost-Benefit Analysis*: "*there are indices in the TAG Data Book that can be used to calculate a real value, in the DfT' s price base, for a future year y"* using the Formula 5-1.

$$Real\ Valye_y = Real\ Value_{Base} * \frac{GDP\ index_y}{GDP\ index_{Base}}$$

**Formula 5-1 GDP correction factor for the VoT**
*Source: TAG Unit A11 – Cost-Benefit Analysis*

The full list of GDP indices may be found in the TAG Data Book (May 2014). Table 5-14 below presents the average GDP per person for the years 2010 to 2031 (our forecast year).

| Year | Average GDP per person | | |
|---|---|---|---|
| | Historic value | Annual growth (%pa) | Index 1996=100 |
| 2010 | 23,672 | 0.85 | 144.97 |
| 2011 | 23,737 | 0.28 | 145.38 |
| 2012 | 23,646 | -0.38 | 144.82 |
| 2013 | - | 1.07 | 146.36 |
| 2014 | - | 2.05 | 149.37 |
| 2015 | - | 1.67 | 151.86 |
| 2016 | - | 1.95 | 154.82 |
| 2017 | - | 1.99 | 157.90 |
| 2018 | - | 1.90 | 160.90 |
| 2019 | - | 2.23 | 164.49 |
| 2020 | - | 2.24 | 168.19 |
| 2021 | - | 1.86 | 171.31 |
| 2022 | - | 1.87 | 174.52 |
| 2023 | - | 1.89 | 177.81 |
| 2024 | - | 1.90 | 181.19 |
| 2025 | - | 2.02 | 184.85 |
| 2026 | - | 2.04 | 188.61 |
| 2027 | - | 2.05 | 192.49 |
| 2028 | - | 2.07 | 196.47 |
| 2029 | - | 2.09 | 200.57 |
| 2030 | - | 2.10 | 204.79 |
| 2031 | - | 2.02 | 208.93 |

**Table 5-14 Average GDP per person**
*Source: TAG Data Book (May 2014) – Annual Parameters*

The value of time is taken from the DfT's TAG data book (May 2014) and includes the hourly market prices per vehicle for year 2010, as presented in Table 5-14. These values have been adjusted according to GDP in order to represent monetary values for the year 2013, as shown in Formula 5-2 and Formula 5-3 below.

$$VoT_{2013} = VoT_{2010} * \frac{146.36}{144.97} = VoT_{2010} * 1.0095$$

**Formula 5-2 GDP adjustment factor for 2013**

$$VoT_{2031} = VoT_{2010} * \frac{208.93}{144.97} = VoT_{2010} * 1.4412$$

**Formula 5-3 GDP adjustment factor for 2031**

**Therefore, the Value of Time has been calculated for this application and the results are summarised in** Table 5-15 below. The values of time that will be applied to the split traffic per trip purpose and vehicle type, as it has been adjusted to reflect the 2013 base year values.

| £ per hour, 2010 prices and 2010 values | | | | GDP growth - Adjusted values for 2013 | | GDP growth - Adjusted values for 2031 | |
|---|---|---|---|---|---|---|---|
| Vehicle Type | Journey Purpose | Weekday | | Weekday | | Weekday | |
| | | 7-10 am | 4-7 pm | 7-10 am | 4-7 pm | 7-10 am | 4-7 pm |
| Car | Work | 31.56 | 30.34 | 31.86 | 30.63 | 45.48 | 43.73 |
| | Commuting | 7.83 | 7.65 | 7.90 | 7.72 | 11.28 | 11.03 |
| | Other | 10.06 | 10.74 | 10.15 | 10.85 | 14.49 | 15.48 |
| | Average Car | 12.92 | 12.03 | 13.05 | 12.14 | 18.63 | 17.34 |
| LGV | Work (freight) | 14.62 | 14.62 | 14.75 | 14.75 | 21.06 | 21.06 |
| | Commuting & Other | 9.15 | 9.15 | 9.24 | 9.24 | 13.19 | 13.19 |
| | Average LGV | 13.96 | 13.96 | 14.09 | 14.09 | 20.12 | 20.12 |
| HGV | Working | 14.35 | 14.35 | 14.49 | 14.49 | 20.68 | 20.68 |

**Table 5-15** **Value of time per vehicle based on distance travelled**
Data source: DFT – Web TAG data book (May 2014) - Table A1.3.5

Group Step 3 has been applied as described to all the examined scenarios:

- Base Year (2013)
- Basic forecast year (2031)
- 20 Scenarios for all the variations of the Sensitivity Testing Forecasting (2031)

The detailed results matrices are included in APPENDIX B Group Step 3 Detailed matrices. Table 5-16 below summarises the costs broken down per trip purpose and vehicle type for the AM and PM peak hours. The costs of the delays are presented in annual values in £.

| | Car | | | | | | LGV | | | | HGV | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| Base Year (2013) | 2701 | 22638 | 1703 | 17914 | 1707 | 28491 | 973 | 11812 | 83 | 1008 | 109 | 1318 |
| Basic Forecast Year (2031) | 127638 | 74414 | 80473 | 58888 | 80673 | 93653 | 45982 | 38826 | 3926 | 3315 | 5131 | 4332 |
| Sensitivity Testing Growth Factor -1% | 126486 | 73725 | 79747 | 58342 | 79945 | 92785 | 45568 | 38467 | 3890 | 3284 | 5084 | 4292 |
| Sensitivity Testing Growth Factor -2% | 125494 | 73151 | 79121 | 57888 | 79317 | 92062 | 45210 | 38167 | 3860 | 3258 | 5044 | 4259 |
| Sensitivity Testing Growth Factor -3% | 124501 | 72577 | 78495 | 57433 | 78690 | 91340 | 44852 | 37867 | 3829 | 3233 | 5004 | 4225 |
| Sensitivity Testing Growth Factor -4% | 123508 | 72002 | 77869 | 56979 | 78062 | 90617 | 44494 | 37568 | 3799 | 3207 | 4965 | 4192 |
| Sensitivity Testing Growth Factor -5% | 122515 | 71428 | 77243 | 56524 | 77435 | 89895 | 44137 | 37268 | 3768 | 3182 | 4925 | 4158 |
| Sensitivity Testing Growth Factor -6% | 121522 | 70854 | 76617 | 56070 | 76807 | 89172 | 43779 | 36969 | 3738 | 3156 | 4885 | 4125 |
| Sensitivity Testing Growth Factor -7% | 120529 | 70280 | 75991 | 55616 | 76180 | 88449 | 43421 | 36669 | 3707 | 3131 | 4845 | 4091 |
| Sensitivity Testing Growth Factor -8% | 119537 | 69706 | 75365 | 55161 | 75552 | 87727 | 43064 | 36369 | 3676 | 3105 | 4805 | 4058 |
| Sensitivity Testing Growth Factor -9% | 118544 | 69132 | 74739 | 54707 | 74925 | 87004 | 42706 | 36070 | 3646 | 3079 | 4765 | 4025 |
| Sensitivity Testing Growth Factor -10% | 117551 | 68557 | 74113 | 54253 | 74297 | 86281 | 42348 | 35770 | 3615 | 3054 | 4725 | 3991 |
| Sensitivity Testing Growth Factor -11% | 116558 | 67983 | 73487 | 53798 | 73670 | 85559 | 41991 | 35471 | 3585 | 3028 | 4685 | 3958 |
| Sensitivity Testing Growth Factor -12% | 115565 | 67409 | 72861 | 53344 | 73042 | 84836 | 41633 | 35171 | 3554 | 3003 | 4645 | 3924 |
| Sensitivity Testing Growth Factor -13% | 114572 | 66835 | 72235 | 52889 | 72415 | 84114 | 41275 | 34872 | 3524 | 2977 | 4605 | 3891 |
| Sensitivity Testing Growth Factor -14% | 113580 | 66261 | 71609 | 52435 | 71787 | 83391 | 40918 | 34572 | 3493 | 2952 | 4565 | 3857 |
| Sensitivity Testing Growth Factor -15% | 112587 | 65686 | 70983 | 51981 | 71160 | 82668 | 40560 | 34272 | 3463 | 2926 | 4526 | 3824 |
| Sensitivity Testing Growth Factor -16% | 111594 | 65112 | 70357 | 51526 | 70532 | 81946 | 40202 | 33973 | 3432 | 2900 | 4486 | 3791 |
| Sensitivity Testing Growth Factor -17% | 110601 | 64538 | 69731 | 51072 | 69905 | 81223 | 39845 | 33673 | 3402 | 2875 | 4446 | 3757 |
| Sensitivity Testing Growth Factor -18% | 109608 | 63964 | 69105 | 50618 | 69277 | 80500 | 39487 | 33374 | 3371 | 2849 | 4406 | 3724 |
| Sensitivity Testing Growth Factor -19% | 108615 | 63390 | 68479 | 50163 | 68650 | 79778 | 39129 | 33074 | 3341 | 2824 | 4366 | 3690 |
| Sensitivity Testing Growth Factor -20% | 107623 | 62816 | 67853 | 49709 | 68022 | 79055 | 38772 | 32774 | 3310 | 2798 | 4326 | 3657 |

**Table 5-16 Summary of annual costs of delays (£) for all tested scenarios - Split per trip purpose, peak hour and vehicle type.**

## 5.5 Group Step 4 – Compare the Generalised Cost of the Externalities

This is the final step of the methodology that calculated the generalised cost of the externalities and compares the different scenarios. In this application, there is only one externality examined, so the generalised cost is basically the annual cost of the delays for each scenario, as it has already been presented in Table 5-16.

Table 5-17 summarises the annual cost of the delays for all the examined scenarios: The annual cost of the delays on the examined road during the base year is estimated to be £22,795,222 and it is forecast to rise to £155,546,846 by 2031, creating an additional cost of £132,751,624 due to increased delays on the A12. The different scenarios that have been used for the sensitivity testing imply a gradient change in the forecasting factors and use a step of -1% change. In the case of forecasting overestimation that is the case for peak car, the growth factor in 2031 would be smaller than the one provided by TEMPRO. A total of 20 scenarios has been tested to cover a range of forecasting inaccuracy from -20% to 0%. Therefore, the growth factor that is officially 1.284 for the AM peak period and 1.294 for the PM peak period has been tested for its impact in the annual cost of delays for a range of 1.084-1.274 for the AM and 1.094-1.284 for the PM peak periods.

It is found that if the growth factor turns out to be 1% less than the official growth factor, the annual cost of the delays will be £154,126,746 that is approximately £2m less than the basic forecasting scenario. Respectively, a growth factor of 10% less would signify approximately £12m less annual cost of delays and a growth factor of 20% less would signify approximately £14m less in annual cost of delays.

The differences in the economic assessment of the annual delays are significant and should be taken under consideration during scheme appraisal. A difference of 1% or 2% in the growth factor is not something unrealistic and it would imply a difference in cost of delays of a few million pounds.

It should be noted that there is a significant difference in the annual cost of delays between the base year and all forecasting scenarios. This may be attributed to the calculation of the travel time on the links under congestion: It has been assumed that if the volume on the lionk exceeds capacity, a maximum travel time will be assumed on the link instead of using the results of the VDF. This is logical, as when congestion occurs on a link the speed reduces faster that when congestion is building up. In the future the number of links on the examined part of the A12 that will experience a V/C>1 is great and the delays experienced on those links have also been calculated and are significant. Therefore, the great difference in the annual cost of delays is justified as a combination of increased delays experiences per vehicle and an increased number of vehicles on the A12.

| | Scenario | Annual Cost of Delays (£) | Cost of delays: (Scenario) – (Base Year) (£) |
|---|---|---|---|
| | Base year 2013 | 22,795,222 | |
| | Forecast year 2031 | 155,546,846 | 132,751,624 |
| Sensitivity Testing Growth Factor % change | -1% | 154,126,746 | 131,331,523 |
| | -2% | 152,921,133 | 130,125,911 |
| | -3% | 151,715,520 | 128,920,298 |
| | -4% | 150,509,907 | 127,714,685 |
| | -5% | 149,304,294 | 126,509,072 |
| | -6% | 148,098,681 | 125,303,459 |
| | -7% | 146,893,068 | 124,097,846 |
| | -8% | 145,687,455 | 122,892,233 |
| | -9% | 144,481,843 | 121,686,620 |
| | -10% | 143,276,230 | 120,481,007 |
| | -11% | 142,070,617 | 119,275,394 |
| | -12% | 140,865,004 | 118,069,782 |
| | -13% | 139,659,391 | 116,864,169 |
| | -14% | 138,453,778 | 115,658,556 |
| | -15% | 137,248,165 | 114,452,943 |
| | -16% | 136,042,552 | 113,247,330 |
| | -17% | 134,836,939 | 112,041,717 |
| | -18% | 133,631,326 | 110,836,104 |
| | -19% | 132,425,714 | 109,630,491 |
| | -20% | 131,220,101 | 108,424,878 |

**Table 5-17 Cost of delays on the A12 for the base and forecast year and sensitivity test.**

# 6. Recommendations / Conclusions

This study has examined the importance of forecasting when it comes to traffic growth and modal share. It has been shown that infrastructure projects are a great part of nations' investment and they are vital to keep people and goods moving and the societies growing. So far forecasting is a fundamental part of decision making and its accuracy is important in terms of financial implications. It has been proven that the forecasting in major infrastructure projects has failed in many cases and the economic implications of such failures are not to be neglected.

As mentioned already, it has been established that the forecasting methods we are using are failing to accurately predict future demand for transport infrastructure projects. There is a wide range of bibliography and research on forecasting methodologies, methods to improve accuracy and it is an ongoing conversation whether we have reached an era of falling out of love with the car. A suggestion of implementing transport and land use has had lots of positive response and has been successful in reducing inaccuracies and strengthening the case for a more realistic approach to transport management.

Academic research and case studies ordered by governments have made a case for a need for a holistic approach to forecasting and increased accuracy. Nevertheless, the methods used by transportation specialists when producing results for stakeholders are the ones suggested by government and the forecasting is done on a national level. Consequently, no matter how much research and progress is done on forecasting methodologies, it will be of no use unless it is incorporated in the national forecasting models.

This study has been motivated by the need to establish a better system in appraising schemes, that will be more realistic and respond to people's behavioural changes. The writer lives and works in the U.K. and has experience of the appraisal processes there as well as the best practices and guidance. The forecasting methodology in the U.K. and the cost benefit analysis guidance are presented in this study and it was considered interesting to test the sensitivity of economic appraisal to changes in the growth factors.

In order to achieve this a strategic road appraisal scheme was selected to be tested, namely a part of the strategic road network was analysed for its current and forecast traffic performance. Available data open to the public was used to assess traffic conditions on the section of the A12 that is within the boundary of the county of Essex. The official growth factors given by the Department for Transport were used to estimate future traffic on the road and a range of growth factors was also applied to current conditions in order to compare the results if peak car occurs and car usage decreases.

The methodology that was followed consists of four steps, namely data collection and analysis; selection and calculation of the values for a series of externalities that will be used to produce the economic performance of the road; translation of the externalities in monetary values; comparison of the generalised costs of the externalities for the scenarios applied. As scenarios, the needs to be a base year scenario, and official forecast scenario and a series of scenarios for the sensitivity testing. The aim is to compare the costs for the different scenarios and consequently the cost of the inaccuracies in forecasting in case peak car occurs and has not been accounted for in the official forecasting.

During the application a series of constraints were faced and dealt with by adjusting the methodology: The data available for the road were broken down in 10 sections and each section included a number of junctions. Therefore it was not possible to use an accurate traffic model. It was chosen to use the BPR's VDF in order to input the traffic volumes on the links and produce the travel times. The VDF was calibrated for each link separately as the data was not consistent enough to produce a single set of parameters for the calibration.

The free flow travel time was calculated as a combination of the link length and the average travel speed. Therefore, the delays were calculated on the links. In the cases where congestion occurred and the V/C was greater than 1, the VDF could not accurately calculate the travel time on the links and in those cases a maximum travel time was assumed as a result of a minimum travel speed on the link at 15 km/h. This procedure allows to calculate the travel times for any given input of traffic flow on the link.

The delays on the links were then translated into monetary values: the traffic was split per trip purpose and vehicle type and a cost was assigned to each category. Additionally, the delays per vehicle were split accordingly and a value of time was assigned to each category of the delays. This methods allowed to calculate the annual cost of the delays on the road during the peak hours.

The results revealed a significant increase in the cost of the delays mainly due to congestion on a great number of road sections and their assigned maximum travel time. The annual cost of the delays on the examined road during the base year is estimated to be £22,795,222 and it is forecast to rise to £155,546,846 by 2031, creating an additional cost of £132,751,624 due to increased delays on the A12. It was also found that if the growth factor turns out to be 1% less than the official growth factor, the annual cost of the delays will be £154,126,746 that is approximately £2m less than the basic forecasting scenario. Respectively, a growth factor of 10% less would signify approximately £12m less annual cost of delays and a growth factor of 20% less would signify approximately £14m less in annual cost of delays.

The above mentioned figures reveal a significant impact of inaccuracies in forecasting, if peak car occurs and has not been included in the official forecasts. They make a case for drawing attention to current methodologies and point out that the economic impacts of forecasting inaccuracies are not to be disregarded.

This application is subject to a series of constraints and assumptions, which leaves a great margin of error in the results. Though, it has a sound base and reaches a logical conclusion. Ideally, the methodology could be followed having a greater amount of data available, to include all traffic performance, environmental and accident indicators to be examined. A model would be a great improvement in the input of all the available data and the calculation of the externalities. Therefore a socio-economic analysis could be run and a great breadth of results could be compared to make a stronger case for peak car effects. In terms of the economic assessment, it is considered that this analysis had enough data and resources available to calculate the costs of the externalities.

Whether this application is accurate in terms of results or not, it makes a case for the effects of inputs data inaccuracies in the economic appraisal of schemes. In most scheme appraisals a relevant methodology is followed, comparing base year data with forecast data with and without the scheme in question. The quality of the input data is crucial in the outcomes of the appraisal process that will are later on used by stakeholders for decision making. An alternative approach to dealing with forecasting inaccuracies would be to include a set of sensitivity testing growth factors in scheme appraisal to account for such errors and alert decision makers that their decisions are subject to a range of outcomes. Another method to deal with peak car in case the forecasting cannot be more accurate is to adopt a staged approach in decision making: break down the schemes in smaller time horizon parts that are subject to greater accuracy. Therefore stakeholders can re assess the future development of a scheme once it has partially worked and affected the network.

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# APPENDIX A – DfT Data

## DfT AADF Temporal Data Analysis

| Year | Pedal Cycles | 2-wheeled Motor Vehicles | Cars &Taxis | Buses &Coaches | LGVs | All HGVs | AADF 2-way |
|---|---|---|---|---|---|---|---|
| 2000 | 83 | 7,766 | 752,898 | 3,966 | 121,963 | 102,401 | 988,994 |
| 2001 | 52 | 8,306 | 797,319 | 3,850 | 129,057 | 101,864 | 1,040,396 |
| 2002 | 25 | 8,137 | 814,344 | 4,310 | 129,887 | 114,810 | 1,071,488 |
| 2003 | 40 | 8,756 | 820,999 | 3,685 | 135,367 | 111,614 | 1,080,421 |
| 2004 | 23 | 7,940 | 840,792 | 3,715 | 139,627 | 113,930 | 1,106,004 |
| 2005 | 35 | 7,483 | 819,605 | 3,488 | 142,694 | 112,731 | 1,086,001 |
| 2006 | 28 | 7,487 | 839,194 | 4,077 | 155,980 | 112,543 | 1,119,281 |
| 2007 | 29 | 7,403 | 821,645 | 3,750 | 165,053 | 112,728 | 1,110,579 |
| 2008 | 67 | 7,322 | 825,099 | 3,136 | 169,942 | 107,631 | 1,113,130 |
| 2009 | 31 | 7,147 | 890,726 | 2,842 | 152,252 | 112,498 | 1,165,465 |
| 2010 | 14 | 6,960 | 831,265 | 2,959 | 138,772 | 115,093 | 1,095,049 |
| 2011 | 59 | 6,310 | 818,926 | 2,298 | 160,857 | 99,544 | 1,087,935 |
| 2012 | 40 | 5,719 | 860,469 | 2,626 | 169,584 | 98,261 | 1,136,670 |

# APPENDIX B Group Step 3 Detailed matrices

## 2013 - From traffic flows to cost of delays (1 of 2)

| | | 2013 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 1724 | 276 | 28 | 3370 | 2494 | 399 | 40 | 312 | 324 | 793 | 1017 | 619 | 1152 | 243 | 351 | 33 | 48 | 28 | 40 |
| | 2 | 2490 | 1842 | 295 | 29 | 3469 | 2567 | 411 | 41 | 333 | 334 | 847 | 1047 | 661 | 1186 | 259 | 361 | 35 | 49 | 29 | 41 |
| | 3 | 1996 | 1477 | 236 | 24 | 3205 | 2372 | 379 | 38 | 267 | 308 | 679 | 968 | 530 | 1096 | 208 | 334 | 28 | 46 | 24 | 38 |
| | 4 | 2913 | 2155 | 345 | 34 | 3705 | 2742 | 439 | 44 | 390 | 356 | 991 | 1119 | 774 | 1267 | 303 | 386 | 41 | 53 | 34 | 44 |
| | 5 | 3020 | 2234 | 358 | 36 | 3698 | 2737 | 438 | 44 | 404 | 356 | 1028 | 1117 | 802 | 1264 | 315 | 385 | 43 | 53 | 36 | 44 |
| | 6 | 3065 | 2268 | 363 | 36 | 4137 | 3062 | 490 | 49 | 410 | 398 | 1043 | 1249 | 814 | 1414 | 319 | 431 | 44 | 59 | 36 | 49 |
| | 7 | 3286 | 2432 | 389 | 39 | 3886 | 2875 | 460 | 46 | 440 | 374 | 1119 | 1173 | 873 | 1328 | 342 | 405 | 47 | 55 | 39 | 46 |
| | 8 | 4157 | 3076 | 492 | 49 | 4642 | 3435 | 550 | 55 | 557 | 447 | 1415 | 1402 | 1104 | 1587 | 433 | 484 | 59 | 66 | 49 | 55 |
| | 10 | 2253 | 1667 | 267 | 27 | 2343 | 1734 | 277 | 28 | 302 | 225 | 767 | 707 | 598 | 801 | 235 | 244 | 32 | 33 | 27 | 28 |
| SB | 1 | 2889 | 2138 | 342 | 34 | 2145 | 1587 | 254 | 25 | 387 | 206 | 983 | 647 | 767 | 733 | 301 | 223 | 41 | 30 | 34 | 25 |
| | 2 | 3063 | 2267 | 363 | 36 | 2379 | 1761 | 282 | 28 | 410 | 229 | 1043 | 718 | 814 | 813 | 319 | 248 | 44 | 34 | 36 | 28 |
| | 3 | 2879 | 2131 | 341 | 34 | 2018 | 1493 | 239 | 24 | 386 | 194 | 980 | 609 | 765 | 690 | 300 | 210 | 41 | 29 | 34 | 24 |
| | 4 | 2879 | 2131 | 341 | 34 | 2018 | 1493 | 239 | 24 | 386 | 194 | 980 | 609 | 765 | 690 | 300 | 210 | 41 | 29 | 34 | 24 |
| | 5 | 3420 | 2531 | 405 | 40 | 3282 | 2429 | 389 | 39 | 458 | 316 | 1164 | 991 | 909 | 1122 | 356 | 342 | 49 | 47 | 40 | 39 |
| | 6 | 3379 | 2500 | 400 | 40 | 2690 | 1991 | 318 | 32 | 453 | 259 | 1150 | 812 | 898 | 920 | 352 | 280 | 48 | 38 | 40 | 32 |
| | 7 | 3677 | 2721 | 435 | 44 | 3265 | 2416 | 387 | 39 | 493 | 314 | 1252 | 986 | 977 | 1116 | 383 | 340 | 52 | 46 | 44 | 39 |
| | 8 | 3982 | 2947 | 471 | 47 | 3911 | 2894 | 463 | 46 | 533 | 376 | 1355 | 1181 | 1058 | 1337 | 415 | 408 | 57 | 56 | 47 | 46 |
| | 10 | 2322 | 1719 | 275 | 27 | 2289 | 1694 | 271 | 27 | 311 | 220 | 791 | 691 | 617 | 783 | 242 | 239 | 33 | 33 | 27 | 27 |

# 2013 - From traffic flows to cost of delays (2 of 2)

| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | Car AM: Work | Car PM: Work | Car AM: Commute | Car PM: Commute | Car AM: Other | Car PM: Other | LGV AM: Work | LGV PM: Work | LGV AM: Non-work | LGV PM: Non-work | HGV AM | HGV PM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2013** | | | | | | | | | | | | | | | | |
| | | **Delays** | | | | | **Cost (£) of delays - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| NB | 1 | 232 | 261 | 0.008 | 323 | 0.025 | 79 | 251 | 50 | 198 | 50 | 315 | 28 | 131 | 2 | 11 | 3 | 15 |
| NB | 2 | 267 | 285 | 0.005 | 345 | 0.022 | 54 | 222 | 34 | 176 | 34 | 280 | 19 | 116 | 2 | 10 | 2 | 13 |
| NB | 3 | 230 | 242 | 0.003 | 353 | 0.034 | 28 | 322 | 18 | 255 | 18 | 406 | 10 | 168 | 1 | 14 | 1 | 19 |
| NB | 4 | 70 | 86 | 0.004 | 523 | 0.126 | 54 | 1374 | 34 | 1087 | 34 | 1729 | 20 | 717 | 2 | 61 | 2 | 80 |
| NB | 5 | 153 | 191 | 0.011 | 1140 | 0.274 | 136 | 2988 | 85 | 2364 | 86 | 3760 | 49 | 1559 | 4 | 133 | 5 | 174 |
| NB | 6 | 761 | 820 | 0.017 | 5683 | 1.367 | 218 | 16669 | 137 | 13191 | 138 | 20978 | 78 | 8697 | 7 | 742 | 9 | 970 |
| NB | 7 | 101 | 108 | 0.002 | 117 | 0.005 | 28 | 53 | 18 | 42 | 18 | 66 | 10 | 27 | 1 | 2 | 1 | 3 |
| NB | 8 | 66 | 79 | 0.004 | 80 | 0.004 | 63 | 53 | 40 | 42 | 40 | 66 | 23 | 28 | 2 | 2 | 3 | 3 |
| NB | 10 | 591 | 777 | 0.052 | 751 | 0.044 | 496 | 305 | 313 | 242 | 314 | 384 | 179 | 159 | 15 | 14 | 20 | 18 |
| SB | 1 | 234 | 321 | 0.024 | 283 | 0.014 | 299 | 85 | 188 | 68 | 189 | 107 | 108 | 45 | 9 | 4 | 12 | 5 |
| SB | 2 | 264 | 295 | 0.009 | 276 | 0.003 | 113 | 22 | 71 | 17 | 72 | 28 | 41 | 12 | 3 | 1 | 5 | 1 |
| SB | 3 | 231 | 262 | 0.009 | 242 | 0.003 | 105 | 17 | 66 | 13 | 66 | 21 | 38 | 9 | 3 | 1 | 4 | 1 |
| SB | 4 | 70 | 86 | 0.004 | 83 | 0.004 | 54 | 22 | 34 | 17 | 34 | 27 | 19 | 11 | 2 | 1 | 2 | 1 |
| SB | 5 | 152 | 190 | 0.010 | 164 | 0.003 | 151 | 31 | 95 | 25 | 95 | 39 | 54 | 16 | 5 | 1 | 6 | 2 |
| SB | 6 | 762 | 880 | 0.033 | 797 | 0.010 | 474 | 78 | 299 | 62 | 299 | 99 | 171 | 41 | 15 | 3 | 19 | 5 |
| SB | 7 | 102 | 114 | 0.003 | 111 | 0.002 | 53 | 23 | 33 | 18 | 33 | 29 | 19 | 12 | 2 | 1 | 2 | 1 |
| SB | 8 | 65 | 79 | 0.004 | 84 | 0.005 | 66 | 60 | 42 | 47 | 42 | 75 | 24 | 31 | 2 | 3 | 3 | 3 |
| SB | 10 | 586 | 669 | 0.023 | 619 | 0.009 | 230 | 63 | 145 | 50 | 146 | 79 | 83 | 33 | 7 | 3 | 9 | 4 |
| | | 232 | 261 | 0.008 | 323 | 0.025 | 79 | 251 | 50 | 198 | 50 | 315 | 28 | 131 | 2 | 11 | 3 | 15 |

| | |
|---|---|
| **Cost of delays per working day** | **£90,457** |
| **Cost of delays per year (252 working days)** | **£22,795,222** |

# 2031 - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2992 | 2214 | 354 | 35 | 4361 | 3227 | 516 | 52 | 401 | 419 | 1019 | 1317 | 795 | 1491 | 312 | 454 | 43 | 62 | 35 | 52 |
| | 2 | 3197 | 2366 | 378 | 38 | 4489 | 3322 | 532 | 53 | 428 | 432 | 1088 | 1355 | 849 | 1535 | 333 | 468 | 45 | 64 | 38 | 53 |
| | 3 | 2563 | 1896 | 303 | 30 | 4147 | 3069 | 491 | 49 | 343 | 399 | 872 | 1252 | 681 | 1418 | 267 | 432 | 36 | 59 | 30 | 49 |
| | 4 | 3740 | 2768 | 443 | 44 | 4794 | 3548 | 568 | 57 | 501 | 461 | 1273 | 1447 | 994 | 1639 | 390 | 500 | 53 | 68 | 44 | 57 |
| | 5 | 3877 | 2869 | 459 | 46 | 4786 | 3541 | 567 | 57 | 519 | 460 | 1320 | 1445 | 1030 | 1636 | 404 | 499 | 55 | 68 | 46 | 57 |
| | 6 | 3935 | 2912 | 466 | 47 | 5354 | 3962 | 634 | 63 | 527 | 515 | 1340 | 1616 | 1045 | 1830 | 410 | 558 | 56 | 76 | 47 | 63 |
| | 7 | 4220 | 3123 | 500 | 50 | 5028 | 3721 | 595 | 60 | 565 | 484 | 1436 | 1518 | 1121 | 1719 | 440 | 524 | 60 | 71 | 50 | 60 |
| | 8 | 5338 | 3950 | 632 | 63 | 6007 | 4445 | 711 | 71 | 715 | 578 | 1817 | 1814 | 1418 | 2054 | 556 | 626 | 76 | 85 | 63 | 71 |
| | 10 | 2892 | 2140 | 342 | 34 | 3032 | 2244 | 359 | 36 | 387 | 292 | 985 | 915 | 768 | 1037 | 301 | 316 | 41 | 43 | 34 | 36 |
| SB | 1 | 3709 | 2745 | 439 | 44 | 2775 | 2054 | 329 | 33 | 497 | 267 | 1263 | 838 | 985 | 949 | 386 | 289 | 53 | 39 | 44 | 33 |
| | 2 | 3933 | 2911 | 466 | 47 | 3079 | 2278 | 365 | 36 | 527 | 296 | 1339 | 929 | 1045 | 1053 | 410 | 321 | 56 | 44 | 47 | 36 |
| | 3 | 3697 | 2736 | 438 | 44 | 2611 | 1932 | 309 | 31 | 495 | 251 | 1258 | 788 | 982 | 893 | 385 | 272 | 53 | 37 | 44 | 31 |
| | 4 | 3697 | 2736 | 438 | 44 | 2611 | 1932 | 309 | 31 | 495 | 251 | 1258 | 788 | 982 | 893 | 385 | 272 | 53 | 37 | 44 | 31 |
| | 5 | 4391 | 3250 | 520 | 52 | 4247 | 3143 | 503 | 50 | 588 | 409 | 1495 | 1282 | 1167 | 1452 | 458 | 443 | 62 | 60 | 52 | 50 |
| | 6 | 4339 | 3211 | 514 | 51 | 3481 | 2576 | 412 | 41 | 581 | 335 | 1477 | 1051 | 1153 | 1190 | 452 | 363 | 62 | 49 | 51 | 41 |
| | 7 | 4722 | 3494 | 559 | 56 | 4225 | 3126 | 500 | 50 | 632 | 406 | 1607 | 1276 | 1254 | 1444 | 492 | 440 | 67 | 60 | 56 | 50 |
| | 8 | 5113 | 3783 | 605 | 61 | 5061 | 3745 | 599 | 60 | 685 | 487 | 1740 | 1528 | 1358 | 1730 | 533 | 527 | 73 | 72 | 61 | 60 |
| | 10 | 2982 | 2207 | 353 | 35 | 2962 | 2192 | 351 | 35 | 399 | 285 | 1015 | 894 | 792 | 1013 | 311 | 309 | 42 | 42 | 35 | 35 |

# 2031 - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 310 | 0.022 | 1740 | 0.419 | 393 | 7683 | 248 | 6080 | 248 | 9670 | 141 | 4009 | 12 | 342 | 16 | 447 |
| | 2 | 267 | 317 | 0.014 | 1982 | 0.477 | 269 | 8999 | 170 | 7122 | 170 | 11326 | 97 | 4695 | 8 | 401 | 11 | 524 |
| | 3 | 230 | 263 | 0.009 | 1723 | 0.415 | 141 | 7235 | 89 | 5726 | 89 | 9106 | 51 | 3775 | 4 | 322 | 6 | 421 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2868 | 2538 | 1808 | 2009 | 1813 | 3195 | 1033 | 1324 | 88 | 113 | 115 | 148 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6476 | 5519 | 4083 | 4368 | 4093 | 6946 | 2333 | 2880 | 199 | 246 | 260 | 321 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 32783 | 30794 | 20669 | 24368 | 20720 | 38755 | 11810 | 16067 | 1008 | 1372 | 1318 | 1793 |
| | 7 | 101 | 121 | 0.005 | 147 | 0.013 | 141 | 272 | 89 | 215 | 89 | 343 | 51 | 142 | 4 | 12 | 6 | 16 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3825 | 2972 | 2411 | 2352 | 2417 | 3740 | 1378 | 1551 | 118 | 132 | 154 | 173 |
| | 10 | 591 | 1097 | 0.140 | 1038 | 0.124 | 2473 | 1581 | 1559 | 1251 | 1563 | 1990 | 891 | 825 | 76 | 70 | 99 | 92 |
| SB | 1 | 234 | 1740 | 0.418 | 370 | 0.038 | 9452 | 442 | 5960 | 350 | 5974 | 556 | 3405 | 231 | 291 | 20 | 380 | 26 |
| | 2 | 264 | 1982 | 0.477 | 296 | 0.009 | 11437 | 114 | 7211 | 91 | 7229 | 144 | 4120 | 60 | 352 | 5 | 460 | 7 |
| | 3 | 231 | 1723 | 0.414 | 260 | 0.008 | 9333 | 88 | 5884 | 70 | 5899 | 111 | 3362 | 46 | 287 | 4 | 375 | 5 |
| | 4 | 70 | 523 | 0.126 | 107 | 0.010 | 2835 | 112 | 1787 | 89 | 1792 | 141 | 1021 | 59 | 87 | 5 | 114 | 7 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 7340 | 4901 | 4627 | 3879 | 4639 | 6168 | 2644 | 2557 | 226 | 218 | 295 | 285 |
| | 6 | 762 | 5683 | 1.367 | 862 | 0.028 | 36134 | 406 | 22782 | 321 | 22838 | 511 | 13018 | 212 | 1111 | 18 | 1452 | 24 |
| | 7 | 102 | 135 | 0.009 | 127 | 0.007 | 264 | 121 | 166 | 96 | 167 | 152 | 95 | 63 | 8 | 5 | 11 | 7 |
| | 8 | 65 | 103 | 0.011 | 117 | 0.015 | 328 | 310 | 207 | 245 | 207 | 390 | 118 | 162 | 10 | 14 | 13 | 18 |
| | 10 | 586 | 813 | 0.063 | 680 | 0.026 | 1148 | 325 | 724 | 257 | 725 | 409 | 413 | 170 | 35 | 14 | 46 | 19 |
| | | 232 | 310 | 0.022 | 1740 | 0.419 | 393 | 7683 | 248 | 6080 | 248 | 9670 | 141 | 4009 | 12 | 342 | 16 | 447 |
| | | | | | | | Cost of delays per working day | | | | | | | | | | **£617,249** | |
| | | | | | | | Cost of delays per year (252 working days) | | | | | | | | | | **£155,546,846** | |

## Sensitivity Testing Growth Factor -1% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2969 | 2197 | 352 | 35 | 4327 | 3202 | 512 | 51 | 398 | 416 | 1011 | 1306 | 789 | 1479 | 309 | 451 | 42 | 61 | 35 | 51 |
| | 2 | 3172 | 2347 | 376 | 38 | 4455 | 3296 | 527 | 53 | 425 | 429 | 1080 | 1345 | 843 | 1523 | 330 | 464 | 45 | 63 | 38 | 53 |
| | 3 | 2543 | 1882 | 301 | 30 | 4115 | 3045 | 487 | 49 | 341 | 396 | 866 | 1243 | 675 | 1407 | 265 | 429 | 36 | 58 | 30 | 49 |
| | 4 | 3711 | 2746 | 439 | 44 | 4757 | 3520 | 563 | 56 | 497 | 458 | 1263 | 1436 | 986 | 1626 | 387 | 496 | 53 | 68 | 44 | 56 |
| | 5 | 3847 | 2847 | 455 | 46 | 4749 | 3514 | 562 | 56 | 515 | 457 | 1309 | 1434 | 1022 | 1624 | 401 | 495 | 55 | 67 | 46 | 56 |
| | 6 | 3905 | 2889 | 462 | 46 | 5312 | 3931 | 629 | 63 | 523 | 511 | 1329 | 1604 | 1037 | 1816 | 407 | 553 | 55 | 75 | 46 | 63 |
| | 7 | 4187 | 3098 | 496 | 50 | 4989 | 3692 | 591 | 59 | 561 | 480 | 1425 | 1506 | 1112 | 1706 | 436 | 520 | 59 | 71 | 50 | 59 |
| | 8 | 5296 | 3919 | 627 | 63 | 5961 | 4411 | 706 | 71 | 709 | 573 | 1803 | 1800 | 1407 | 2038 | 552 | 621 | 75 | 85 | 63 | 71 |
| | 10 | 2870 | 2124 | 340 | 34 | 3008 | 2226 | 356 | 36 | 384 | 289 | 977 | 908 | 762 | 1028 | 299 | 313 | 41 | 43 | 34 | 36 |
| SB | 1 | 3680 | 2723 | 436 | 44 | 2754 | 2038 | 326 | 33 | 493 | 265 | 1253 | 831 | 978 | 941 | 383 | 287 | 52 | 39 | 44 | 33 |
| | 2 | 3903 | 2888 | 462 | 46 | 3055 | 2261 | 362 | 36 | 523 | 294 | 1329 | 922 | 1037 | 1044 | 407 | 318 | 55 | 43 | 46 | 36 |
| | 3 | 3668 | 2714 | 434 | 43 | 2591 | 1917 | 307 | 31 | 491 | 249 | 1249 | 782 | 975 | 886 | 382 | 270 | 52 | 37 | 43 | 31 |
| | 4 | 3668 | 2714 | 434 | 43 | 2591 | 1917 | 307 | 31 | 491 | 249 | 1249 | 782 | 975 | 886 | 382 | 270 | 52 | 37 | 43 | 31 |
| | 5 | 4357 | 3224 | 516 | 52 | 4214 | 3119 | 499 | 50 | 584 | 405 | 1483 | 1272 | 1158 | 1441 | 454 | 439 | 62 | 60 | 52 | 50 |
| | 6 | 4305 | 3186 | 510 | 51 | 3454 | 2556 | 409 | 41 | 577 | 332 | 1465 | 1043 | 1144 | 1181 | 449 | 360 | 61 | 49 | 51 | 41 |
| | 7 | 4685 | 3467 | 555 | 55 | 4192 | 3102 | 496 | 50 | 628 | 403 | 1595 | 1266 | 1245 | 1433 | 488 | 437 | 67 | 60 | 55 | 50 |
| | 8 | 5073 | 3754 | 601 | 60 | 5022 | 3716 | 595 | 59 | 679 | 483 | 1727 | 1516 | 1348 | 1717 | 529 | 523 | 72 | 71 | 60 | 59 |
| | 10 | 2959 | 2189 | 350 | 35 | 2939 | 2175 | 348 | 35 | 396 | 283 | 1007 | 887 | 786 | 1005 | 308 | 306 | 42 | 42 | 35 | 35 |

# Sensitivity Testing Growth Factor -1% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 378 | 7624 | 238 | 6033 | 239 | 9595 | 136 | 3978 | 12 | 340 | 15 | 444 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 259 | 8930 | 163 | 7066 | 164 | 11238 | 93 | 4659 | 8 | 398 | 10 | 520 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 136 | 7180 | 85 | 5682 | 86 | 9036 | 49 | 3746 | 4 | 320 | 5 | 418 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2846 | 2519 | 1794 | 1993 | 1798 | 3170 | 1025 | 1314 | 88 | 112 | 114 | 147 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6425 | 5477 | 4051 | 4334 | 4061 | 6892 | 2315 | 2857 | 198 | 244 | 258 | 319 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 32527 | 30556 | 20508 | 24180 | 20559 | 38455 | 11718 | 15943 | 1000 | 1361 | 1307 | 1779 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 135 | 262 | 85 | 207 | 85 | 329 | 49 | 137 | 4 | 12 | 5 | 15 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3795 | 2949 | 2393 | 2333 | 2398 | 3711 | 1367 | 1539 | 117 | 131 | 153 | 172 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2378 | 1521 | 1499 | 1203 | 1503 | 1914 | 857 | 793 | 73 | 68 | 96 | 89 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 9379 | 425 | 5913 | 336 | 5928 | 535 | 3379 | 222 | 288 | 19 | 377 | 25 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 11348 | 110 | 7155 | 87 | 7172 | 138 | 4088 | 57 | 349 | 5 | 456 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 9260 | 85 | 5838 | 67 | 5853 | 106 | 3336 | 44 | 285 | 4 | 372 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2813 | 108 | 1773 | 86 | 1778 | 136 | 1013 | 56 | 87 | 5 | 113 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 7282 | 4863 | 4591 | 3849 | 4603 | 6121 | 2624 | 2538 | 224 | 217 | 293 | 283 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 35853 | 391 | 22604 | 309 | 22661 | 492 | 12916 | 204 | 1103 | 17 | 1441 | 23 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 254 | 116 | 160 | 92 | 160 | 146 | 91 | 61 | 8 | 5 | 10 | 7 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 316 | 298 | 199 | 236 | 199 | 376 | 114 | 156 | 10 | 13 | 13 | 17 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1104 | 313 | 696 | 248 | 697 | 394 | 398 | 163 | 34 | 14 | 44 | 18 |

| | |
|---|---|
| **Cost of delays per working day** | **£611,614** |
| **Cost of delays per year (252 working days)** | **£154,126,746** |

# Sensitivity Testing Growth Factor -2%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2946 | 2180 | 349 | 35 | 4293 | 3177 | 508 | 51 | 395 | 413 | 1003 | 1296 | 783 | 1468 | 307 | 447 | 42 | 61 | 35 | 51 |
| | 2 | 3147 | 2329 | 373 | 37 | 4420 | 3271 | 523 | 52 | 422 | 425 | 1071 | 1334 | 836 | 1511 | 328 | 461 | 45 | 63 | 37 | 52 |
| | 3 | 2523 | 1867 | 299 | 30 | 4083 | 3022 | 483 | 48 | 338 | 393 | 859 | 1233 | 670 | 1396 | 263 | 425 | 36 | 58 | 30 | 48 |
| | 4 | 3682 | 2724 | 436 | 44 | 4720 | 3493 | 559 | 56 | 493 | 454 | 1253 | 1425 | 978 | 1614 | 384 | 492 | 52 | 67 | 44 | 56 |
| | 5 | 3817 | 2824 | 452 | 45 | 4712 | 3487 | 558 | 56 | 511 | 453 | 1299 | 1423 | 1014 | 1611 | 398 | 491 | 54 | 67 | 45 | 56 |
| | 6 | 3874 | 2867 | 459 | 46 | 5271 | 3900 | 624 | 62 | 519 | 507 | 1319 | 1591 | 1029 | 1802 | 404 | 549 | 55 | 75 | 46 | 62 |
| | 7 | 4154 | 3074 | 492 | 49 | 4950 | 3663 | 586 | 59 | 556 | 476 | 1414 | 1495 | 1104 | 1692 | 433 | 516 | 59 | 70 | 49 | 59 |
| | 8 | 5255 | 3889 | 622 | 62 | 5914 | 4376 | 700 | 70 | 704 | 569 | 1789 | 1786 | 1396 | 2022 | 548 | 616 | 75 | 84 | 62 | 70 |
| | 10 | 2847 | 2107 | 337 | 34 | 2985 | 2209 | 353 | 35 | 381 | 287 | 969 | 901 | 756 | 1020 | 297 | 311 | 40 | 42 | 34 | 35 |
| SB | 1 | 3651 | 2702 | 432 | 43 | 2732 | 2022 | 323 | 32 | 489 | 263 | 1243 | 825 | 970 | 934 | 380 | 285 | 52 | 39 | 43 | 32 |
| | 2 | 3872 | 2865 | 458 | 46 | 3031 | 2243 | 359 | 36 | 519 | 292 | 1318 | 915 | 1029 | 1036 | 403 | 316 | 55 | 43 | 46 | 36 |
| | 3 | 3639 | 2693 | 431 | 43 | 2571 | 1902 | 304 | 30 | 487 | 247 | 1239 | 776 | 967 | 879 | 379 | 268 | 52 | 37 | 43 | 30 |
| | 4 | 3639 | 2693 | 431 | 43 | 2571 | 1902 | 304 | 30 | 487 | 247 | 1239 | 776 | 967 | 879 | 379 | 268 | 52 | 37 | 43 | 30 |
| | 5 | 4323 | 3199 | 512 | 51 | 4182 | 3094 | 495 | 50 | 579 | 402 | 1472 | 1262 | 1148 | 1430 | 450 | 436 | 61 | 59 | 51 | 50 |
| | 6 | 4271 | 3161 | 506 | 51 | 3427 | 2536 | 406 | 41 | 572 | 330 | 1454 | 1035 | 1135 | 1172 | 445 | 357 | 61 | 49 | 51 | 41 |
| | 7 | 4648 | 3440 | 550 | 55 | 4159 | 3078 | 492 | 49 | 623 | 400 | 1582 | 1256 | 1235 | 1422 | 484 | 433 | 66 | 59 | 55 | 49 |
| | 8 | 5033 | 3725 | 596 | 60 | 4983 | 3688 | 590 | 59 | 674 | 479 | 1713 | 1505 | 1337 | 1704 | 524 | 519 | 72 | 71 | 60 | 59 |
| | 10 | 2935 | 2172 | 348 | 35 | 2916 | 2158 | 345 | 35 | 393 | 281 | 999 | 881 | 780 | 997 | 306 | 304 | 42 | 41 | 35 | 35 |

# Sensitivity Testing Growth Factor -2% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 375 | 7564 | 236 | 5986 | 237 | 9520 | 135 | 3947 | 12 | 337 | 15 | 440 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 257 | 8860 | 162 | 7011 | 162 | 11151 | 93 | 4623 | 8 | 395 | 10 | 516 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 134 | 7124 | 85 | 5637 | 85 | 8965 | 48 | 3717 | 4 | 317 | 5 | 415 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2823 | 2499 | 1780 | 1978 | 1784 | 3145 | 1017 | 1304 | 87 | 111 | 113 | 145 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6375 | 5434 | 4019 | 4300 | 4029 | 6839 | 2297 | 2835 | 196 | 242 | 256 | 316 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 32272 | 30318 | 20347 | 23992 | 20397 | 38156 | 11626 | 15818 | 993 | 1350 | 1297 | 1765 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 134 | 260 | 85 | 206 | 85 | 327 | 48 | 136 | 4 | 12 | 5 | 15 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3765 | 2926 | 2374 | 2315 | 2380 | 3682 | 1356 | 1527 | 116 | 130 | 151 | 170 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2359 | 1509 | 1488 | 1194 | 1491 | 1899 | 850 | 787 | 73 | 67 | 95 | 88 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 9305 | 422 | 5867 | 334 | 5881 | 531 | 3352 | 220 | 286 | 19 | 374 | 25 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 11259 | 109 | 7098 | 86 | 7116 | 137 | 4056 | 57 | 346 | 5 | 453 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 9188 | 84 | 5793 | 66 | 5807 | 106 | 3310 | 44 | 283 | 4 | 369 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2791 | 107 | 1760 | 85 | 1764 | 135 | 1005 | 56 | 86 | 5 | 112 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 7225 | 4826 | 4555 | 3819 | 4567 | 6073 | 2603 | 2518 | 222 | 215 | 290 | 281 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 35572 | 388 | 22427 | 307 | 22483 | 488 | 12815 | 202 | 1094 | 17 | 1430 | 23 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 252 | 115 | 159 | 91 | 159 | 145 | 91 | 60 | 8 | 5 | 10 | 7 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 313 | 296 | 197 | 234 | 198 | 373 | 113 | 154 | 10 | 13 | 13 | 17 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1095 | 310 | 690 | 246 | 692 | 391 | 394 | 162 | 34 | 14 | 44 | 18 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 375 | 7564 | 236 | 5986 | 237 | 9520 | 135 | 3947 | 12 | 337 | 15 | 440 |

| | |
|---|---|
| **Cost of delays per working day** | **£606,830** |
| **Cost of delays per year (252 working days)** | **£152,921,133** |

# Sensitivity Testing Growth Factor -3%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2922 | 2162 | 346 | 35 | 4259 | 3152 | 504 | 50 | 391 | 410 | 995 | 1286 | 776 | 1456 | 304 | 444 | 42 | 61 |
| | 2 | 2490 | 3469 | 3122 | 2310 | 370 | 37 | 4385 | 3245 | 519 | 52 | 418 | 422 | 1063 | 1324 | 829 | 1499 | 325 | 457 | 44 | 62 |
| | 3 | 1996 | 3205 | 2503 | 1852 | 296 | 30 | 4051 | 2998 | 480 | 48 | 335 | 390 | 852 | 1223 | 665 | 1385 | 261 | 422 | 36 | 58 |
| | 4 | 2913 | 3705 | 3653 | 2703 | 432 | 43 | 4683 | 3466 | 554 | 55 | 489 | 451 | 1243 | 1414 | 970 | 1601 | 381 | 488 | 52 | 67 |
| | 5 | 3020 | 3698 | 3786 | 2802 | 448 | 45 | 4675 | 3459 | 553 | 55 | 507 | 450 | 1289 | 1411 | 1006 | 1598 | 395 | 487 | 54 | 66 |
| | 6 | 3065 | 4137 | 3843 | 2844 | 455 | 46 | 5229 | 3870 | 619 | 62 | 515 | 503 | 1308 | 1579 | 1021 | 1788 | 400 | 545 | 55 | 74 |
| | 7 | 3286 | 3886 | 4121 | 3050 | 488 | 49 | 4912 | 3635 | 582 | 58 | 552 | 472 | 1403 | 1483 | 1095 | 1679 | 429 | 512 | 59 | 70 |
| | 8 | 4157 | 4642 | 5213 | 3858 | 617 | 62 | 5868 | 4342 | 695 | 69 | 698 | 564 | 1775 | 1772 | 1385 | 2006 | 543 | 611 | 74 | 83 |
| | 10 | 2253 | 2343 | 2825 | 2090 | 334 | 33 | 2962 | 2192 | 351 | 35 | 378 | 285 | 962 | 894 | 750 | 1012 | 294 | 309 | 40 | 42 |
| SB | 1 | 2889 | 2145 | 3622 | 2680 | 429 | 43 | 2711 | 2006 | 321 | 32 | 485 | 261 | 1233 | 818 | 962 | 927 | 377 | 282 | 51 | 39 |
| | 2 | 3063 | 2379 | 3842 | 2843 | 455 | 45 | 3007 | 2225 | 356 | 36 | 515 | 289 | 1308 | 908 | 1021 | 1028 | 400 | 313 | 55 | 43 |
| | 3 | 2879 | 2018 | 3611 | 2672 | 428 | 43 | 2550 | 1887 | 302 | 30 | 484 | 245 | 1229 | 770 | 959 | 872 | 376 | 266 | 51 | 36 |
| | 4 | 2879 | 2018 | 3611 | 2672 | 428 | 43 | 2550 | 1887 | 302 | 30 | 484 | 245 | 1229 | 770 | 959 | 872 | 376 | 266 | 51 | 36 |
| | 5 | 3420 | 3282 | 4289 | 3174 | 508 | 51 | 4149 | 3070 | 491 | 49 | 574 | 399 | 1460 | 1253 | 1139 | 1418 | 447 | 432 | 61 | 59 |
| | 6 | 3379 | 2690 | 4237 | 3136 | 502 | 50 | 3400 | 2516 | 403 | 40 | 568 | 327 | 1442 | 1027 | 1126 | 1162 | 441 | 354 | 60 | 48 |
| | 7 | 3677 | 3265 | 4612 | 3413 | 546 | 55 | 4127 | 3054 | 489 | 49 | 618 | 397 | 1570 | 1246 | 1225 | 1411 | 480 | 430 | 66 | 59 |
| | 8 | 3982 | 3911 | 4993 | 3695 | 591 | 59 | 4944 | 3659 | 585 | 59 | 669 | 476 | 1700 | 1493 | 1327 | 1690 | 520 | 515 | 71 | 70 |
| | 10 | 2322 | 2289 | 2912 | 2155 | 345 | 34 | 2893 | 2141 | 343 | 34 | 390 | 278 | 991 | 874 | 774 | 989 | 303 | 301 | 41 | 41 |

# Sensitivity Testing Growth Factor -3% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 372 | 7505 | 234 | 5939 | 235 | 9445 | 134 | 3916 | 11 | 334 | 15 | 437 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 255 | 8791 | 161 | 6956 | 161 | 11063 | 92 | 4587 | 8 | 392 | 10 | 512 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 133 | 7068 | 84 | 5593 | 84 | 8895 | 48 | 3688 | 4 | 315 | 5 | 411 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2801 | 2480 | 1766 | 1962 | 1770 | 3121 | 1009 | 1294 | 86 | 110 | 113 | 144 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6324 | 5391 | 3987 | 4266 | 3997 | 6785 | 2278 | 2813 | 195 | 240 | 254 | 314 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 32017 | 30080 | 20186 | 23803 | 20236 | 37856 | 11534 | 15694 | 985 | 1340 | 1287 | 1751 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 133 | 258 | 84 | 204 | 84 | 324 | 48 | 134 | 4 | 11 | 5 | 15 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3735 | 2903 | 2355 | 2297 | 2361 | 3653 | 1346 | 1515 | 115 | 129 | 150 | 169 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2341 | 1497 | 1476 | 1185 | 1479 | 1884 | 843 | 781 | 72 | 67 | 94 | 87 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 9232 | 419 | 5820 | 331 | 5835 | 527 | 3326 | 218 | 284 | 19 | 371 | 24 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 11170 | 108 | 7042 | 86 | 7060 | 136 | 4024 | 57 | 344 | 5 | 449 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 9115 | 83 | 5747 | 66 | 5761 | 105 | 3284 | 43 | 280 | 4 | 366 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2769 | 106 | 1746 | 84 | 1750 | 134 | 997 | 56 | 85 | 5 | 111 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 7168 | 4788 | 4519 | 3789 | 4531 | 6025 | 2582 | 2498 | 220 | 213 | 288 | 279 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 35290 | 385 | 22250 | 304 | 22305 | 484 | 12713 | 201 | 1085 | 17 | 1419 | 22 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 250 | 115 | 157 | 91 | 158 | 144 | 90 | 60 | 8 | 5 | 10 | 7 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 311 | 294 | 196 | 232 | 196 | 370 | 112 | 153 | 10 | 13 | 12 | 17 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1086 | 308 | 685 | 244 | 687 | 388 | 391 | 161 | 33 | 14 | 44 | 18 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 372 | 7505 | 234 | 5939 | 235 | 9445 | 134 | 3916 | 11 | 334 | 15 | 437 |

| | |
|---|---|
| **Cost of delays per working day** | **£602,046** |
| **Cost of delays per year (252 working days)** | **£151,715,520** |

# Sensitivity Testing Growth Factor -4% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2899 | 2145 | 343 | 34 | 4226 | 3127 | 500 | 50 | 388 | 407 | 987 | 1276 | 770 | 1445 | 302 | 440 | 41 | 60 |
| | 2 | 2490 | 3469 | 3097 | 2292 | 367 | 37 | 4350 | 3219 | 515 | 52 | 415 | 419 | 1054 | 1313 | 823 | 1487 | 323 | 453 | 44 | 62 |
| | 3 | 1996 | 3205 | 2483 | 1837 | 294 | 29 | 4019 | 2974 | 476 | 48 | 333 | 387 | 845 | 1213 | 660 | 1374 | 259 | 419 | 35 | 57 |
| | 4 | 2913 | 3705 | 3623 | 2681 | 429 | 43 | 4646 | 3438 | 550 | 55 | 485 | 447 | 1233 | 1403 | 963 | 1588 | 378 | 484 | 51 | 66 |
| | 5 | 3020 | 3698 | 3756 | 2780 | 445 | 44 | 4638 | 3432 | 549 | 55 | 503 | 446 | 1279 | 1400 | 998 | 1586 | 391 | 483 | 53 | 66 |
| | 6 | 3065 | 4137 | 3813 | 2821 | 451 | 45 | 5188 | 3839 | 614 | 61 | 511 | 499 | 1298 | 1566 | 1013 | 1774 | 397 | 541 | 54 | 74 |
| | 7 | 3286 | 3886 | 4088 | 3025 | 484 | 48 | 4873 | 3606 | 577 | 58 | 548 | 469 | 1392 | 1471 | 1086 | 1666 | 426 | 508 | 58 | 69 |
| | 8 | 4157 | 4642 | 5172 | 3827 | 612 | 61 | 5821 | 4308 | 689 | 69 | 693 | 560 | 1760 | 1758 | 1374 | 1990 | 539 | 607 | 73 | 83 |
| | 10 | 2253 | 2343 | 2802 | 2074 | 332 | 33 | 2938 | 2174 | 348 | 35 | 375 | 283 | 954 | 887 | 744 | 1004 | 292 | 306 | 40 | 42 |
| SB | 1 | 2889 | 2145 | 3593 | 2659 | 425 | 43 | 2689 | 1990 | 318 | 32 | 481 | 259 | 1223 | 812 | 955 | 919 | 374 | 280 | 51 | 38 |
| | 2 | 3063 | 2379 | 3811 | 2820 | 451 | 45 | 2983 | 2208 | 353 | 35 | 510 | 287 | 1297 | 901 | 1012 | 1020 | 397 | 311 | 54 | 42 |
| | 3 | 2879 | 2018 | 3582 | 2651 | 424 | 42 | 2530 | 1872 | 300 | 30 | 480 | 243 | 1219 | 764 | 952 | 865 | 373 | 264 | 51 | 36 |
| | 4 | 2879 | 2018 | 3582 | 2651 | 424 | 42 | 2530 | 1872 | 300 | 30 | 480 | 243 | 1219 | 764 | 952 | 865 | 373 | 264 | 51 | 36 |
| | 5 | 3420 | 3282 | 4255 | 3148 | 504 | 50 | 4116 | 3046 | 487 | 49 | 570 | 396 | 1448 | 1243 | 1130 | 1407 | 443 | 429 | 60 | 58 |
| | 6 | 3379 | 2690 | 4204 | 3111 | 498 | 50 | 3373 | 2496 | 399 | 40 | 563 | 325 | 1431 | 1018 | 1117 | 1153 | 438 | 351 | 60 | 48 |
| | 7 | 3677 | 3265 | 4575 | 3385 | 542 | 54 | 4094 | 3030 | 485 | 48 | 613 | 394 | 1557 | 1236 | 1215 | 1400 | 477 | 427 | 65 | 58 |
| | 8 | 3982 | 3911 | 4953 | 3666 | 586 | 59 | 4905 | 3630 | 581 | 58 | 663 | 472 | 1686 | 1481 | 1316 | 1677 | 516 | 511 | 70 | 70 |
| | 10 | 2322 | 2289 | 2889 | 2138 | 342 | 34 | 2871 | 2124 | 340 | 34 | 387 | 276 | 983 | 867 | 767 | 981 | 301 | 299 | 41 | 41 |

# Sensitivity Testing Growth Factor -4%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 369 | 7446 | 232 | 5892 | 233 | 9371 | 133 | 3885 | 11 | 332 | 15 | 433 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 253 | 8721 | 159 | 6901 | 160 | 10976 | 91 | 4550 | 8 | 388 | 10 | 508 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 132 | 7012 | 83 | 5549 | 84 | 8825 | 48 | 3658 | 4 | 312 | 5 | 408 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2779 | 2460 | 1752 | 1947 | 1756 | 3096 | 1001 | 1283 | 85 | 110 | 112 | 143 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6274 | 5349 | 3956 | 4233 | 3965 | 6731 | 2260 | 2791 | 193 | 238 | 252 | 311 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 31761 | 29842 | 20025 | 23615 | 20074 | 37557 | 11442 | 15570 | 977 | 1329 | 1277 | 1737 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 132 | 256 | 83 | 202 | 83 | 322 | 48 | 133 | 4 | 11 | 5 | 15 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3705 | 2880 | 2336 | 2279 | 2342 | 3624 | 1335 | 1503 | 114 | 128 | 149 | 168 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2322 | 1485 | 1464 | 1175 | 1468 | 1869 | 837 | 775 | 71 | 66 | 93 | 86 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 9158 | 415 | 5774 | 329 | 5788 | 523 | 3299 | 217 | 282 | 18 | 368 | 24 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 11081 | 107 | 6986 | 85 | 7003 | 135 | 3992 | 56 | 341 | 5 | 445 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 9042 | 83 | 5701 | 65 | 5715 | 104 | 3258 | 43 | 278 | 4 | 363 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2747 | 106 | 1732 | 84 | 1736 | 133 | 989 | 55 | 84 | 5 | 110 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 7111 | 4750 | 4483 | 3759 | 4494 | 5978 | 2562 | 2478 | 219 | 212 | 286 | 277 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 35009 | 382 | 22072 | 302 | 22127 | 480 | 12612 | 199 | 1077 | 17 | 1407 | 22 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 248 | 114 | 156 | 90 | 157 | 143 | 89 | 59 | 8 | 5 | 10 | 7 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 308 | 291 | 194 | 231 | 195 | 367 | 111 | 152 | 9 | 13 | 12 | 17 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1078 | 306 | 679 | 242 | 681 | 384 | 388 | 159 | 33 | 14 | 43 | 18 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 369 | 7446 | 232 | 5892 | 233 | 9371 | 133 | 3885 | 11 | 332 | 15 | 433 |

| | |
|---|---|
| **Cost of delays per working day** | **£597,262** |
| **Cost of delays per year (252 working days)** | **£150,509,907** |

# Sensitivity Testing Growth Factor -5%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2876 | 2128 | 340 | 34 | 4192 | 3102 | 496 | 50 | 385 | 403 | 979 | 1266 | 764 | 1433 | 300 | 437 | 41 | 60 |
| | 2 | 2490 | 3469 | 3072 | 2273 | 364 | 36 | 4316 | 3194 | 511 | 51 | 412 | 415 | 1046 | 1303 | 816 | 1475 | 320 | 450 | 44 | 61 |
| | 3 | 1996 | 3205 | 2463 | 1822 | 292 | 29 | 3987 | 2950 | 472 | 47 | 330 | 384 | 838 | 1204 | 654 | 1363 | 257 | 415 | 35 | 57 |
| | 4 | 2913 | 3705 | 3594 | 2660 | 426 | 43 | 4609 | 3411 | 546 | 55 | 481 | 443 | 1224 | 1392 | 955 | 1576 | 374 | 480 | 51 | 65 |
| | 5 | 3020 | 3698 | 3726 | 2757 | 441 | 44 | 4601 | 3405 | 545 | 54 | 499 | 443 | 1268 | 1389 | 990 | 1573 | 388 | 479 | 53 | 65 |
| | 6 | 3065 | 4137 | 3782 | 2799 | 448 | 45 | 5147 | 3809 | 609 | 61 | 507 | 495 | 1287 | 1554 | 1005 | 1760 | 394 | 536 | 54 | 73 |
| | 7 | 3286 | 3886 | 4055 | 3001 | 480 | 48 | 4834 | 3577 | 572 | 57 | 543 | 465 | 1380 | 1459 | 1077 | 1653 | 423 | 504 | 58 | 69 |
| | 8 | 4157 | 4642 | 5130 | 3796 | 607 | 61 | 5775 | 4273 | 684 | 68 | 687 | 556 | 1746 | 1744 | 1363 | 1974 | 535 | 602 | 73 | 82 |
| | 10 | 2253 | 2343 | 2780 | 2057 | 329 | 33 | 2915 | 2157 | 345 | 35 | 372 | 280 | 946 | 880 | 738 | 996 | 290 | 304 | 39 | 41 |
| SB | 1 | 2889 | 2145 | 3564 | 2638 | 422 | 42 | 2668 | 1974 | 316 | 32 | 477 | 257 | 1213 | 805 | 947 | 912 | 371 | 278 | 51 | 38 |
| | 2 | 3063 | 2379 | 3780 | 2797 | 448 | 45 | 2960 | 2190 | 350 | 35 | 506 | 285 | 1287 | 894 | 1004 | 1012 | 394 | 308 | 54 | 42 |
| | 3 | 2879 | 2018 | 3553 | 2629 | 421 | 42 | 2510 | 1857 | 297 | 30 | 476 | 241 | 1209 | 758 | 944 | 858 | 370 | 262 | 50 | 36 |
| | 4 | 2879 | 2018 | 3553 | 2629 | 421 | 42 | 2510 | 1857 | 297 | 30 | 476 | 241 | 1209 | 758 | 944 | 858 | 370 | 262 | 50 | 36 |
| | 5 | 3420 | 3282 | 4220 | 3123 | 500 | 50 | 4083 | 3021 | 483 | 48 | 565 | 393 | 1437 | 1233 | 1121 | 1396 | 440 | 425 | 60 | 58 |
| | 6 | 3379 | 2690 | 4170 | 3086 | 494 | 49 | 3346 | 2476 | 396 | 40 | 558 | 322 | 1419 | 1010 | 1108 | 1144 | 434 | 349 | 59 | 48 |
| | 7 | 3677 | 3265 | 4538 | 3358 | 537 | 54 | 4062 | 3006 | 481 | 48 | 608 | 391 | 1545 | 1226 | 1206 | 1389 | 473 | 423 | 64 | 58 |
| | 8 | 3982 | 3911 | 4914 | 3636 | 582 | 58 | 4866 | 3601 | 576 | 58 | 658 | 468 | 1673 | 1469 | 1305 | 1664 | 512 | 507 | 70 | 69 |
| | 10 | 2322 | 2289 | 2866 | 2121 | 339 | 34 | 2848 | 2107 | 337 | 34 | 384 | 274 | 975 | 860 | 761 | 974 | 299 | 297 | 41 | 40 |

# Sensitivity Testing Growth Factor -5% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 366 | 7386 | 231 | 5845 | 231 | 9296 | 132 | 3854 | 11 | 329 | 15 | 430 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 251 | 8652 | 158 | 6846 | 158 | 10888 | 90 | 4514 | 8 | 385 | 10 | 504 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 131 | 6956 | 83 | 5505 | 83 | 8754 | 47 | 3629 | 4 | 310 | 5 | 405 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2756 | 2440 | 1738 | 1931 | 1742 | 3071 | 993 | 1273 | 85 | 109 | 111 | 142 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6224 | 5306 | 3924 | 4199 | 3934 | 6678 | 2242 | 2768 | 191 | 236 | 250 | 309 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 31506 | 29604 | 19864 | 23427 | 19913 | 37257 | 11350 | 15446 | 969 | 1319 | 1266 | 1723 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 131 | 254 | 83 | 201 | 83 | 319 | 47 | 132 | 4 | 11 | 5 | 15 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3676 | 2857 | 2317 | 2261 | 2323 | 3596 | 1324 | 1491 | 113 | 127 | 148 | 166 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2303 | 1473 | 1452 | 1166 | 1456 | 1854 | 830 | 769 | 71 | 66 | 93 | 86 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 9084 | 412 | 5727 | 326 | 5742 | 518 | 3273 | 215 | 279 | 18 | 365 | 24 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10992 | 107 | 6930 | 84 | 6947 | 134 | 3960 | 56 | 338 | 5 | 442 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8970 | 82 | 5655 | 65 | 5669 | 103 | 3231 | 43 | 276 | 4 | 361 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2725 | 105 | 1718 | 83 | 1722 | 132 | 982 | 55 | 84 | 5 | 110 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 7054 | 4712 | 4447 | 3729 | 4458 | 5930 | 2541 | 2458 | 217 | 210 | 284 | 274 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 34727 | 379 | 21895 | 300 | 21949 | 476 | 12511 | 198 | 1068 | 17 | 1396 | 22 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 246 | 113 | 155 | 89 | 155 | 142 | 89 | 59 | 8 | 5 | 10 | 7 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 306 | 289 | 193 | 229 | 193 | 364 | 110 | 151 | 9 | 13 | 12 | 17 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1069 | 303 | 674 | 240 | 676 | 381 | 385 | 158 | 33 | 13 | 43 | 18 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 366 | 7386 | 231 | 5845 | 231 | 9296 | 132 | 3854 | 11 | 329 | 15 | 430 |

| | |
|---|---|
| **Cost of delays per working day** | **£592,477** |
| **Cost of delays per year (252 working days)** | **£149,304,294** |

# Sensitivity Testing Growth Factor -6% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2852 | 2111 | 338 | 34 | 4158 | 3077 | 492 | 49 | 382 | 400 | 971 | 1256 | 758 | 1422 | 297 | 433 | 41 | 59 |
| | 2 | 2490 | 3469 | 3047 | 2255 | 361 | 36 | 4281 | 3168 | 507 | 51 | 408 | 412 | 1037 | 1293 | 810 | 1464 | 318 | 446 | 43 | 61 |
| | 3 | 1996 | 3205 | 2443 | 1808 | 289 | 29 | 3955 | 2927 | 468 | 47 | 327 | 380 | 832 | 1194 | 649 | 1352 | 255 | 412 | 35 | 56 |
| | 4 | 2913 | 3705 | 3565 | 2638 | 422 | 42 | 4572 | 3383 | 541 | 54 | 478 | 440 | 1214 | 1380 | 947 | 1563 | 371 | 476 | 51 | 65 |
| | 5 | 3020 | 3698 | 3696 | 2735 | 438 | 44 | 4564 | 3377 | 540 | 54 | 495 | 439 | 1258 | 1378 | 982 | 1560 | 385 | 476 | 53 | 65 |
| | 6 | 3065 | 4137 | 3751 | 2776 | 444 | 44 | 5105 | 3778 | 604 | 60 | 502 | 491 | 1277 | 1541 | 997 | 1745 | 391 | 532 | 53 | 73 |
| | 7 | 3286 | 3886 | 4022 | 2977 | 476 | 48 | 4795 | 3548 | 568 | 57 | 539 | 461 | 1369 | 1448 | 1069 | 1639 | 419 | 500 | 57 | 68 |
| | 8 | 4157 | 4642 | 5088 | 3765 | 602 | 60 | 5728 | 4239 | 678 | 68 | 682 | 551 | 1732 | 1730 | 1352 | 1958 | 530 | 597 | 72 | 81 |
| | 10 | 2253 | 2343 | 2757 | 2040 | 326 | 33 | 2891 | 2139 | 342 | 34 | 369 | 278 | 939 | 873 | 732 | 988 | 287 | 301 | 39 | 41 |
| SB | 1 | 2889 | 2145 | 3536 | 2616 | 419 | 42 | 2646 | 1958 | 313 | 31 | 474 | 255 | 1204 | 799 | 939 | 905 | 368 | 276 | 50 | 38 |
| | 2 | 3063 | 2379 | 3750 | 2775 | 444 | 44 | 2936 | 2173 | 348 | 35 | 502 | 282 | 1276 | 886 | 996 | 1004 | 391 | 306 | 53 | 42 |
| | 3 | 2879 | 2018 | 3524 | 2608 | 417 | 42 | 2490 | 1843 | 295 | 29 | 472 | 240 | 1200 | 752 | 936 | 851 | 367 | 259 | 50 | 35 |
| | 4 | 2879 | 2018 | 3524 | 2608 | 417 | 42 | 2490 | 1843 | 295 | 29 | 472 | 240 | 1200 | 752 | 936 | 851 | 367 | 259 | 50 | 35 |
| | 5 | 3420 | 3282 | 4186 | 3098 | 496 | 50 | 4050 | 2997 | 480 | 48 | 561 | 390 | 1425 | 1223 | 1112 | 1385 | 436 | 422 | 59 | 58 |
| | 6 | 3379 | 2690 | 4136 | 3061 | 490 | 49 | 3319 | 2456 | 393 | 39 | 554 | 319 | 1408 | 1002 | 1099 | 1135 | 431 | 346 | 59 | 47 |
| | 7 | 3677 | 3265 | 4501 | 3331 | 533 | 53 | 4029 | 2981 | 477 | 48 | 603 | 388 | 1532 | 1216 | 1196 | 1377 | 469 | 420 | 64 | 57 |
| | 8 | 3982 | 3911 | 4874 | 3607 | 577 | 58 | 4827 | 3572 | 571 | 57 | 653 | 464 | 1659 | 1457 | 1295 | 1650 | 508 | 503 | 69 | 69 |
| | 10 | 2322 | 2289 | 2843 | 2103 | 337 | 34 | 2825 | 2090 | 334 | 33 | 381 | 272 | 968 | 853 | 755 | 966 | 296 | 294 | 40 | 40 |

# Sensitivity Testing Growth Factor -6%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 363 | 7327 | 229 | 5798 | 229 | 9221 | 131 | 3823 | 11 | 326 | 15 | 427 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 249 | 8582 | 157 | 6791 | 157 | 10801 | 90 | 4478 | 8 | 382 | 10 | 500 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 130 | 6900 | 82 | 5460 | 82 | 8684 | 47 | 3600 | 4 | 307 | 5 | 402 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2734 | 2421 | 1724 | 1916 | 1728 | 3047 | 985 | 1263 | 84 | 108 | 110 | 141 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6173 | 5263 | 3892 | 4165 | 3902 | 6624 | 2224 | 2746 | 190 | 234 | 248 | 306 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 31251 | 29366 | 19703 | 23238 | 19752 | 36958 | 11258 | 15322 | 961 | 1308 | 1256 | 1710 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 130 | 252 | 82 | 199 | 82 | 317 | 47 | 131 | 4 | 11 | 5 | 15 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3646 | 2834 | 2299 | 2243 | 2304 | 3567 | 1313 | 1479 | 112 | 126 | 147 | 165 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2285 | 1462 | 1441 | 1157 | 1444 | 1839 | 823 | 763 | 70 | 65 | 92 | 85 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 9011 | 409 | 5681 | 323 | 5695 | 514 | 3246 | 213 | 277 | 18 | 362 | 24 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10903 | 106 | 6874 | 84 | 6891 | 133 | 3928 | 55 | 335 | 5 | 438 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8897 | 81 | 5609 | 64 | 5623 | 102 | 3205 | 42 | 274 | 4 | 358 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2702 | 104 | 1704 | 82 | 1708 | 131 | 974 | 54 | 83 | 5 | 109 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6997 | 4674 | 4411 | 3699 | 4422 | 5882 | 2521 | 2439 | 215 | 208 | 281 | 272 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 34446 | 376 | 21717 | 297 | 21771 | 473 | 12409 | 196 | 1059 | 17 | 1385 | 22 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 244 | 112 | 154 | 88 | 154 | 141 | 88 | 58 | 7 | 5 | 10 | 7 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 303 | 287 | 191 | 227 | 192 | 361 | 109 | 150 | 9 | 13 | 12 | 17 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1060 | 301 | 668 | 238 | 670 | 378 | 382 | 157 | 33 | 13 | 43 | 18 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 363 | 7327 | 229 | 5798 | 229 | 9221 | 131 | 3823 | 11 | 326 | 15 | 427 |
| | | | | | | | Cost of delays per working day | | | | | | | | | | £587,693 | |
| | | | | | | | Cost of delays per year (252 working days) | | | | | | | | | | £148,098,681 | |

# Sensitivity Testing Growth Factor -7%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2829 | 2093 | 335 | 33 | 4125 | 3052 | 488 | 49 | 379 | 397 | 963 | 1245 | 752 | 1410 | 295 | 430 | 40 | 59 |
| | 2 | 2490 | 3469 | 3022 | 2237 | 358 | 36 | 4246 | 3142 | 503 | 50 | 405 | 409 | 1029 | 1282 | 803 | 1452 | 315 | 442 | 43 | 60 |
| | 3 | 1996 | 3205 | 2423 | 1793 | 287 | 29 | 3923 | 2903 | 464 | 46 | 325 | 377 | 825 | 1184 | 644 | 1341 | 252 | 409 | 34 | 56 |
| | 4 | 2913 | 3705 | 3536 | 2617 | 419 | 42 | 4535 | 3356 | 537 | 54 | 474 | 436 | 1204 | 1369 | 939 | 1550 | 368 | 473 | 50 | 64 |
| | 5 | 3020 | 3698 | 3666 | 2713 | 434 | 43 | 4527 | 3350 | 536 | 54 | 491 | 435 | 1248 | 1367 | 974 | 1548 | 382 | 472 | 52 | 64 |
| | 6 | 3065 | 4137 | 3721 | 2753 | 441 | 44 | 5064 | 3747 | 600 | 60 | 498 | 487 | 1267 | 1529 | 988 | 1731 | 388 | 528 | 53 | 72 |
| | 7 | 3286 | 3886 | 3990 | 2952 | 472 | 47 | 4756 | 3520 | 563 | 56 | 534 | 458 | 1358 | 1436 | 1060 | 1626 | 416 | 496 | 57 | 68 |
| | 8 | 4157 | 4642 | 5047 | 3735 | 598 | 60 | 5682 | 4205 | 673 | 67 | 676 | 547 | 1718 | 1716 | 1341 | 1943 | 526 | 592 | 72 | 81 |
| | 10 | 2253 | 2343 | 2735 | 2024 | 324 | 32 | 2868 | 2122 | 340 | 34 | 366 | 276 | 931 | 866 | 727 | 980 | 285 | 299 | 39 | 41 |
| SB | 1 | 2889 | 2145 | 3507 | 2595 | 415 | 42 | 2625 | 1942 | 311 | 31 | 470 | 253 | 1194 | 793 | 932 | 897 | 365 | 273 | 50 | 37 |
| | 2 | 3063 | 2379 | 3719 | 2752 | 440 | 44 | 2912 | 2155 | 345 | 34 | 498 | 280 | 1266 | 879 | 988 | 996 | 387 | 303 | 53 | 41 |
| | 3 | 2879 | 2018 | 3495 | 2587 | 414 | 41 | 2470 | 1828 | 292 | 29 | 468 | 238 | 1190 | 746 | 929 | 844 | 364 | 257 | 50 | 35 |
| | 4 | 2879 | 2018 | 3495 | 2587 | 414 | 41 | 2470 | 1828 | 292 | 29 | 468 | 238 | 1190 | 746 | 929 | 844 | 364 | 257 | 50 | 35 |
| | 5 | 3420 | 3282 | 4152 | 3072 | 492 | 49 | 4017 | 2973 | 476 | 48 | 556 | 386 | 1413 | 1213 | 1103 | 1373 | 433 | 419 | 59 | 57 |
| | 6 | 3379 | 2690 | 4102 | 3036 | 486 | 49 | 3292 | 2436 | 390 | 39 | 549 | 317 | 1396 | 994 | 1090 | 1126 | 427 | 343 | 58 | 47 |
| | 7 | 3677 | 3265 | 4464 | 3304 | 529 | 53 | 3996 | 2957 | 473 | 47 | 598 | 384 | 1520 | 1207 | 1186 | 1366 | 465 | 416 | 63 | 57 |
| | 8 | 3982 | 3911 | 4834 | 3577 | 572 | 57 | 4788 | 3543 | 567 | 57 | 647 | 461 | 1646 | 1445 | 1284 | 1637 | 504 | 499 | 69 | 68 |
| | 10 | 2322 | 2289 | 2819 | 2086 | 334 | 33 | 2802 | 2073 | 332 | 33 | 378 | 270 | 960 | 846 | 749 | 958 | 294 | 292 | 40 | 40 |

## Sensitivity Testing Growth Factor -7%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 360 | 7268 | 227 | 5751 | 227 | 9146 | 130 | 3792 | 11 | 324 | 14 | 423 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 247 | 8512 | 156 | 6736 | 156 | 10713 | 89 | 4441 | 8 | 379 | 10 | 496 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 129 | 6844 | 81 | 5416 | 82 | 8613 | 47 | 3571 | 4 | 305 | 5 | 398 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2712 | 2401 | 1710 | 1900 | 1714 | 3022 | 977 | 1253 | 83 | 107 | 109 | 140 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6123 | 5221 | 3860 | 4131 | 3870 | 6570 | 2206 | 2724 | 188 | 233 | 246 | 304 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 30995 | 29128 | 19542 | 23050 | 19590 | 36658 | 11166 | 15198 | 953 | 1297 | 1246 | 1696 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 129 | 250 | 81 | 197 | 81 | 314 | 46 | 130 | 4 | 11 | 5 | 15 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3616 | 2811 | 2280 | 2224 | 2285 | 3538 | 1303 | 1467 | 111 | 125 | 145 | 164 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2266 | 1450 | 1429 | 1147 | 1432 | 1824 | 816 | 756 | 70 | 65 | 91 | 84 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8937 | 405 | 5635 | 321 | 5649 | 510 | 3220 | 211 | 275 | 18 | 359 | 24 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10813 | 105 | 6818 | 83 | 6835 | 132 | 3896 | 55 | 333 | 5 | 435 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8824 | 81 | 5564 | 64 | 5577 | 101 | 3179 | 42 | 271 | 4 | 355 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2680 | 103 | 1690 | 82 | 1694 | 130 | 966 | 54 | 82 | 5 | 108 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6939 | 4636 | 4375 | 3669 | 4386 | 5835 | 2500 | 2419 | 213 | 207 | 279 | 270 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 34164 | 372 | 21540 | 295 | 21593 | 469 | 12308 | 194 | 1051 | 17 | 1373 | 22 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 242 | 111 | 152 | 88 | 153 | 140 | 87 | 58 | 7 | 5 | 10 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 301 | 284 | 190 | 225 | 190 | 358 | 108 | 148 | 9 | 13 | 12 | 17 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1052 | 298 | 663 | 236 | 665 | 375 | 379 | 156 | 32 | 13 | 42 | 17 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 360 | 7268 | 227 | 5751 | 227 | 9146 | 130 | 3792 | 11 | 324 | 14 | 423 |

| | |
|---|---|
| **Cost of delays per working day** | **£582,909** |
| **Cost of delays per year (252 working days)** | **£146,893,068** |

# Sensitivity Testing Growth Factor -8%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2806 | 2076 | 332 | 33 | 4091 | 3027 | 484 | 48 | 376 | 394 | 955 | 1235 | 745 | 1399 | 292 | 426 | 40 | 58 |
| | 2 | 2490 | 3469 | 2998 | 2218 | 355 | 35 | 4212 | 3117 | 499 | 50 | 401 | 405 | 1020 | 1272 | 796 | 1440 | 312 | 439 | 43 | 60 |
| | 3 | 1996 | 3205 | 2403 | 1778 | 285 | 28 | 3891 | 2879 | 461 | 46 | 322 | 374 | 818 | 1175 | 638 | 1330 | 250 | 405 | 34 | 55 |
| | 4 | 2913 | 3705 | 3507 | 2595 | 415 | 42 | 4498 | 3328 | 533 | 53 | 470 | 433 | 1194 | 1358 | 932 | 1538 | 365 | 469 | 50 | 64 |
| | 5 | 3020 | 3698 | 3635 | 2690 | 430 | 43 | 4490 | 3322 | 532 | 53 | 487 | 432 | 1238 | 1356 | 966 | 1535 | 379 | 468 | 52 | 64 |
| | 6 | 3065 | 4137 | 3690 | 2731 | 437 | 44 | 5023 | 3717 | 595 | 59 | 494 | 483 | 1256 | 1516 | 980 | 1717 | 384 | 523 | 52 | 71 |
| | 7 | 3286 | 3886 | 3957 | 2928 | 468 | 47 | 4717 | 3491 | 559 | 56 | 530 | 454 | 1347 | 1424 | 1051 | 1613 | 412 | 492 | 56 | 67 |
| | 8 | 4157 | 4642 | 5005 | 3704 | 593 | 59 | 5636 | 4170 | 667 | 67 | 670 | 542 | 1704 | 1702 | 1330 | 1927 | 522 | 587 | 71 | 80 |
| | 10 | 2253 | 2343 | 2712 | 2007 | 321 | 32 | 2844 | 2105 | 337 | 34 | 363 | 274 | 923 | 859 | 721 | 972 | 283 | 296 | 39 | 40 |
| SB | 1 | 2889 | 2145 | 3478 | 2574 | 412 | 41 | 2603 | 1927 | 308 | 31 | 466 | 250 | 1184 | 786 | 924 | 890 | 362 | 271 | 49 | 37 |
| | 2 | 3063 | 2379 | 3688 | 2729 | 437 | 44 | 2888 | 2137 | 342 | 34 | 494 | 278 | 1256 | 872 | 980 | 987 | 384 | 301 | 52 | 41 |
| | 3 | 2879 | 2018 | 3467 | 2565 | 410 | 41 | 2450 | 1813 | 290 | 29 | 464 | 236 | 1180 | 740 | 921 | 837 | 361 | 255 | 49 | 35 |
| | 4 | 2879 | 2018 | 3467 | 2565 | 410 | 41 | 2450 | 1813 | 290 | 29 | 464 | 236 | 1180 | 740 | 921 | 837 | 361 | 255 | 49 | 35 |
| | 5 | 3420 | 3282 | 4118 | 3047 | 488 | 49 | 3985 | 2949 | 472 | 47 | 552 | 383 | 1402 | 1203 | 1094 | 1362 | 429 | 415 | 59 | 57 |
| | 6 | 3379 | 2690 | 4068 | 3011 | 482 | 48 | 3266 | 2417 | 387 | 39 | 545 | 314 | 1385 | 986 | 1081 | 1116 | 424 | 340 | 58 | 46 |
| | 7 | 3677 | 3265 | 4428 | 3276 | 524 | 52 | 3964 | 2933 | 469 | 47 | 593 | 381 | 1507 | 1197 | 1176 | 1355 | 461 | 413 | 63 | 56 |
| | 8 | 3982 | 3911 | 4794 | 3548 | 568 | 57 | 4748 | 3514 | 562 | 56 | 642 | 457 | 1632 | 1434 | 1274 | 1623 | 500 | 495 | 68 | 67 |
| | 10 | 2322 | 2289 | 2796 | 2069 | 331 | 33 | 2779 | 2056 | 329 | 33 | 375 | 267 | 952 | 839 | 743 | 950 | 291 | 290 | 40 | 39 |

# Sensitivity Testing Growth Factor -8%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 357 | 7208 | 225 | 5704 | 225 | 9072 | 129 | 3761 | 11 | 321 | 14 | 420 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 245 | 8443 | 154 | 6681 | 155 | 10626 | 88 | 4405 | 8 | 376 | 10 | 492 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 128 | 6788 | 81 | 5372 | 81 | 8543 | 46 | 3542 | 4 | 302 | 5 | 395 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2689 | 2381 | 1695 | 1885 | 1700 | 2997 | 969 | 1243 | 83 | 106 | 108 | 139 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6072 | 5178 | 3828 | 4098 | 3838 | 6517 | 2188 | 2702 | 187 | 231 | 244 | 301 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 30740 | 28890 | 19381 | 22862 | 19429 | 36359 | 11074 | 15073 | 945 | 1287 | 1236 | 1682 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 128 | 248 | 81 | 196 | 81 | 312 | 46 | 129 | 4 | 11 | 5 | 14 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3586 | 2788 | 2261 | 2206 | 2267 | 3509 | 1292 | 1455 | 110 | 124 | 144 | 162 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2247 | 1438 | 1417 | 1138 | 1421 | 1810 | 810 | 750 | 69 | 64 | 90 | 84 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8863 | 402 | 5588 | 318 | 5602 | 506 | 3193 | 210 | 273 | 18 | 356 | 23 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10724 | 104 | 6761 | 82 | 6778 | 131 | 3864 | 54 | 330 | 5 | 431 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8752 | 80 | 5518 | 63 | 5531 | 101 | 3153 | 42 | 269 | 4 | 352 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2658 | 102 | 1676 | 81 | 1680 | 129 | 958 | 53 | 82 | 5 | 107 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6882 | 4598 | 4339 | 3639 | 4350 | 5787 | 2479 | 2399 | 212 | 205 | 277 | 268 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 33883 | 369 | 21362 | 292 | 21416 | 465 | 12207 | 193 | 1042 | 16 | 1362 | 22 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 240 | 110 | 151 | 87 | 152 | 138 | 86 | 57 | 7 | 5 | 10 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 298 | 282 | 188 | 223 | 188 | 355 | 107 | 147 | 9 | 13 | 12 | 16 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1043 | 296 | 658 | 234 | 659 | 372 | 376 | 154 | 32 | 13 | 42 | 17 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 357 | 7208 | 225 | 5704 | 225 | 9072 | 129 | 3761 | 11 | 321 | 14 | 420 |

| | |
|---|---|
| Cost of delays per working day | £578,125 |
| Cost of delays per year (252 working days) | £145,687,455 |

# Sensitivity Testing Growth Factor -9% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2782 | 2059 | 329 | 33 | 4057 | 3002 | 480 | 48 | 373 | 390 | 947 | 1225 | 739 | 1387 | 290 | 423 | 40 | 58 |
| | 2 | 2490 | 3469 | 2973 | 2200 | 352 | 35 | 4177 | 3091 | 495 | 49 | 398 | 402 | 1012 | 1261 | 790 | 1428 | 310 | 435 | 42 | 59 |
| | 3 | 1996 | 3205 | 2383 | 1763 | 282 | 28 | 3859 | 2856 | 457 | 46 | 319 | 371 | 811 | 1165 | 633 | 1319 | 248 | 402 | 34 | 55 |
| | 4 | 2913 | 3705 | 3478 | 2574 | 412 | 41 | 4461 | 3301 | 528 | 53 | 466 | 429 | 1184 | 1347 | 924 | 1525 | 362 | 465 | 49 | 63 |
| | 5 | 3020 | 3698 | 3605 | 2668 | 427 | 43 | 4453 | 3295 | 527 | 53 | 483 | 428 | 1227 | 1344 | 958 | 1522 | 376 | 464 | 51 | 63 |
| | 6 | 3065 | 4137 | 3659 | 2708 | 433 | 43 | 4981 | 3686 | 590 | 59 | 490 | 479 | 1246 | 1504 | 972 | 1703 | 381 | 519 | 52 | 71 |
| | 7 | 3286 | 3886 | 3924 | 2904 | 465 | 46 | 4678 | 3462 | 554 | 55 | 526 | 450 | 1336 | 1413 | 1042 | 1599 | 409 | 487 | 56 | 66 |
| | 8 | 4157 | 4642 | 4964 | 3673 | 588 | 59 | 5589 | 4136 | 662 | 66 | 665 | 538 | 1690 | 1687 | 1319 | 1911 | 517 | 582 | 71 | 79 |
| | 10 | 2253 | 2343 | 2690 | 1990 | 318 | 32 | 2821 | 2087 | 334 | 33 | 360 | 271 | 916 | 852 | 715 | 964 | 280 | 294 | 38 | 40 |
| SB | 1 | 2889 | 2145 | 3449 | 2552 | 408 | 41 | 2582 | 1911 | 306 | 31 | 462 | 248 | 1174 | 780 | 916 | 883 | 359 | 269 | 49 | 37 |
| | 2 | 3063 | 2379 | 3658 | 2707 | 433 | 43 | 2864 | 2120 | 339 | 34 | 490 | 276 | 1245 | 865 | 972 | 979 | 381 | 298 | 52 | 41 |
| | 3 | 2879 | 2018 | 3438 | 2544 | 407 | 41 | 2429 | 1798 | 288 | 29 | 460 | 234 | 1170 | 733 | 913 | 831 | 358 | 253 | 49 | 35 |
| | 4 | 2879 | 2018 | 3438 | 2544 | 407 | 41 | 2429 | 1798 | 288 | 29 | 460 | 234 | 1170 | 733 | 913 | 831 | 358 | 253 | 49 | 35 |
| | 5 | 3420 | 3282 | 4084 | 3022 | 483 | 48 | 3952 | 2924 | 468 | 47 | 547 | 380 | 1390 | 1193 | 1085 | 1351 | 425 | 412 | 58 | 56 |
| | 6 | 3379 | 2690 | 4035 | 2986 | 478 | 48 | 3239 | 2397 | 383 | 38 | 540 | 312 | 1373 | 978 | 1072 | 1107 | 420 | 337 | 57 | 46 |
| | 7 | 3677 | 3265 | 4391 | 3249 | 520 | 52 | 3931 | 2909 | 465 | 47 | 588 | 378 | 1495 | 1187 | 1166 | 1344 | 457 | 410 | 62 | 56 |
| | 8 | 3982 | 3911 | 4754 | 3518 | 563 | 56 | 4709 | 3485 | 558 | 56 | 637 | 453 | 1618 | 1422 | 1263 | 1610 | 495 | 491 | 68 | 67 |
| | 10 | 2322 | 2289 | 2773 | 2052 | 328 | 33 | 2756 | 2040 | 326 | 33 | 371 | 265 | 944 | 832 | 737 | 942 | 289 | 287 | 39 | 39 |

# Sensitivity Testing Growth Factor -9% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 354 | 7149 | 223 | 5657 | 224 | 8997 | 127 | 3730 | 11 | 318 | 14 | 416 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 243 | 8373 | 153 | 6626 | 153 | 10538 | 87 | 4369 | 7 | 373 | 10 | 487 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 127 | 6732 | 80 | 5328 | 80 | 8473 | 46 | 3513 | 4 | 300 | 5 | 392 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2667 | 2362 | 1681 | 1869 | 1686 | 2972 | 961 | 1232 | 82 | 105 | 107 | 137 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 6022 | 5135 | 3797 | 4064 | 3806 | 6463 | 2169 | 2679 | 185 | 229 | 242 | 299 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 30485 | 28652 | 19220 | 22674 | 19268 | 36059 | 10982 | 14949 | 938 | 1276 | 1225 | 1668 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 127 | 245 | 80 | 194 | 80 | 309 | 46 | 128 | 4 | 11 | 5 | 14 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3556 | 2765 | 2242 | 2188 | 2248 | 3480 | 1281 | 1443 | 109 | 123 | 143 | 161 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2229 | 1426 | 1405 | 1128 | 1409 | 1795 | 803 | 744 | 69 | 64 | 90 | 83 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8790 | 399 | 5542 | 316 | 5556 | 502 | 3167 | 208 | 270 | 18 | 353 | 23 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10635 | 103 | 6705 | 82 | 6722 | 130 | 3831 | 54 | 327 | 5 | 427 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8679 | 79 | 5472 | 63 | 5485 | 100 | 3127 | 41 | 267 | 4 | 349 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2636 | 101 | 1662 | 80 | 1666 | 128 | 950 | 53 | 81 | 5 | 106 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6825 | 4560 | 4303 | 3609 | 4314 | 5739 | 2459 | 2379 | 210 | 203 | 274 | 265 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 33602 | 366 | 21185 | 290 | 21238 | 461 | 12105 | 191 | 1033 | 16 | 1351 | 21 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 238 | 109 | 150 | 86 | 150 | 137 | 86 | 57 | 7 | 5 | 10 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 296 | 280 | 186 | 221 | 187 | 352 | 107 | 146 | 9 | 12 | 12 | 16 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1034 | 293 | 652 | 232 | 654 | 369 | 373 | 153 | 32 | 13 | 42 | 17 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 354 | 7149 | 223 | 5657 | 224 | 8997 | 127 | 3730 | 11 | 318 | 14 | 416 |
| | | | | | | | Cost of delays per working day | | | | | | | | | | £573,341 | |
| | | | | | | | Cost of delays per year (252 working days) | | | | | | | | | | £144,481,843 | |

# Sensitivity Testing Growth Factor -10%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2759 | 2042 | 327 | 33 | 4024 | 2977 | 476 | 48 | 370 | 387 | 939 | 1215 | 733 | 1376 | 287 | 419 | 39 | 57 |
| | 2 | 2490 | 3469 | 2948 | 2181 | 349 | 35 | 4142 | 3065 | 490 | 49 | 395 | 398 | 1003 | 1251 | 783 | 1416 | 307 | 432 | 42 | 59 |
| | 3 | 1996 | 3205 | 2363 | 1749 | 280 | 28 | 3827 | 2832 | 453 | 45 | 317 | 368 | 804 | 1155 | 628 | 1308 | 246 | 399 | 34 | 54 |
| | 4 | 2913 | 3705 | 3449 | 2552 | 408 | 41 | 4424 | 3274 | 524 | 52 | 462 | 426 | 1174 | 1336 | 916 | 1512 | 359 | 461 | 49 | 63 |
| | 5 | 3020 | 3698 | 3575 | 2646 | 423 | 42 | 4416 | 3268 | 523 | 52 | 479 | 425 | 1217 | 1333 | 950 | 1510 | 372 | 460 | 51 | 63 |
| | 6 | 3065 | 4137 | 3629 | 2685 | 430 | 43 | 4940 | 3655 | 585 | 58 | 486 | 475 | 1235 | 1491 | 964 | 1689 | 378 | 515 | 52 | 70 |
| | 7 | 3286 | 3886 | 3891 | 2879 | 461 | 46 | 4640 | 3433 | 549 | 55 | 521 | 446 | 1325 | 1401 | 1034 | 1586 | 405 | 483 | 55 | 66 |
| | 8 | 4157 | 4642 | 4922 | 3642 | 583 | 58 | 5543 | 4102 | 656 | 66 | 659 | 533 | 1676 | 1673 | 1308 | 1895 | 513 | 578 | 70 | 79 |
| | 10 | 2253 | 2343 | 2667 | 1974 | 316 | 32 | 2797 | 2070 | 331 | 33 | 357 | 269 | 908 | 845 | 709 | 956 | 278 | 291 | 38 | 40 |
| SB | 1 | 2889 | 2145 | 3420 | 2531 | 405 | 40 | 2561 | 1895 | 303 | 30 | 458 | 246 | 1164 | 773 | 909 | 875 | 356 | 267 | 49 | 36 |
| | 2 | 3063 | 2379 | 3627 | 2684 | 429 | 43 | 2841 | 2102 | 336 | 34 | 486 | 273 | 1235 | 858 | 964 | 971 | 378 | 296 | 52 | 40 |
| | 3 | 2879 | 2018 | 3409 | 2523 | 404 | 40 | 2409 | 1783 | 285 | 29 | 457 | 232 | 1160 | 727 | 906 | 824 | 355 | 251 | 48 | 34 |
| | 4 | 2879 | 2018 | 3409 | 2523 | 404 | 40 | 2409 | 1783 | 285 | 29 | 457 | 232 | 1160 | 727 | 906 | 824 | 355 | 251 | 48 | 34 |
| | 5 | 3420 | 3282 | 4049 | 2997 | 479 | 48 | 3919 | 2900 | 464 | 46 | 542 | 377 | 1378 | 1183 | 1076 | 1340 | 422 | 408 | 58 | 56 |
| | 6 | 3379 | 2690 | 4001 | 2961 | 474 | 47 | 3212 | 2377 | 380 | 38 | 536 | 309 | 1362 | 970 | 1063 | 1098 | 417 | 335 | 57 | 46 |
| | 7 | 3677 | 3265 | 4354 | 3222 | 516 | 52 | 3898 | 2885 | 462 | 46 | 583 | 375 | 1482 | 1177 | 1157 | 1333 | 454 | 406 | 62 | 55 |
| | 8 | 3982 | 3911 | 4715 | 3489 | 558 | 56 | 4670 | 3456 | 553 | 55 | 631 | 449 | 1605 | 1410 | 1252 | 1597 | 491 | 487 | 67 | 66 |
| | 10 | 2322 | 2289 | 2750 | 2035 | 326 | 33 | 2733 | 2023 | 324 | 32 | 368 | 263 | 936 | 825 | 730 | 934 | 286 | 285 | 39 | 39 |

# Sensitivity Testing Growth Factor -10%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 351 | 7089 | 221 | 5610 | 222 | 8922 | 126 | 3699 | 11 | 316 | 14 | 413 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 241 | 8304 | 152 | 6571 | 152 | 10451 | 87 | 4333 | 7 | 370 | 10 | 483 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 126 | 6676 | 79 | 5283 | 80 | 8402 | 45 | 3483 | 4 | 297 | 5 | 389 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2645 | 2342 | 1667 | 1854 | 1671 | 2948 | 953 | 1222 | 81 | 104 | 106 | 136 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5971 | 5093 | 3765 | 4030 | 3774 | 6409 | 2151 | 2657 | 184 | 227 | 240 | 296 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 30229 | 28414 | 19059 | 22485 | 19106 | 35760 | 10890 | 14825 | 930 | 1266 | 1215 | 1654 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 126 | 243 | 79 | 193 | 79 | 306 | 45 | 127 | 4 | 11 | 5 | 14 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3527 | 2742 | 2223 | 2170 | 2229 | 3451 | 1271 | 1431 | 108 | 122 | 142 | 160 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2210 | 1414 | 1393 | 1119 | 1397 | 1780 | 796 | 738 | 68 | 63 | 89 | 82 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8716 | 395 | 5495 | 313 | 5509 | 498 | 3140 | 206 | 268 | 18 | 350 | 23 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10546 | 102 | 6649 | 81 | 6666 | 129 | 3799 | 53 | 324 | 5 | 424 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8606 | 79 | 5426 | 62 | 5440 | 99 | 3100 | 41 | 265 | 4 | 346 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2614 | 101 | 1648 | 80 | 1652 | 127 | 942 | 52 | 80 | 4 | 105 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6768 | 4523 | 4267 | 3579 | 4278 | 5692 | 2438 | 2360 | 208 | 201 | 272 | 263 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 33320 | 363 | 21008 | 288 | 21060 | 457 | 12004 | 190 | 1025 | 16 | 1339 | 21 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 236 | 108 | 149 | 86 | 149 | 136 | 85 | 56 | 7 | 5 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 293 | 277 | 185 | 220 | 185 | 349 | 106 | 145 | 9 | 12 | 12 | 16 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1026 | 291 | 647 | 230 | 648 | 366 | 369 | 152 | 32 | 13 | 41 | 17 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 351 | 7089 | 221 | 5610 | 222 | 8922 | 126 | 3699 | 11 | 316 | 14 | 413 |

| | |
|---|---|
| **Cost of delays per working day** | **£568,556** |
| **Cost of delays per year (252 working days)** | **£143,276,230** |

# Sensitivity Testing Growth Factor -11% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2736 | 2025 | 324 | 32 | 3990 | 2953 | 472 | 47 | 366 | 384 | 931 | 1205 | 727 | 1364 | 285 | 416 | 39 | 57 |
| | 2 | 2490 | 3469 | 2923 | 2163 | 346 | 35 | 4108 | 3040 | 486 | 49 | 391 | 395 | 995 | 1240 | 776 | 1404 | 305 | 428 | 42 | 58 |
| | 3 | 1996 | 3205 | 2343 | 1734 | 277 | 28 | 3795 | 2808 | 449 | 45 | 314 | 365 | 798 | 1146 | 622 | 1297 | 244 | 395 | 33 | 54 |
| | 4 | 2913 | 3705 | 3420 | 2530 | 405 | 40 | 4387 | 3246 | 519 | 52 | 458 | 422 | 1164 | 1324 | 908 | 1500 | 356 | 457 | 49 | 62 |
| | 5 | 3020 | 3698 | 3545 | 2623 | 420 | 42 | 4379 | 3240 | 518 | 52 | 475 | 421 | 1207 | 1322 | 942 | 1497 | 369 | 456 | 50 | 62 |
| | 6 | 3065 | 4137 | 3598 | 2663 | 426 | 43 | 4898 | 3625 | 580 | 58 | 482 | 471 | 1225 | 1479 | 956 | 1675 | 375 | 510 | 51 | 70 |
| | 7 | 3286 | 3886 | 3858 | 2855 | 457 | 46 | 4601 | 3405 | 545 | 54 | 517 | 443 | 1313 | 1389 | 1025 | 1573 | 402 | 479 | 55 | 65 |
| | 8 | 4157 | 4642 | 4881 | 3612 | 578 | 58 | 5496 | 4067 | 651 | 65 | 654 | 529 | 1661 | 1659 | 1297 | 1879 | 509 | 573 | 69 | 78 |
| | 10 | 2253 | 2343 | 2645 | 1957 | 313 | 31 | 2774 | 2053 | 328 | 33 | 354 | 267 | 900 | 838 | 703 | 948 | 276 | 289 | 38 | 39 |
| SB | 1 | 2889 | 2145 | 3391 | 2509 | 402 | 40 | 2539 | 1879 | 301 | 30 | 454 | 244 | 1154 | 767 | 901 | 868 | 353 | 265 | 48 | 36 |
| | 2 | 3063 | 2379 | 3596 | 2661 | 426 | 43 | 2817 | 2085 | 334 | 33 | 482 | 271 | 1224 | 850 | 955 | 963 | 375 | 293 | 51 | 40 |
| | 3 | 2879 | 2018 | 3380 | 2501 | 400 | 40 | 2389 | 1768 | 283 | 28 | 453 | 230 | 1151 | 721 | 898 | 817 | 352 | 249 | 48 | 34 |
| | 4 | 2879 | 2018 | 3380 | 2501 | 400 | 40 | 2389 | 1768 | 283 | 28 | 453 | 230 | 1151 | 721 | 898 | 817 | 352 | 249 | 48 | 34 |
| | 5 | 3420 | 3282 | 4015 | 2971 | 475 | 48 | 3886 | 2876 | 460 | 46 | 538 | 374 | 1367 | 1173 | 1067 | 1329 | 418 | 405 | 57 | 55 |
| | 6 | 3379 | 2690 | 3967 | 2936 | 470 | 47 | 3185 | 2357 | 377 | 38 | 531 | 306 | 1350 | 962 | 1054 | 1089 | 413 | 332 | 56 | 45 |
| | 7 | 3677 | 3265 | 4317 | 3195 | 511 | 51 | 3866 | 2861 | 458 | 46 | 578 | 372 | 1470 | 1167 | 1147 | 1322 | 450 | 403 | 61 | 55 |
| | 8 | 3982 | 3911 | 4675 | 3459 | 553 | 55 | 4631 | 3427 | 548 | 55 | 626 | 446 | 1591 | 1398 | 1242 | 1583 | 487 | 483 | 66 | 66 |
| | 10 | 2322 | 2289 | 2726 | 2018 | 323 | 32 | 2710 | 2006 | 321 | 32 | 365 | 261 | 928 | 818 | 724 | 927 | 284 | 282 | 39 | 39 |

# Sensitivity Testing Growth Factor -11% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 348 | 7030 | 219 | 5563 | 220 | 8848 | 125 | 3668 | 11 | 313 | 14 | 409 | 348 | 7030 | 219 | 5563 | 220 |
| | 2 | 239 | 8234 | 150 | 6516 | 151 | 10363 | 86 | 4296 | 7 | 367 | 10 | 479 | 239 | 8234 | 150 | 6516 | 151 |
| | 3 | 125 | 6620 | 79 | 5239 | 79 | 8332 | 45 | 3454 | 4 | 295 | 5 | 385 | 125 | 6620 | 79 | 5239 | 79 |
| | 4 | 2622 | 2323 | 1653 | 1838 | 1657 | 2923 | 945 | 1212 | 81 | 103 | 105 | 135 | 2622 | 2323 | 1653 | 1838 | 1657 |
| | 5 | 5921 | 5050 | 3733 | 3996 | 3742 | 6356 | 2133 | 2635 | 182 | 225 | 238 | 294 | 5921 | 5050 | 3733 | 3996 | 3742 |
| | 6 | 29974 | 28176 | 18898 | 22297 | 18945 | 35460 | 10798 | 14701 | 922 | 1255 | 1205 | 1640 | 29974 | 28176 | 18898 | 22297 | 18945 |
| | 7 | 125 | 241 | 79 | 191 | 79 | 304 | 45 | 126 | 4 | 11 | 5 | 14 | 125 | 241 | 79 | 191 | 79 |
| | 8 | 3497 | 2719 | 2205 | 2152 | 2210 | 3422 | 1260 | 1419 | 108 | 121 | 141 | 158 | 3497 | 2719 | 2205 | 2152 | 2210 |
| | 10 | 2191 | 1402 | 1382 | 1110 | 1385 | 1765 | 789 | 732 | 67 | 62 | 88 | 82 | 2191 | 1402 | 1382 | 1110 | 1385 |
| SB | 1 | 8643 | 392 | 5449 | 310 | 5462 | 493 | 3114 | 205 | 266 | 17 | 347 | 23 | 8643 | 392 | 5449 | 310 | 5462 |
| | 2 | 10457 | 101 | 6593 | 80 | 6609 | 128 | 3767 | 53 | 322 | 5 | 420 | 6 | 10457 | 101 | 6593 | 80 | 6609 |
| | 3 | 8534 | 78 | 5380 | 62 | 5394 | 98 | 3074 | 41 | 262 | 3 | 343 | 5 | 8534 | 78 | 5380 | 62 | 5394 |
| | 4 | 2592 | 100 | 1634 | 79 | 1638 | 125 | 934 | 52 | 80 | 4 | 104 | 6 | 2592 | 100 | 1634 | 79 | 1638 |
| | 5 | 6711 | 4485 | 4231 | 3549 | 4241 | 5644 | 2418 | 2340 | 206 | 200 | 270 | 261 | 6711 | 4485 | 4231 | 3549 | 4241 |
| | 6 | 33039 | 360 | 20830 | 285 | 20882 | 453 | 11902 | 188 | 1016 | 16 | 1328 | 21 | 33039 | 360 | 20830 | 285 | 20882 |
| | 7 | 234 | 107 | 147 | 85 | 148 | 135 | 84 | 56 | 7 | 5 | 9 | 6 | 234 | 107 | 147 | 85 | 148 |
| | 8 | 291 | 275 | 183 | 218 | 184 | 346 | 105 | 144 | 9 | 12 | 12 | 16 | 291 | 275 | 183 | 218 | 184 |
| | 10 | 1017 | 288 | 641 | 228 | 643 | 363 | 366 | 151 | 31 | 13 | 41 | 17 | 1017 | 288 | 641 | 228 | 643 |
| | | 348 | 7030 | 219 | 5563 | 220 | 8848 | 125 | 3668 | 11 | 313 | 14 | 409 | 348 | 7030 | 219 | 5563 | 220 |

| | |
|---|---|
| **Cost of delays per working day** | **£563,772** |
| **Cost of delays per year (252 working days)** | **£142,070,617** |

# Sensitivity Testing Growth Factor -12%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2713 | 2007 | 321 | 32 | 3956 | 2928 | 468 | 47 | 363 | 381 | 923 | 1194 | 721 | 1353 | 283 | 412 | 39 | 56 |
| | 2 | 2490 | 3469 | 2898 | 2145 | 343 | 34 | 4073 | 3014 | 482 | 48 | 388 | 392 | 986 | 1230 | 770 | 1392 | 302 | 424 | 41 | 58 |
| | 3 | 1996 | 3205 | 2323 | 1719 | 275 | 28 | 3763 | 2784 | 446 | 45 | 311 | 362 | 791 | 1136 | 617 | 1286 | 242 | 392 | 33 | 53 |
| | 4 | 2913 | 3705 | 3390 | 2509 | 401 | 40 | 4350 | 3219 | 515 | 52 | 454 | 418 | 1154 | 1313 | 901 | 1487 | 353 | 453 | 48 | 62 |
| | 5 | 3020 | 3698 | 3515 | 2601 | 416 | 42 | 4342 | 3213 | 514 | 51 | 471 | 418 | 1196 | 1311 | 934 | 1484 | 366 | 452 | 50 | 62 |
| | 6 | 3065 | 4137 | 3567 | 2640 | 422 | 42 | 4857 | 3594 | 575 | 58 | 478 | 467 | 1214 | 1466 | 948 | 1661 | 372 | 506 | 51 | 69 |
| | 7 | 3286 | 3886 | 3825 | 2831 | 453 | 45 | 4562 | 3376 | 540 | 54 | 512 | 439 | 1302 | 1377 | 1016 | 1560 | 399 | 475 | 54 | 65 |
| | 8 | 4157 | 4642 | 4839 | 3581 | 573 | 57 | 5450 | 4033 | 645 | 65 | 648 | 524 | 1647 | 1645 | 1286 | 1863 | 504 | 568 | 69 | 77 |
| | 10 | 2253 | 2343 | 2622 | 1940 | 310 | 31 | 2751 | 2035 | 326 | 33 | 351 | 265 | 893 | 830 | 697 | 940 | 273 | 287 | 37 | 39 |
| SB | 1 | 2889 | 2145 | 3362 | 2488 | 398 | 40 | 2518 | 1863 | 298 | 30 | 450 | 242 | 1145 | 760 | 893 | 861 | 350 | 262 | 48 | 36 |
| | 2 | 3063 | 2379 | 3566 | 2639 | 422 | 42 | 2793 | 2067 | 331 | 33 | 478 | 269 | 1214 | 843 | 947 | 955 | 372 | 291 | 51 | 40 |
| | 3 | 2879 | 2018 | 3352 | 2480 | 397 | 40 | 2369 | 1753 | 280 | 28 | 449 | 228 | 1141 | 715 | 890 | 810 | 349 | 247 | 48 | 34 |
| | 4 | 2879 | 2018 | 3352 | 2480 | 397 | 40 | 2369 | 1753 | 280 | 28 | 449 | 228 | 1141 | 715 | 890 | 810 | 349 | 247 | 48 | 34 |
| | 5 | 3420 | 3282 | 3981 | 2946 | 471 | 47 | 3853 | 2851 | 456 | 46 | 533 | 371 | 1355 | 1163 | 1058 | 1317 | 415 | 401 | 57 | 55 |
| | 6 | 3379 | 2690 | 3933 | 2911 | 466 | 47 | 3158 | 2337 | 374 | 37 | 527 | 304 | 1339 | 953 | 1045 | 1080 | 410 | 329 | 56 | 45 |
| | 7 | 3677 | 3265 | 4281 | 3168 | 507 | 51 | 3833 | 2836 | 454 | 45 | 573 | 369 | 1457 | 1157 | 1137 | 1310 | 446 | 399 | 61 | 54 |
| | 8 | 3982 | 3911 | 4635 | 3430 | 549 | 55 | 4592 | 3398 | 544 | 54 | 621 | 442 | 1578 | 1386 | 1231 | 1570 | 483 | 478 | 66 | 65 |
| | 10 | 2322 | 2289 | 2703 | 2000 | 320 | 32 | 2687 | 1989 | 318 | 32 | 362 | 259 | 920 | 811 | 718 | 919 | 282 | 280 | 38 | 38 |

# Sensitivity Testing Growth Factor -12% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 345 | 6971 | 217 | 5516 | 218 | 8773 | 124 | 3637 | 11 | 311 | 14 | 406 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 237 | 8165 | 149 | 6461 | 150 | 10275 | 85 | 4260 | 7 | 364 | 10 | 475 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 124 | 6565 | 78 | 5195 | 78 | 8262 | 45 | 3425 | 4 | 292 | 5 | 382 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2600 | 2303 | 1639 | 1822 | 1643 | 2898 | 937 | 1202 | 80 | 103 | 105 | 134 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5871 | 5007 | 3701 | 3963 | 3710 | 6302 | 2115 | 2613 | 181 | 223 | 236 | 292 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 29719 | 27938 | 18737 | 22109 | 18784 | 35161 | 10706 | 14577 | 914 | 1244 | 1195 | 1626 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 124 | 239 | 78 | 189 | 78 | 301 | 45 | 125 | 4 | 11 | 5 | 14 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3467 | 2696 | 2186 | 2134 | 2191 | 3393 | 1249 | 1407 | 107 | 120 | 139 | 157 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2173 | 1390 | 1370 | 1100 | 1373 | 1750 | 783 | 725 | 67 | 62 | 87 | 81 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8569 | 389 | 5403 | 308 | 5416 | 489 | 3087 | 203 | 264 | 17 | 344 | 23 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10368 | 101 | 6537 | 80 | 6553 | 127 | 3735 | 52 | 319 | 4 | 417 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8461 | 77 | 5334 | 61 | 5348 | 97 | 3048 | 40 | 260 | 3 | 340 | 5 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2570 | 99 | 1620 | 78 | 1624 | 124 | 926 | 52 | 79 | 4 | 103 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6654 | 4447 | 4195 | 3519 | 4205 | 5596 | 2397 | 2320 | 205 | 198 | 267 | 259 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 32757 | 357 | 20653 | 283 | 20704 | 450 | 11801 | 186 | 1007 | 16 | 1317 | 21 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 232 | 106 | 146 | 84 | 146 | 134 | 83 | 55 | 7 | 5 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 288 | 273 | 182 | 216 | 182 | 343 | 104 | 142 | 9 | 12 | 12 | 16 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1008 | 286 | 636 | 226 | 637 | 360 | 363 | 149 | 31 | 13 | 41 | 17 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 345 | 6971 | 217 | 5516 | 218 | 8773 | 124 | 3637 | 11 | 311 | 14 | 406 |
| | | | | | | | Cost of delays per working day | | | | | | | | | | £558,988 | |
| | | | | | | | Cost of delays per year (252 working days) | | | | | | | | | | £140,865,004 | |

# Sensitivity Testing Growth Factor -13% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2689 | 1990 | 318 | 32 | 3923 | 2903 | 464 | 46 | 360 | 377 | 915 | 1184 | 714 | 1341 | 280 | 409 | 38 | 56 |
| | 2 | 2490 | 3469 | 2873 | 2126 | 340 | 34 | 4038 | 2988 | 478 | 48 | 385 | 388 | 978 | 1219 | 763 | 1381 | 299 | 421 | 41 | 57 |
| | 3 | 1996 | 3205 | 2303 | 1704 | 273 | 27 | 3731 | 2761 | 442 | 44 | 308 | 359 | 784 | 1126 | 612 | 1275 | 240 | 389 | 33 | 53 |
| | 4 | 2913 | 3705 | 3361 | 2487 | 398 | 40 | 4313 | 3191 | 511 | 51 | 450 | 415 | 1144 | 1302 | 893 | 1474 | 350 | 449 | 48 | 61 |
| | 5 | 3020 | 3698 | 3485 | 2579 | 413 | 41 | 4305 | 3186 | 510 | 51 | 467 | 414 | 1186 | 1300 | 926 | 1472 | 363 | 449 | 50 | 61 |
| | 6 | 3065 | 4137 | 3537 | 2617 | 419 | 42 | 4816 | 3564 | 570 | 57 | 474 | 463 | 1204 | 1454 | 940 | 1646 | 369 | 502 | 50 | 68 |
| | 7 | 3286 | 3886 | 3792 | 2806 | 449 | 45 | 4523 | 3347 | 536 | 54 | 508 | 435 | 1291 | 1366 | 1008 | 1546 | 395 | 471 | 54 | 64 |
| | 8 | 4157 | 4642 | 4797 | 3550 | 568 | 57 | 5404 | 3999 | 640 | 64 | 643 | 520 | 1633 | 1631 | 1274 | 1847 | 500 | 563 | 68 | 77 |
| | 10 | 2253 | 2343 | 2600 | 1924 | 308 | 31 | 2727 | 2018 | 323 | 32 | 348 | 262 | 885 | 823 | 691 | 932 | 271 | 284 | 37 | 39 |
| SB | 1 | 2889 | 2145 | 3333 | 2467 | 395 | 39 | 2496 | 1847 | 296 | 30 | 446 | 240 | 1135 | 754 | 886 | 853 | 347 | 260 | 47 | 35 |
| | 2 | 3063 | 2379 | 3535 | 2616 | 419 | 42 | 2769 | 2049 | 328 | 33 | 473 | 266 | 1203 | 836 | 939 | 947 | 368 | 289 | 50 | 39 |
| | 3 | 2879 | 2018 | 3323 | 2459 | 393 | 39 | 2349 | 1738 | 278 | 28 | 445 | 226 | 1131 | 709 | 883 | 803 | 346 | 245 | 47 | 33 |
| | 4 | 2879 | 2018 | 3323 | 2459 | 393 | 39 | 2349 | 1738 | 278 | 28 | 445 | 226 | 1131 | 709 | 883 | 803 | 346 | 245 | 47 | 33 |
| | 5 | 3420 | 3282 | 3947 | 2921 | 467 | 47 | 3820 | 2827 | 452 | 45 | 529 | 368 | 1343 | 1153 | 1048 | 1306 | 411 | 398 | 56 | 54 |
| | 6 | 3379 | 2690 | 3899 | 2886 | 462 | 46 | 3131 | 2317 | 371 | 37 | 522 | 301 | 1327 | 945 | 1036 | 1070 | 406 | 326 | 55 | 44 |
| | 7 | 3677 | 3265 | 4244 | 3140 | 502 | 50 | 3800 | 2812 | 450 | 45 | 568 | 366 | 1445 | 1147 | 1127 | 1299 | 442 | 396 | 60 | 54 |
| | 8 | 3982 | 3911 | 4595 | 3400 | 544 | 54 | 4553 | 3369 | 539 | 54 | 615 | 438 | 1564 | 1375 | 1221 | 1557 | 479 | 474 | 65 | 65 |
| | 10 | 2322 | 2289 | 2680 | 1983 | 317 | 32 | 2665 | 1972 | 315 | 32 | 359 | 256 | 912 | 804 | 712 | 911 | 279 | 278 | 38 | 38 |

# Sensitivity Testing Growth Factor -13% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 342 | 6911 | 216 | 5469 | 216 | 8698 | 123 | 3606 | 11 | 308 | 14 | 402 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 235 | 8095 | 148 | 6406 | 148 | 10188 | 84 | 4224 | 7 | 361 | 9 | 471 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 123 | 6509 | 77 | 5151 | 78 | 8191 | 44 | 3396 | 4 | 290 | 5 | 379 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2578 | 2283 | 1625 | 1807 | 1629 | 2874 | 929 | 1191 | 79 | 102 | 104 | 133 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5820 | 4965 | 3669 | 3929 | 3679 | 6248 | 2097 | 2590 | 179 | 221 | 234 | 289 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 29463 | 27700 | 18576 | 21920 | 18622 | 34861 | 10614 | 14453 | 906 | 1234 | 1184 | 1613 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 123 | 237 | 77 | 188 | 77 | 299 | 44 | 124 | 4 | 11 | 5 | 14 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3437 | 2673 | 2167 | 2115 | 2173 | 3364 | 1238 | 1395 | 106 | 119 | 138 | 156 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2154 | 1379 | 1358 | 1091 | 1362 | 1735 | 776 | 719 | 66 | 61 | 87 | 80 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8495 | 385 | 5356 | 305 | 5369 | 485 | 3061 | 201 | 261 | 17 | 341 | 22 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10279 | 100 | 6481 | 79 | 6497 | 126 | 3703 | 52 | 316 | 4 | 413 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8388 | 77 | 5289 | 61 | 5302 | 96 | 3022 | 40 | 258 | 3 | 337 | 4 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2548 | 98 | 1606 | 78 | 1610 | 123 | 918 | 51 | 78 | 4 | 102 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6596 | 4409 | 4159 | 3489 | 4169 | 5549 | 2376 | 2300 | 203 | 196 | 265 | 257 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 32476 | 354 | 20475 | 280 | 20526 | 446 | 11700 | 185 | 999 | 16 | 1305 | 21 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 230 | 105 | 145 | 83 | 145 | 133 | 83 | 55 | 7 | 5 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 286 | 270 | 180 | 214 | 181 | 340 | 103 | 141 | 9 | 12 | 11 | 16 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 1000 | 284 | 630 | 224 | 632 | 357 | 360 | 148 | 31 | 13 | 40 | 17 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 342 | 6911 | 216 | 5469 | 216 | 8698 | 123 | 3606 | 11 | 308 | 14 | 402 |

| | |
|---|---|
| **Cost of delays per working day** | **£554,204** |
| **Cost of delays per year (252 working days)** | **£139,659,391** |

# Sensitivity Testing Growth Factor -14% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2666 | 1973 | 316 | 32 | 3889 | 2878 | 460 | 46 | 357 | 374 | 907 | 1174 | 708 | 1330 | 278 | 405 | 38 | 55 |
| | 2 | 2490 | 3469 | 2848 | 2108 | 337 | 34 | 4004 | 2963 | 474 | 47 | 381 | 385 | 970 | 1209 | 757 | 1369 | 297 | 417 | 40 | 57 |
| | 3 | 1996 | 3205 | 2283 | 1690 | 270 | 27 | 3699 | 2737 | 438 | 44 | 306 | 356 | 777 | 1117 | 607 | 1265 | 238 | 385 | 32 | 53 |
| | 4 | 2913 | 3705 | 3332 | 2466 | 395 | 39 | 4276 | 3164 | 506 | 51 | 446 | 411 | 1134 | 1291 | 885 | 1462 | 347 | 445 | 47 | 61 |
| | 5 | 3020 | 3698 | 3454 | 2556 | 409 | 41 | 4268 | 3158 | 505 | 51 | 463 | 411 | 1176 | 1289 | 918 | 1459 | 360 | 445 | 49 | 61 |
| | 6 | 3065 | 4137 | 3506 | 2595 | 415 | 42 | 4774 | 3533 | 565 | 57 | 470 | 459 | 1193 | 1441 | 931 | 1632 | 365 | 497 | 50 | 68 |
| | 7 | 3286 | 3886 | 3760 | 2782 | 445 | 45 | 4484 | 3318 | 531 | 53 | 504 | 431 | 1280 | 1354 | 999 | 1533 | 392 | 467 | 53 | 64 |
| | 8 | 4157 | 4642 | 4756 | 3519 | 563 | 56 | 5357 | 3964 | 634 | 63 | 637 | 515 | 1619 | 1617 | 1263 | 1831 | 496 | 558 | 68 | 76 |
| | 10 | 2253 | 2343 | 2577 | 1907 | 305 | 31 | 2704 | 2001 | 320 | 32 | 345 | 260 | 877 | 816 | 685 | 924 | 269 | 282 | 37 | 38 |
| SB | 1 | 2889 | 2145 | 3305 | 2445 | 391 | 39 | 2475 | 1831 | 293 | 29 | 443 | 238 | 1125 | 747 | 878 | 846 | 344 | 258 | 47 | 35 |
| | 2 | 3063 | 2379 | 3505 | 2593 | 415 | 41 | 2746 | 2032 | 325 | 33 | 469 | 264 | 1193 | 829 | 931 | 939 | 365 | 286 | 50 | 39 |
| | 3 | 2879 | 2018 | 3294 | 2438 | 390 | 39 | 2328 | 1723 | 276 | 28 | 441 | 224 | 1121 | 703 | 875 | 796 | 343 | 243 | 47 | 33 |
| | 4 | 2879 | 2018 | 3294 | 2438 | 390 | 39 | 2328 | 1723 | 276 | 28 | 441 | 224 | 1121 | 703 | 875 | 796 | 343 | 243 | 47 | 33 |
| | 5 | 3420 | 3282 | 3913 | 2895 | 463 | 46 | 3788 | 2803 | 448 | 45 | 524 | 364 | 1332 | 1144 | 1039 | 1295 | 408 | 395 | 56 | 54 |
| | 6 | 3379 | 2690 | 3866 | 2861 | 458 | 46 | 3104 | 2297 | 368 | 37 | 518 | 299 | 1316 | 937 | 1027 | 1061 | 403 | 323 | 55 | 44 |
| | 7 | 3677 | 3265 | 4207 | 3113 | 498 | 50 | 3768 | 2788 | 446 | 45 | 563 | 362 | 1432 | 1138 | 1118 | 1288 | 438 | 393 | 60 | 54 |
| | 8 | 3982 | 3911 | 4555 | 3371 | 539 | 54 | 4514 | 3340 | 534 | 53 | 610 | 434 | 1551 | 1363 | 1210 | 1543 | 475 | 470 | 65 | 64 |
| | 10 | 2322 | 2289 | 2657 | 1966 | 315 | 31 | 2642 | 1955 | 313 | 31 | 356 | 254 | 904 | 798 | 706 | 903 | 277 | 275 | 38 | 38 |

## Sensitivity Testing Growth Factor -14%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 339 | 6852 | 214 | 5422 | 214 | 8623 | 122 | 3575 | 10 | 305 | 14 | 399 | 339 | 6852 | 214 | 5422 | 214 |
| | 2 | 232 | 8026 | 147 | 6351 | 147 | 10100 | 84 | 4187 | 7 | 357 | 9 | 467 | 232 | 8026 | 147 | 6351 | 147 |
| | 3 | 122 | 6453 | 77 | 5106 | 77 | 8121 | 44 | 3367 | 4 | 287 | 5 | 376 | 122 | 6453 | 77 | 5106 | 77 |
| | 4 | 2555 | 2264 | 1611 | 1791 | 1615 | 2849 | 921 | 1181 | 79 | 101 | 103 | 132 | 2555 | 2264 | 1611 | 1791 | 1615 |
| | 5 | 5770 | 4922 | 3638 | 3895 | 3647 | 6195 | 2079 | 2568 | 177 | 219 | 232 | 287 | 5770 | 4922 | 3638 | 3895 | 3647 |
| | 6 | 29208 | 27462 | 18415 | 21732 | 18461 | 34562 | 10522 | 14328 | 898 | 1223 | 1174 | 1599 | 29208 | 27462 | 18415 | 21732 | 18461 |
| | 7 | 121 | 235 | 77 | 186 | 77 | 296 | 44 | 123 | 4 | 10 | 5 | 14 | 121 | 235 | 77 | 186 | 77 |
| | 8 | 3408 | 2650 | 2148 | 2097 | 2154 | 3335 | 1228 | 1383 | 105 | 118 | 137 | 154 | 3408 | 2650 | 2148 | 2097 | 2154 |
| | 10 | 2135 | 1367 | 1346 | 1082 | 1350 | 1720 | 769 | 713 | 66 | 61 | 86 | 80 | 2135 | 1367 | 1346 | 1082 | 1350 |
| SB | 1 | 8422 | 382 | 5310 | 302 | 5323 | 481 | 3034 | 199 | 259 | 17 | 339 | 22 | 8422 | 382 | 5310 | 302 | 5323 |
| | 2 | 10190 | 99 | 6425 | 78 | 6440 | 124 | 3671 | 52 | 313 | 4 | 410 | 6 | 10190 | 99 | 6425 | 78 | 6440 |
| | 3 | 8315 | 76 | 5243 | 60 | 5256 | 96 | 2996 | 40 | 256 | 3 | 334 | 4 | 8315 | 76 | 5243 | 60 | 5256 |
| | 4 | 2526 | 97 | 1592 | 77 | 1596 | 122 | 910 | 51 | 78 | 4 | 102 | 6 | 2526 | 97 | 1592 | 77 | 1596 |
| | 5 | 6539 | 4371 | 4123 | 3459 | 4133 | 5501 | 2356 | 2281 | 201 | 195 | 263 | 254 | 6539 | 4371 | 4123 | 3459 | 4133 |
| | 6 | 32195 | 351 | 20298 | 278 | 20348 | 442 | 11598 | 183 | 990 | 16 | 1294 | 20 | 32195 | 351 | 20298 | 278 | 20348 |
| | 7 | 228 | 105 | 144 | 83 | 144 | 132 | 82 | 55 | 7 | 5 | 9 | 6 | 228 | 105 | 144 | 83 | 144 |
| | 8 | 283 | 268 | 179 | 212 | 179 | 337 | 102 | 140 | 9 | 12 | 11 | 16 | 283 | 268 | 179 | 212 | 179 |
| | 10 | 991 | 281 | 625 | 222 | 626 | 354 | 357 | 147 | 30 | 13 | 40 | 16 | 991 | 281 | 625 | 222 | 626 |
| | | 339 | 6852 | 214 | 5422 | 214 | 8623 | 122 | 3575 | 10 | 305 | 14 | 399 | 339 | 6852 | 214 | 5422 | 214 |

| | |
|---|---|
| **Cost of delays per working day** | **£549,420** |
| **Cost of delays per year (252 working days)** | **£138,453,778** |

# Sensitivity Testing Growth Factor -15% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2643 | 1956 | 313 | 31 | 3855 | 2853 | 456 | 46 | 354 | 371 | 900 | 1164 | 702 | 1318 | 275 | 402 | 38 | 55 |
| | 2 | 2490 | 3469 | 2823 | 2089 | 334 | 33 | 3969 | 2937 | 470 | 47 | 378 | 382 | 961 | 1198 | 750 | 1357 | 294 | 414 | 40 | 56 |
| | 3 | 1996 | 3205 | 2263 | 1675 | 268 | 27 | 3667 | 2713 | 434 | 43 | 303 | 353 | 770 | 1107 | 601 | 1254 | 236 | 382 | 32 | 52 |
| | 4 | 2913 | 3705 | 3303 | 2444 | 391 | 39 | 4239 | 3137 | 502 | 50 | 442 | 408 | 1124 | 1280 | 877 | 1449 | 344 | 442 | 47 | 60 |
| | 5 | 3020 | 3698 | 3424 | 2534 | 405 | 41 | 4231 | 3131 | 501 | 50 | 459 | 407 | 1166 | 1277 | 910 | 1446 | 357 | 441 | 49 | 60 |
| | 6 | 3065 | 4137 | 3475 | 2572 | 411 | 41 | 4733 | 3502 | 560 | 56 | 466 | 455 | 1183 | 1429 | 923 | 1618 | 362 | 493 | 49 | 67 |
| | 7 | 3286 | 3886 | 3727 | 2758 | 441 | 44 | 4445 | 3290 | 526 | 53 | 499 | 428 | 1269 | 1342 | 990 | 1520 | 388 | 463 | 53 | 63 |
| | 8 | 4157 | 4642 | 4714 | 3489 | 558 | 56 | 5311 | 3930 | 629 | 63 | 631 | 511 | 1605 | 1603 | 1252 | 1816 | 491 | 553 | 67 | 75 |
| | 10 | 2253 | 2343 | 2555 | 1890 | 302 | 30 | 2680 | 1983 | 317 | 32 | 342 | 258 | 870 | 809 | 679 | 916 | 266 | 279 | 36 | 38 |
| SB | 1 | 2889 | 2145 | 3276 | 2424 | 388 | 39 | 2453 | 1815 | 290 | 29 | 439 | 236 | 1115 | 741 | 870 | 839 | 341 | 256 | 47 | 35 |
| | 2 | 3063 | 2379 | 3474 | 2571 | 411 | 41 | 2722 | 2014 | 322 | 32 | 465 | 262 | 1183 | 822 | 923 | 931 | 362 | 284 | 49 | 39 |
| | 3 | 2879 | 2018 | 3265 | 2416 | 387 | 39 | 2308 | 1708 | 273 | 27 | 437 | 222 | 1111 | 697 | 867 | 789 | 340 | 241 | 46 | 33 |
| | 4 | 2879 | 2018 | 3265 | 2416 | 387 | 39 | 2308 | 1708 | 273 | 27 | 437 | 222 | 1111 | 697 | 867 | 789 | 340 | 241 | 46 | 33 |
| | 5 | 3420 | 3282 | 3878 | 2870 | 459 | 46 | 3755 | 2779 | 445 | 44 | 519 | 361 | 1320 | 1134 | 1030 | 1284 | 404 | 391 | 55 | 53 |
| | 6 | 3379 | 2690 | 3832 | 2836 | 454 | 45 | 3077 | 2277 | 364 | 36 | 513 | 296 | 1304 | 929 | 1018 | 1052 | 399 | 321 | 54 | 44 |
| | 7 | 3677 | 3265 | 4170 | 3086 | 494 | 49 | 3735 | 2764 | 442 | 44 | 559 | 359 | 1420 | 1128 | 1108 | 1277 | 435 | 389 | 59 | 53 |
| | 8 | 3982 | 3911 | 4515 | 3341 | 535 | 53 | 4475 | 3311 | 530 | 53 | 605 | 430 | 1537 | 1351 | 1200 | 1530 | 470 | 466 | 64 | 64 |
| | 10 | 2322 | 2289 | 2633 | 1949 | 312 | 31 | 2619 | 1938 | 310 | 31 | 353 | 252 | 896 | 791 | 700 | 895 | 274 | 273 | 37 | 37 |

# Sensitivity Testing Growth Factor -15% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Delays** | | | | | **Cost (£) of delays - split per vehicle type AND trip purpose** | | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 336 | 6793 | 212 | 5375 | 212 | 8549 | 121 | 3544 | 10 | 303 | 14 | 395 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 230 | 7956 | 145 | 6296 | 146 | 10013 | 83 | 4151 | 7 | 354 | 9 | 463 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 121 | 6397 | 76 | 5062 | 76 | 8051 | 43 | 3338 | 4 | 285 | 5 | 372 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2533 | 2244 | 1597 | 1776 | 1601 | 2824 | 912 | 1171 | 78 | 100 | 102 | 131 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5719 | 4879 | 3606 | 3861 | 3615 | 6141 | 2060 | 2546 | 176 | 217 | 230 | 284 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 28953 | 27224 | 18254 | 21544 | 18299 | 34262 | 10430 | 14204 | 890 | 1213 | 1164 | 1585 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 120 | 233 | 76 | 185 | 76 | 294 | 43 | 122 | 4 | 10 | 5 | 14 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3378 | 2627 | 2130 | 2079 | 2135 | 3306 | 1217 | 1371 | 104 | 117 | 136 | 153 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2117 | 1355 | 1335 | 1072 | 1338 | 1705 | 763 | 707 | 65 | 60 | 85 | 79 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8348 | 379 | 5263 | 300 | 5276 | 477 | 3007 | 198 | 257 | 17 | 336 | 22 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10101 | 98 | 6368 | 78 | 6384 | 123 | 3639 | 51 | 311 | 4 | 406 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8243 | 75 | 5197 | 60 | 5210 | 95 | 2970 | 39 | 254 | 3 | 331 | 4 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2504 | 96 | 1579 | 76 | 1582 | 121 | 902 | 50 | 77 | 4 | 101 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6482 | 4333 | 4087 | 3429 | 4097 | 5453 | 2335 | 2261 | 199 | 193 | 261 | 252 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 31913 | 348 | 20120 | 275 | 20170 | 438 | 11497 | 182 | 982 | 16 | 1283 | 20 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 226 | 104 | 142 | 82 | 143 | 130 | 81 | 54 | 7 | 5 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 281 | 266 | 177 | 210 | 178 | 335 | 101 | 139 | 9 | 12 | 11 | 15 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 982 | 279 | 619 | 221 | 621 | 351 | 354 | 145 | 30 | 12 | 39 | 16 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 336 | 6793 | 212 | 5375 | 212 | 8549 | 121 | 3544 | 10 | 303 | 14 | 395 |

| | |
|---|---|
| **Cost of delays per working day** | **£544,636** |
| **Cost of delays per year (252 working days)** | **£137,248,165** |

# Sensitivity Testing Growth Factor -16%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2619 | 1938 | 310 | 31 | 3821 | 2828 | 452 | 45 | 351 | 368 | 892 | 1154 | 696 | 1306 | 273 | 398 | 37 | 54 |
| | 2 | 2490 | 3469 | 2798 | 2071 | 331 | 33 | 3934 | 2911 | 466 | 47 | 375 | 378 | 953 | 1188 | 743 | 1345 | 292 | 410 | 40 | 56 |
| | 3 | 1996 | 3205 | 2243 | 1660 | 266 | 27 | 3635 | 2690 | 430 | 43 | 300 | 350 | 764 | 1097 | 596 | 1243 | 234 | 379 | 32 | 52 |
| | 4 | 2913 | 3705 | 3274 | 2423 | 388 | 39 | 4201 | 3109 | 497 | 50 | 439 | 404 | 1114 | 1269 | 870 | 1436 | 341 | 438 | 47 | 60 |
| | 5 | 3020 | 3698 | 3394 | 2511 | 402 | 40 | 4194 | 3104 | 497 | 50 | 455 | 403 | 1155 | 1266 | 902 | 1434 | 354 | 437 | 48 | 60 |
| | 6 | 3065 | 4137 | 3445 | 2549 | 408 | 41 | 4692 | 3472 | 555 | 56 | 461 | 451 | 1173 | 1416 | 915 | 1604 | 359 | 489 | 49 | 67 |
| | 7 | 3286 | 3886 | 3694 | 2733 | 437 | 44 | 4406 | 3261 | 522 | 52 | 495 | 424 | 1257 | 1330 | 981 | 1506 | 385 | 459 | 52 | 63 |
| | 8 | 4157 | 4642 | 4673 | 3458 | 553 | 55 | 5264 | 3896 | 623 | 62 | 626 | 506 | 1591 | 1589 | 1241 | 1800 | 487 | 548 | 66 | 75 |
| | 10 | 2253 | 2343 | 2532 | 1874 | 300 | 30 | 2657 | 1966 | 315 | 31 | 339 | 256 | 862 | 802 | 673 | 908 | 264 | 277 | 36 | 38 |
| SB | 1 | 2889 | 2145 | 3247 | 2403 | 384 | 38 | 2432 | 1800 | 288 | 29 | 435 | 234 | 1105 | 734 | 863 | 831 | 338 | 253 | 46 | 35 |
| | 2 | 3063 | 2379 | 3443 | 2548 | 408 | 41 | 2698 | 1996 | 319 | 32 | 461 | 260 | 1172 | 815 | 915 | 922 | 359 | 281 | 49 | 38 |
| | 3 | 2879 | 2018 | 3236 | 2395 | 383 | 38 | 2288 | 1693 | 271 | 27 | 433 | 220 | 1102 | 691 | 860 | 782 | 337 | 238 | 46 | 33 |
| | 4 | 2879 | 2018 | 3236 | 2395 | 383 | 38 | 2288 | 1693 | 271 | 27 | 433 | 220 | 1102 | 691 | 860 | 782 | 337 | 238 | 46 | 33 |
| | 5 | 3420 | 3282 | 3844 | 2845 | 455 | 46 | 3722 | 2754 | 441 | 44 | 515 | 358 | 1309 | 1124 | 1021 | 1272 | 401 | 388 | 55 | 53 |
| | 6 | 3379 | 2690 | 3798 | 2811 | 450 | 45 | 3050 | 2257 | 361 | 36 | 509 | 293 | 1293 | 921 | 1009 | 1043 | 396 | 318 | 54 | 43 |
| | 7 | 3677 | 3265 | 4133 | 3059 | 489 | 49 | 3702 | 2740 | 438 | 44 | 554 | 356 | 1407 | 1118 | 1098 | 1266 | 431 | 386 | 59 | 53 |
| | 8 | 3982 | 3911 | 4476 | 3312 | 530 | 53 | 4436 | 3282 | 525 | 53 | 599 | 427 | 1524 | 1339 | 1189 | 1516 | 466 | 462 | 64 | 63 |
| | 10 | 2322 | 2289 | 2610 | 1932 | 309 | 31 | 2596 | 1921 | 307 | 31 | 350 | 250 | 889 | 784 | 693 | 887 | 272 | 270 | 37 | 37 |

# Sensitivity Testing Growth Factor -16%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 333 | 6733 | 210 | 5328 | 211 | 8474 | 120 | 3513 | 10 | 300 | 13 | 392 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 228 | 7887 | 144 | 6241 | 144 | 9925 | 82 | 4115 | 7 | 351 | 9 | 459 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 120 | 6341 | 75 | 5018 | 76 | 7980 | 43 | 3308 | 4 | 282 | 5 | 369 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2510 | 2225 | 1583 | 1760 | 1587 | 2800 | 904 | 1161 | 77 | 99 | 101 | 130 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5669 | 4837 | 3574 | 3828 | 3583 | 6087 | 2042 | 2524 | 174 | 215 | 228 | 282 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 28698 | 26986 | 18093 | 21355 | 18138 | 33963 | 10338 | 14080 | 883 | 1202 | 1154 | 1571 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 119 | 231 | 75 | 183 | 75 | 291 | 43 | 121 | 4 | 10 | 5 | 13 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3348 | 2604 | 2111 | 2061 | 2116 | 3278 | 1206 | 1359 | 103 | 116 | 135 | 152 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2098 | 1343 | 1323 | 1063 | 1326 | 1690 | 756 | 701 | 65 | 60 | 84 | 78 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8275 | 376 | 5217 | 297 | 5230 | 473 | 2981 | 196 | 254 | 17 | 333 | 22 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 10012 | 97 | 6312 | 77 | 6328 | 122 | 3607 | 51 | 308 | 4 | 402 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8170 | 75 | 5151 | 59 | 5164 | 94 | 2943 | 39 | 251 | 3 | 328 | 4 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2482 | 95 | 1565 | 76 | 1569 | 120 | 894 | 50 | 76 | 4 | 100 | 6 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6425 | 4295 | 4051 | 3399 | 4061 | 5406 | 2315 | 2241 | 198 | 191 | 258 | 250 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 31632 | 345 | 19943 | 273 | 19993 | 434 | 11396 | 180 | 973 | 15 | 1271 | 20 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 224 | 103 | 141 | 81 | 141 | 129 | 81 | 54 | 7 | 5 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 278 | 264 | 176 | 209 | 176 | 332 | 100 | 137 | 9 | 12 | 11 | 15 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 974 | 276 | 614 | 219 | 615 | 348 | 351 | 144 | 30 | 12 | 39 | 16 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 333 | 6733 | 210 | 5328 | 211 | 8474 | 120 | 3513 | 10 | 300 | 13 | 392 |
| | | | | | | | **Cost of delays per working day** | | | | | | | | | | **£539,851** | |
| | | | | | | | **Cost of delays per year (252 working days)** | | | | | | | | | | **£136,042,552** | |

# Sensitivity Testing Growth Factor -17%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2596 | 1921 | 307 | 31 | 3788 | 2803 | 448 | 45 | 348 | 364 | 884 | 1144 | 690 | 1295 | 270 | 395 | 37 | 54 |
| | 2 | 2490 | 3469 | 2774 | 2052 | 328 | 33 | 3899 | 2886 | 462 | 46 | 371 | 375 | 944 | 1177 | 737 | 1333 | 289 | 406 | 39 | 55 |
| | 3 | 1996 | 3205 | 2223 | 1645 | 263 | 26 | 3603 | 2666 | 427 | 43 | 298 | 347 | 757 | 1088 | 591 | 1232 | 232 | 375 | 32 | 51 |
| | 4 | 2913 | 3705 | 3245 | 2401 | 384 | 38 | 4164 | 3082 | 493 | 49 | 435 | 401 | 1105 | 1257 | 862 | 1424 | 338 | 434 | 46 | 59 |
| | 5 | 3020 | 3698 | 3364 | 2489 | 398 | 40 | 4157 | 3076 | 492 | 49 | 451 | 400 | 1145 | 1255 | 894 | 1421 | 350 | 433 | 48 | 59 |
| | 6 | 3065 | 4137 | 3414 | 2526 | 404 | 40 | 4650 | 3441 | 551 | 55 | 457 | 447 | 1162 | 1404 | 907 | 1590 | 356 | 485 | 49 | 66 |
| | 7 | 3286 | 3886 | 3661 | 2709 | 433 | 43 | 4368 | 3232 | 517 | 52 | 490 | 420 | 1246 | 1319 | 973 | 1493 | 381 | 455 | 52 | 62 |
| | 8 | 4157 | 4642 | 4631 | 3427 | 548 | 55 | 5218 | 3861 | 618 | 62 | 620 | 502 | 1576 | 1575 | 1230 | 1784 | 483 | 544 | 66 | 74 |
| | 10 | 2253 | 2343 | 2509 | 1857 | 297 | 30 | 2633 | 1949 | 312 | 31 | 336 | 253 | 854 | 795 | 667 | 900 | 261 | 274 | 36 | 37 |
| SB | 1 | 2889 | 2145 | 3218 | 2381 | 381 | 38 | 2410 | 1784 | 285 | 29 | 431 | 232 | 1095 | 728 | 855 | 824 | 335 | 251 | 46 | 34 |
| | 2 | 3063 | 2379 | 3413 | 2525 | 404 | 40 | 2674 | 1979 | 317 | 32 | 457 | 257 | 1162 | 807 | 907 | 914 | 356 | 279 | 48 | 38 |
| | 3 | 2879 | 2018 | 3208 | 2374 | 380 | 38 | 2268 | 1678 | 269 | 27 | 430 | 218 | 1092 | 685 | 852 | 775 | 334 | 236 | 46 | 32 |
| | 4 | 2879 | 2018 | 3208 | 2374 | 380 | 38 | 2268 | 1678 | 269 | 27 | 430 | 218 | 1092 | 685 | 852 | 775 | 334 | 236 | 46 | 32 |
| | 5 | 3420 | 3282 | 3810 | 2819 | 451 | 45 | 3689 | 2730 | 437 | 44 | 510 | 355 | 1297 | 1114 | 1012 | 1261 | 397 | 384 | 54 | 52 |
| | 6 | 3379 | 2690 | 3764 | 2786 | 446 | 45 | 3023 | 2237 | 358 | 36 | 504 | 291 | 1281 | 913 | 1000 | 1034 | 392 | 315 | 53 | 43 |
| | 7 | 3677 | 3265 | 4097 | 3032 | 485 | 49 | 3670 | 2716 | 434 | 43 | 549 | 353 | 1395 | 1108 | 1088 | 1255 | 427 | 382 | 58 | 52 |
| | 8 | 3982 | 3911 | 4436 | 3283 | 525 | 53 | 4396 | 3253 | 521 | 52 | 594 | 423 | 1510 | 1327 | 1178 | 1503 | 462 | 458 | 63 | 62 |
| | 10 | 2322 | 2289 | 2587 | 1914 | 306 | 31 | 2573 | 1904 | 305 | 30 | 347 | 248 | 881 | 777 | 687 | 880 | 270 | 268 | 37 | 37 |

# Sensitivity Testing Growth Factor -17%  - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 330 | 6674 | 208 | 5281 | 209 | 8399 | 119 | 3482 | 10 | 297 | 13 | 389 | 330 | 6674 | 208 | 5281 | 209 |
| | 2 | 226 | 7817 | 143 | 6186 | 143 | 9838 | 82 | 4079 | 7 | 348 | 9 | 455 | 226 | 7817 | 143 | 6186 | 143 |
| | 3 | 119 | 6285 | 75 | 4974 | 75 | 7910 | 43 | 3279 | 4 | 280 | 5 | 366 | 119 | 6285 | 75 | 4974 | 75 |
| | 4 | 2488 | 2205 | 1569 | 1745 | 1573 | 2775 | 896 | 1150 | 77 | 98 | 100 | 128 | 2488 | 2205 | 1569 | 1745 | 1573 |
| | 5 | 5618 | 4794 | 3542 | 3794 | 3551 | 6034 | 2024 | 2501 | 173 | 214 | 226 | 279 | 5618 | 4794 | 3542 | 3794 | 3551 |
| | 6 | 28442 | 26748 | 17932 | 21167 | 17977 | 33663 | 10246 | 13956 | 875 | 1191 | 1143 | 1557 | 28442 | 26748 | 17932 | 21167 | 17977 |
| | 7 | 118 | 229 | 75 | 181 | 75 | 288 | 43 | 120 | 4 | 10 | 5 | 13 | 118 | 229 | 75 | 181 | 75 |
| | 8 | 3318 | 2581 | 2092 | 2043 | 2097 | 3249 | 1195 | 1347 | 102 | 115 | 133 | 150 | 3318 | 2581 | 2092 | 2043 | 2097 |
| | 10 | 2079 | 1331 | 1311 | 1053 | 1314 | 1675 | 749 | 695 | 64 | 59 | 84 | 77 | 2079 | 1331 | 1311 | 1053 | 1314 |
| SB | 1 | 8201 | 372 | 5170 | 295 | 5183 | 468 | 2954 | 194 | 252 | 17 | 330 | 22 | 8201 | 372 | 5170 | 295 | 5183 |
| | 2 | 9923 | 96 | 6256 | 76 | 6272 | 121 | 3575 | 50 | 305 | 4 | 399 | 6 | 9923 | 96 | 6256 | 76 | 6272 |
| | 3 | 8097 | 74 | 5105 | 59 | 5118 | 93 | 2917 | 39 | 249 | 3 | 325 | 4 | 8097 | 74 | 5105 | 59 | 5118 |
| | 4 | 2460 | 95 | 1551 | 75 | 1555 | 119 | 886 | 49 | 76 | 4 | 99 | 6 | 2460 | 95 | 1551 | 75 | 1555 |
| | 5 | 6368 | 4257 | 4015 | 3369 | 4025 | 5358 | 2294 | 2221 | 196 | 190 | 256 | 248 | 6368 | 4257 | 4015 | 3369 | 4025 |
| | 6 | 31350 | 342 | 19766 | 271 | 19815 | 430 | 11294 | 178 | 964 | 15 | 1260 | 20 | 31350 | 342 | 19766 | 271 | 19815 |
| | 7 | 222 | 102 | 140 | 81 | 140 | 128 | 80 | 53 | 7 | 5 | 9 | 6 | 222 | 102 | 140 | 81 | 140 |
| | 8 | 276 | 261 | 174 | 207 | 174 | 329 | 99 | 136 | 8 | 12 | 11 | 15 | 276 | 261 | 174 | 207 | 174 |
| | 10 | 965 | 274 | 608 | 217 | 610 | 345 | 348 | 143 | 30 | 12 | 39 | 16 | 965 | 274 | 608 | 217 | 610 |
| | | 330 | 6674 | 208 | 5281 | 209 | 8399 | 119 | 3482 | 10 | 297 | 13 | 389 | 330 | 6674 | 208 | 5281 | 209 |
| | | | | | | | **Cost of delays per working day** | | | | | | | | | **£535,067** | | |
| | | | | | | | **Cost of delays per year (252 working days)** | | | | | | | | | **£134,836,939** | | |

# Sensitivity Testing Growth Factor -18%  - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Traffic Volumes Split by vehicle type** | | | | | | | | **Traffic volumes - split per vehicle type AND trip purpose** | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2573 | 1904 | 305 | 30 | 3754 | 2778 | 444 | 44 | 345 | 361 | 876 | 1133 | 683 | 1283 | 268 | 391 | 37 | 53 |
| | 2 | 2490 | 3469 | 2749 | 2034 | 325 | 33 | 3865 | 2860 | 458 | 46 | 368 | 372 | 936 | 1167 | 730 | 1321 | 286 | 403 | 39 | 55 |
| | 3 | 1996 | 3205 | 2203 | 1630 | 261 | 26 | 3570 | 2642 | 423 | 42 | 295 | 343 | 750 | 1078 | 585 | 1221 | 230 | 372 | 31 | 51 |
| | 4 | 2913 | 3705 | 3216 | 2380 | 381 | 38 | 4127 | 3054 | 489 | 49 | 431 | 397 | 1095 | 1246 | 854 | 1411 | 335 | 430 | 46 | 59 |
| | 5 | 3020 | 3698 | 3334 | 2467 | 395 | 39 | 4120 | 3049 | 488 | 49 | 446 | 396 | 1135 | 1244 | 886 | 1409 | 347 | 429 | 47 | 59 |
| | 6 | 3065 | 4137 | 3384 | 2504 | 401 | 40 | 4609 | 3411 | 546 | 55 | 453 | 443 | 1152 | 1392 | 899 | 1576 | 353 | 480 | 48 | 65 |
| | 7 | 3286 | 3886 | 3628 | 2685 | 430 | 43 | 4329 | 3203 | 513 | 51 | 486 | 416 | 1235 | 1307 | 964 | 1480 | 378 | 451 | 52 | 62 |
| | 8 | 4157 | 4642 | 4590 | 3396 | 543 | 54 | 5171 | 3827 | 612 | 61 | 615 | 497 | 1562 | 1561 | 1219 | 1768 | 478 | 539 | 65 | 73 |
| | 10 | 2253 | 2343 | 2487 | 1840 | 294 | 29 | 2610 | 1931 | 309 | 31 | 333 | 251 | 847 | 788 | 661 | 892 | 259 | 272 | 35 | 37 |
| SB | 1 | 2889 | 2145 | 3189 | 2360 | 378 | 38 | 2389 | 1768 | 283 | 28 | 427 | 230 | 1086 | 721 | 847 | 817 | 332 | 249 | 45 | 34 |
| | 2 | 3063 | 2379 | 3382 | 2503 | 400 | 40 | 2650 | 1961 | 314 | 31 | 453 | 255 | 1151 | 800 | 898 | 906 | 352 | 276 | 48 | 38 |
| | 3 | 2879 | 2018 | 3179 | 2352 | 376 | 38 | 2248 | 1663 | 266 | 27 | 426 | 216 | 1082 | 679 | 844 | 768 | 331 | 234 | 45 | 32 |
| | 4 | 2879 | 2018 | 3179 | 2352 | 376 | 38 | 2248 | 1663 | 266 | 27 | 426 | 216 | 1082 | 679 | 844 | 768 | 331 | 234 | 45 | 32 |
| | 5 | 3420 | 3282 | 3776 | 2794 | 447 | 45 | 3656 | 2706 | 433 | 43 | 506 | 352 | 1285 | 1104 | 1003 | 1250 | 393 | 381 | 54 | 52 |
| | 6 | 3379 | 2690 | 3730 | 2761 | 442 | 44 | 2997 | 2217 | 355 | 35 | 500 | 288 | 1270 | 905 | 991 | 1024 | 389 | 312 | 53 | 43 |
| | 7 | 3677 | 3265 | 4060 | 3004 | 481 | 48 | 3637 | 2691 | 431 | 43 | 544 | 350 | 1382 | 1098 | 1079 | 1243 | 423 | 379 | 58 | 52 |
| | 8 | 3982 | 3911 | 4396 | 3253 | 520 | 52 | 4357 | 3224 | 516 | 52 | 589 | 419 | 1496 | 1316 | 1168 | 1490 | 458 | 454 | 62 | 62 |
| | 10 | 2322 | 2289 | 2564 | 1897 | 304 | 30 | 2550 | 1887 | 302 | 30 | 343 | 245 | 873 | 770 | 681 | 872 | 267 | 266 | 36 | 36 |

# Sensitivity Testing Growth Factor -18% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 327 | 6614 | 206 | 5234 | 207 | 8324 | 118 | 3451 | 10 | 295 | 13 | 385 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 224 | 7747 | 141 | 6131 | 142 | 9750 | 81 | 4042 | 7 | 345 | 9 | 451 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 117 | 6229 | 74 | 4929 | 74 | 7839 | 42 | 3250 | 4 | 277 | 5 | 363 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2466 | 2185 | 1555 | 1729 | 1559 | 2750 | 888 | 1140 | 76 | 97 | 99 | 127 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5568 | 4752 | 3510 | 3760 | 3519 | 5980 | 2006 | 2479 | 171 | 212 | 224 | 277 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 28187 | 26510 | 17771 | 20979 | 17815 | 33364 | 10155 | 13832 | 867 | 1181 | 1133 | 1543 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 117 | 227 | 74 | 180 | 74 | 286 | 42 | 119 | 4 | 10 | 5 | 13 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3288 | 2558 | 2073 | 2025 | 2078 | 3220 | 1185 | 1335 | 101 | 114 | 132 | 149 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2061 | 1319 | 1299 | 1044 | 1303 | 1660 | 742 | 688 | 63 | 59 | 83 | 77 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8127 | 369 | 5124 | 292 | 5137 | 464 | 2928 | 192 | 250 | 16 | 327 | 21 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 9834 | 95 | 6200 | 76 | 6215 | 120 | 3543 | 50 | 302 | 4 | 395 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 8025 | 73 | 5059 | 58 | 5072 | 92 | 2891 | 38 | 247 | 3 | 323 | 4 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2438 | 94 | 1537 | 74 | 1541 | 118 | 878 | 49 | 75 | 4 | 98 | 5 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6311 | 4220 | 3979 | 3339 | 3989 | 5310 | 2273 | 2202 | 194 | 188 | 254 | 246 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 31069 | 339 | 19588 | 268 | 19637 | 427 | 11193 | 177 | 956 | 15 | 1249 | 20 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 220 | 101 | 139 | 80 | 139 | 127 | 79 | 53 | 7 | 4 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 273 | 259 | 172 | 205 | 173 | 326 | 99 | 135 | 8 | 12 | 11 | 15 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 956 | 271 | 603 | 215 | 604 | 342 | 345 | 142 | 29 | 12 | 38 | 16 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 327 | 6614 | 206 | 5234 | 207 | 8324 | 118 | 3451 | 10 | 295 | 13 | 385 |

| | |
|---|---|
| **Cost of delays per working day** | **£530,283** |
| **Cost of delays per year (252 working days)** | **£133,631,326** |

# Sensitivity Testing Growth Factor -19% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2549 | 1887 | 302 | 30 | 3720 | 2753 | 440 | 44 | 341 | 358 | 868 | 1123 | 677 | 1272 | 266 | 388 | 36 | 53 |
| | 2 | 2490 | 3469 | 2724 | 2016 | 322 | 32 | 3830 | 2834 | 453 | 45 | 365 | 368 | 927 | 1156 | 724 | 1309 | 284 | 399 | 39 | 54 |
| | 3 | 1996 | 3205 | 2183 | 1616 | 259 | 26 | 3538 | 2618 | 419 | 42 | 292 | 340 | 743 | 1068 | 580 | 1210 | 227 | 369 | 31 | 50 |
| | 4 | 2913 | 3705 | 3187 | 2358 | 377 | 38 | 4090 | 3027 | 484 | 48 | 427 | 393 | 1085 | 1235 | 847 | 1398 | 332 | 426 | 45 | 58 |
| | 5 | 3020 | 3698 | 3303 | 2444 | 391 | 39 | 4083 | 3021 | 483 | 48 | 442 | 393 | 1124 | 1233 | 878 | 1396 | 344 | 425 | 47 | 58 |
| | 6 | 3065 | 4137 | 3353 | 2481 | 397 | 40 | 4567 | 3380 | 541 | 54 | 449 | 439 | 1141 | 1379 | 891 | 1562 | 349 | 476 | 48 | 65 |
| | 7 | 3286 | 3886 | 3595 | 2660 | 426 | 43 | 4290 | 3175 | 508 | 51 | 482 | 413 | 1224 | 1295 | 955 | 1467 | 375 | 447 | 51 | 61 |
| | 8 | 4157 | 4642 | 4548 | 3366 | 538 | 54 | 5125 | 3792 | 607 | 61 | 609 | 493 | 1548 | 1547 | 1208 | 1752 | 474 | 534 | 65 | 73 |
| | 10 | 2253 | 2343 | 2464 | 1824 | 292 | 29 | 2587 | 1914 | 306 | 31 | 330 | 249 | 839 | 781 | 655 | 884 | 257 | 270 | 35 | 37 |
| SB | 1 | 2889 | 2145 | 3160 | 2338 | 374 | 37 | 2368 | 1752 | 280 | 28 | 423 | 228 | 1076 | 715 | 840 | 809 | 329 | 247 | 45 | 34 |
| | 2 | 3063 | 2379 | 3351 | 2480 | 397 | 40 | 2627 | 1944 | 311 | 31 | 449 | 253 | 1141 | 793 | 890 | 898 | 349 | 274 | 48 | 37 |
| | 3 | 2879 | 2018 | 3150 | 2331 | 373 | 37 | 2228 | 1648 | 264 | 26 | 422 | 214 | 1072 | 673 | 837 | 762 | 328 | 232 | 45 | 32 |
| | 4 | 2879 | 2018 | 3150 | 2331 | 373 | 37 | 2228 | 1648 | 264 | 26 | 422 | 214 | 1072 | 673 | 837 | 762 | 328 | 232 | 45 | 32 |
| | 5 | 3420 | 3282 | 3742 | 2769 | 443 | 44 | 3624 | 2681 | 429 | 43 | 501 | 349 | 1274 | 1094 | 994 | 1239 | 390 | 378 | 53 | 51 |
| | 6 | 3379 | 2690 | 3697 | 2736 | 438 | 44 | 2970 | 2198 | 352 | 35 | 495 | 286 | 1258 | 897 | 982 | 1015 | 385 | 309 | 53 | 42 |
| | 7 | 3677 | 3265 | 4023 | 2977 | 476 | 48 | 3604 | 2667 | 427 | 43 | 539 | 347 | 1369 | 1088 | 1069 | 1232 | 419 | 376 | 57 | 51 |
| | 8 | 3982 | 3911 | 4356 | 3224 | 516 | 52 | 4318 | 3195 | 511 | 51 | 583 | 415 | 1483 | 1304 | 1157 | 1476 | 454 | 450 | 62 | 61 |
| | 10 | 2322 | 2289 | 2541 | 1880 | 301 | 30 | 2527 | 1870 | 299 | 30 | 340 | 243 | 865 | 763 | 675 | 864 | 265 | 263 | 36 | 36 |

# Sensitivity Testing Growth Factor -19% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 324 | 6555 | 204 | 5187 | 205 | 8250 | 117 | 3420 | 10 | 292 | 13 | 382 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 222 | 7678 | 140 | 6076 | 141 | 9663 | 80 | 4006 | 7 | 342 | 9 | 447 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 116 | 6173 | 73 | 4885 | 74 | 7769 | 42 | 3221 | 4 | 275 | 5 | 359 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2443 | 2166 | 1541 | 1714 | 1544 | 2726 | 880 | 1130 | 75 | 96 | 98 | 126 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5517 | 4709 | 3479 | 3726 | 3487 | 5926 | 1988 | 2457 | 170 | 210 | 222 | 274 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 27932 | 26272 | 17610 | 20790 | 17654 | 33064 | 10063 | 13708 | 859 | 1170 | 1123 | 1529 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 116 | 225 | 73 | 178 | 73 | 283 | 42 | 117 | 4 | 10 | 5 | 13 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3259 | 2535 | 2054 | 2006 | 2060 | 3191 | 1174 | 1323 | 100 | 113 | 131 | 148 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2042 | 1308 | 1288 | 1035 | 1291 | 1646 | 736 | 682 | 63 | 58 | 82 | 76 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 8054 | 366 | 5078 | 289 | 5090 | 460 | 2901 | 191 | 248 | 16 | 324 | 21 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 9745 | 95 | 6144 | 75 | 6159 | 119 | 3511 | 49 | 300 | 4 | 392 | 6 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 7952 | 73 | 5014 | 58 | 5026 | 92 | 2865 | 38 | 245 | 3 | 320 | 4 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2415 | 93 | 1523 | 74 | 1527 | 117 | 870 | 48 | 74 | 4 | 97 | 5 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6253 | 4182 | 3943 | 3309 | 3952 | 5263 | 2253 | 2182 | 192 | 186 | 251 | 243 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 30787 | 336 | 19411 | 266 | 19459 | 423 | 11091 | 175 | 947 | 15 | 1238 | 20 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 218 | 100 | 137 | 79 | 138 | 126 | 78 | 52 | 7 | 4 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 271 | 257 | 171 | 203 | 171 | 323 | 98 | 134 | 8 | 11 | 11 | 15 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 948 | 269 | 597 | 213 | 599 | 338 | 341 | 140 | 29 | 12 | 38 | 16 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 324 | 6555 | 204 | 5187 | 205 | 8250 | 117 | 3420 | 10 | 292 | 13 | 382 |

| | |
|---|---|
| **Cost of delays per working day** | **£525,499** |
| **Cost of delays per year (252 working days)** | **£132,425,714** |

# Sensitivity Testing Growth Factor -20% - From traffic flows to cost of delays (1 of 2)

| | | 2031 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traffic Volumes Split by vehicle type | | | | | | | | Traffic volumes - split per vehicle type AND trip purpose | | | | | | | | | | | |
| | | Volume AM (veh) | | | | Volume PM (veh) | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | All traffic | Car | LGV | HGV | All traffic | Car | LGV | HGV | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 2330 | 3370 | 2526 | 1869 | 299 | 30 | 3687 | 2728 | 436 | 44 | 338 | 355 | 860 | 1113 | 671 | 1260 | 263 | 384 | 36 | 52 |
| | 2 | 2490 | 3469 | 2699 | 1997 | 320 | 32 | 3795 | 2809 | 449 | 45 | 361 | 365 | 919 | 1146 | 717 | 1298 | 281 | 395 | 38 | 54 |
| | 3 | 1996 | 3205 | 2163 | 1601 | 256 | 26 | 3506 | 2595 | 415 | 42 | 290 | 337 | 736 | 1059 | 575 | 1199 | 225 | 365 | 31 | 50 |
| | 4 | 2913 | 3705 | 3157 | 2336 | 374 | 37 | 4053 | 2999 | 480 | 48 | 423 | 390 | 1075 | 1224 | 839 | 1386 | 329 | 422 | 45 | 58 |
| | 5 | 3020 | 3698 | 3273 | 2422 | 388 | 39 | 4046 | 2994 | 479 | 48 | 438 | 389 | 1114 | 1222 | 870 | 1383 | 341 | 422 | 47 | 57 |
| | 6 | 3065 | 4137 | 3322 | 2458 | 393 | 39 | 4526 | 3349 | 536 | 54 | 445 | 435 | 1131 | 1367 | 883 | 1547 | 346 | 472 | 47 | 64 |
| | 7 | 3286 | 3886 | 3562 | 2636 | 422 | 42 | 4251 | 3146 | 503 | 50 | 477 | 409 | 1213 | 1283 | 946 | 1453 | 371 | 443 | 51 | 60 |
| | 8 | 4157 | 4642 | 4506 | 3335 | 534 | 53 | 5079 | 3758 | 601 | 60 | 604 | 489 | 1534 | 1533 | 1197 | 1736 | 470 | 529 | 64 | 72 |
| | 10 | 2253 | 2343 | 2442 | 1807 | 289 | 29 | 2563 | 1897 | 303 | 30 | 327 | 247 | 831 | 774 | 649 | 876 | 254 | 267 | 35 | 36 |
| SB | 1 | 2889 | 2145 | 3131 | 2317 | 371 | 37 | 2346 | 1736 | 278 | 28 | 419 | 226 | 1066 | 708 | 832 | 802 | 326 | 244 | 44 | 33 |
| | 2 | 3063 | 2379 | 3321 | 2457 | 393 | 39 | 2603 | 1926 | 308 | 31 | 445 | 250 | 1130 | 786 | 882 | 890 | 346 | 271 | 47 | 37 |
| | 3 | 2879 | 2018 | 3121 | 2310 | 370 | 37 | 2207 | 1633 | 261 | 26 | 418 | 212 | 1062 | 666 | 829 | 755 | 325 | 230 | 44 | 31 |
| | 4 | 2879 | 2018 | 3121 | 2310 | 370 | 37 | 2207 | 1633 | 261 | 26 | 418 | 212 | 1062 | 666 | 829 | 755 | 325 | 230 | 44 | 31 |
| | 5 | 3420 | 3282 | 3707 | 2743 | 439 | 44 | 3591 | 2657 | 425 | 43 | 497 | 345 | 1262 | 1084 | 985 | 1228 | 386 | 374 | 53 | 51 |
| | 6 | 3379 | 2690 | 3663 | 2711 | 434 | 43 | 2943 | 2178 | 348 | 35 | 491 | 283 | 1247 | 888 | 973 | 1006 | 382 | 307 | 52 | 42 |
| | 7 | 3677 | 3265 | 3986 | 2950 | 472 | 47 | 3572 | 2643 | 423 | 42 | 534 | 344 | 1357 | 1078 | 1059 | 1221 | 415 | 372 | 57 | 51 |
| | 8 | 3982 | 3911 | 4316 | 3194 | 511 | 51 | 4279 | 3167 | 507 | 51 | 578 | 412 | 1469 | 1292 | 1147 | 1463 | 450 | 446 | 61 | 61 |
| | 10 | 2322 | 2289 | 2517 | 1863 | 298 | 30 | 2504 | 1853 | 297 | 30 | 337 | 241 | 857 | 756 | 669 | 856 | 262 | 261 | 36 | 36 |

# Sensitivity Testing Growth Factor -20% - From traffic flows to cost of delays (2 of 2)

| | | 2031 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delays | | | | | Cost (£) of delays - split per vehicle type AND trip purpose | | | | | | | | | | |
| | | | | | | | Car | | | | | | LGV | | | | HGV | |
| | Road Sections | Free Flow Time (sec) | Time AM (sec) | AM Delay per vehicle (hours) | Time PM (sec) | PM delay per vehicle (hours) | AM: Work | PM: Work | AM: Commute | PM: Commute | AM: Other | PM: Other | AM: Work | PM: Work | AM: Non-work | PM: Non-work | AM | PM |
| NB | 1 | 232 | 307 | 0.021 | 1740 | 0.419 | 321 | 6496 | 203 | 5140 | 203 | 8175 | 116 | 3389 | 10 | 289 | 13 | 378 |
| | 2 | 267 | 315 | 0.013 | 1982 | 0.477 | 220 | 7608 | 139 | 6021 | 139 | 9575 | 79 | 3970 | 7 | 339 | 9 | 443 |
| | 3 | 230 | 262 | 0.009 | 1723 | 0.415 | 115 | 6117 | 73 | 4841 | 73 | 7699 | 42 | 3192 | 4 | 272 | 5 | 356 |
| | 4 | 70 | 523 | 0.126 | 523 | 0.126 | 2421 | 2146 | 1526 | 1698 | 1530 | 2701 | 872 | 1120 | 74 | 96 | 97 | 125 |
| | 5 | 153 | 1140 | 0.274 | 1140 | 0.274 | 5467 | 4666 | 3447 | 3693 | 3455 | 5873 | 1970 | 2435 | 168 | 208 | 220 | 272 |
| | 6 | 761 | 5683 | 1.367 | 5683 | 1.367 | 27676 | 26034 | 17449 | 20602 | 17493 | 32765 | 9971 | 13583 | 851 | 1160 | 1112 | 1516 |
| | 7 | 101 | 120 | 0.005 | 146 | 0.012 | 115 | 223 | 73 | 177 | 73 | 281 | 41 | 116 | 4 | 10 | 5 | 13 |
| | 8 | 66 | 490 | 0.118 | 490 | 0.118 | 3229 | 2512 | 2036 | 1988 | 2041 | 3162 | 1163 | 1311 | 99 | 112 | 130 | 146 |
| | 10 | 591 | 1081 | 0.136 | 1024 | 0.120 | 2023 | 1296 | 1276 | 1025 | 1279 | 1631 | 729 | 676 | 62 | 58 | 81 | 75 |
| SB | 1 | 234 | 1740 | 0.418 | 366 | 0.037 | 7980 | 362 | 5031 | 287 | 5044 | 456 | 2875 | 189 | 245 | 16 | 321 | 21 |
| | 2 | 264 | 1982 | 0.477 | 295 | 0.009 | 9656 | 94 | 6088 | 74 | 6103 | 118 | 3478 | 49 | 297 | 4 | 388 | 5 |
| | 3 | 231 | 1723 | 0.414 | 259 | 0.008 | 7879 | 72 | 4968 | 57 | 4980 | 91 | 2839 | 38 | 242 | 3 | 317 | 4 |
| | 4 | 70 | 523 | 0.126 | 106 | 0.010 | 2393 | 92 | 1509 | 73 | 1513 | 116 | 862 | 48 | 74 | 4 | 96 | 5 |
| | 5 | 152 | 1140 | 0.274 | 1140 | 0.274 | 6196 | 4144 | 3907 | 3279 | 3916 | 5215 | 2232 | 2162 | 191 | 185 | 249 | 241 |
| | 6 | 762 | 5683 | 1.367 | 859 | 0.027 | 30506 | 333 | 19233 | 263 | 19281 | 419 | 10990 | 174 | 938 | 15 | 1226 | 19 |
| | 7 | 102 | 134 | 0.009 | 126 | 0.007 | 216 | 99 | 136 | 78 | 136 | 125 | 78 | 52 | 7 | 4 | 9 | 6 |
| | 8 | 65 | 102 | 0.010 | 116 | 0.014 | 268 | 254 | 169 | 201 | 170 | 320 | 97 | 133 | 8 | 11 | 11 | 15 |
| | 10 | 586 | 806 | 0.061 | 677 | 0.025 | 939 | 267 | 592 | 211 | 593 | 335 | 338 | 139 | 29 | 12 | 38 | 16 |
| | | 232 | 307 | 0.021 | 1740 | 0.419 | 321 | 6496 | 203 | 5140 | 203 | 8175 | 116 | 3389 | 10 | 289 | 13 | 378 |
| | | | | | | | Cost of delays per working day | | | | | | | | | | £520,715 | |
| | | | | | | | Cost of delays per year (252 working days) | | | | | | | | | | £131,220,101 | |