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M4 Corridor around Newport

Economic Appraisal Report

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Contents

1 The Project

1.1 Context

1.1.1 The Welsh Government has awarded a Professional Services Contract for the next stage of Scheme development and environmental surveys for the M4 Corridor around Newport Project (the "Scheme") up to publication of draft Orders and an Environmental Statement. The contract has been awarded to a Joint Venture of Costain, Vinci and Taylor Woodrow with consultants Arup and Atkins, supported by sub-consultant RPS. The team shall be developing proposals in anticipation of publishing draft Orders and an Environmental Statement in Spring 2016 and a Public Local Inquiry later that year. This process will then inform the next stage of Ministerial decision making.

1.1.2 Since 1989 there have been various studies to identify the problems and propose possible solutions. The M4 Corridor around Newport WelTAG Stage 1 (Strategy Level) Appraisal concluded that a new section of 3-lane motorway to the south of Newport following a protected (TR111) route, in addition to complementary measures, would best achieve the goals and address the problems of the M4 Corridor around Newport and should be progressed for further appraisal. These options have subsequently formed the basis for the development of the draft Plan, which was published in September 2013 and was the subject of public consultation from September to December 2013.

1.1.3 Having taken into account the responses to this participation process, as well as the assessments of the draft Plan, the Welsh Government has decided to publish a Plan for the M4 Corridor around Newport. Alongside this Plan, the Welsh Government has published updated strategy-level reports, including a Strategic Environmental Assessment Statement, to demonstrate how the participation process has informed its decision making. It also announced in July 2014 a revised preferred route, which will protect a corridor for planning purposes. These documents can be accessed from the website http://m4newport.com.

1.2 Scheme objectives and reason for the Scheme

1.2.1 The aims of the Welsh Government for the M4 Corridor around Newport are to:

a) Make it easier and safer for people to access their homes, workplaces and services by walking, cycling, public transport or road.

b) Deliver a more efficient and sustainable transport network supporting and encouraging long-term prosperity in the region, across Wales, and enabling access to international markets.

c) To produce positive effects overall on people and the environment, making a positive contribution to the over-arching Welsh Government goals to reduce greenhouse gas emissions and to making Wales more resilient to the effects of climate change.

1.2.2 The Scheme aims to help to achieve or facilitate these aims as part of a wider transport strategy for South East Wales, as outlined within the Prioritised National Transport Plan.

1.2.3 The Transport Planning Objectives (TPOs), or goals, are:

- TPO 1: Safer, easier and more reliable travel east-west in South Wales.
- TPO 2: Improved transport connections within Wales and to England, the Republic of Ireland and the rest of Europe on all modes on the international transport network.

- TPO 3: More effective and integrated use of alternatives to the M4, including other parts of the transport network and other modes of transport for local and strategic journeys around Newport.
- TPO 4: Best possible use of the existing M4, local road network and other transport networks.
- TPO 5: More reliable journey times along the M4 Corridor.
- TPO 6: Increased level of choice for all people making journeys within the transport Corridor by all modes between Magor and Castleton, commensurate with demand for alternatives.
- TPO 7: Improved safety on the M4 Corridor between Magor and Castleton.
- TPO 8: Improved air quality in areas next to the M4 around Newport.
- TPO 9: Reduced disturbance to people from high noise levels, from all transport modes and traffic within the M4 Corridor.
- TPO 10: Reduced greenhouse gas emissions per vehicle and/or person kilometre.
- TPO 11: Improved travel experience into South Wales along the M4 Corridor.
- TPO 12: An M4 attractive for strategic journeys that discourages local traffic use.
- TPO 13: Improved traffic management in and around Newport on the M4 Corridor.
- TPO 14: Easier access to local key services and residential and commercial centres.
- TPO 15: A cultural shift in travel behaviour towards more sustainable choices.

2 Introduction

2.1 Scope of this Report

2.1.1 The purpose of this Economic Appraisal Report is to provide a detailed summary of the economic appraisal undertaken for the M4 CAN scheme at Key Stage 3. The report outlines the methodology and assumptions adopted in undertaking the economic assessment and presents the results of the appraisal.

2.1.2

2.2 Report Structure

2.2.1 Following this introduction, the report is structured as follows:

- Chapter 3 provides information on the Scheme and the traffic forecasts used as the basis for the economic appraisal;
- Chapter 4 outlines the approach used for the economic appraisal;
- Chapter 5 details the cost estimates for the Scheme used in the appraisal;
- Chapter 6 provides an overview of the different categories of benefits assessed for the Scheme;
- Chapter 7 presents the results of the economic appraisal for a Core Scenario and for a range of sensitivity tests;
- Chapter 8 describes the assessment of wider economic benefits; and
- Chapter 9 contains concluding comments.

3 M4CaN Transport Model

3.1 M4CaN Transport Model

3.1.1 The basis for forecasting is the M4CaN transport model which has been validated for a 2014 base year. The development and the validation of the base year traffic model has been detailed in the Local Model Validation Report (LMVR)[1]. Further details on the approach to traffic forecasting is provided in the Traffic Forecasting Report (TFR)[2].

3.1.2 There are three components of the M4CaN transport model. The first component is the highway assignment model which provides a representation of the highway network within the study area, the traffic using it and the resulting traffic conditions.

3.1.3 The second component, a variable demand model (VDM), is also necessary for a scheme of this scale. This is to ensure that changes in travel demand in response to changes in travel costs that result from the Scheme are taken into account in the Scheme appraisal such as changes in travel mode used and/or a change in trip destination.

3.1.4 The third component of the M4CaN model is a public transport module, which allows highway demand to respond to public transport changes. The separate public transport module, which replicates bus and rail services in the modelled area, was built using 2014 data provided by the public transport operators and supplemented by survey data.

3.1.5 Travel costs from the highway and public transport assignment models both feed into the VDM to enable changes in highway demand to be calculated. The changes in forecast demand produced by the VDM are then fed back into the highway assignment model for a final assignment of the highway demand to the road network which produces the forecast of traffic flows on each link and conditions on the highway network.

3.1.6 The M4CaN transport model has been used to produce forecasts for a 'Do Minimum' scenario, which represents the future situation without the Scheme, and a 'Do Something' scenario which represents the future situation with the Scheme. It is the comparison of these two future situations which provides the basis for the economic appraisal.

3.1.7 The M4CaN transport model represents typical operational conditions on the highway network in terms of average flows and speeds on a normal day of operation. The model does not reflect those occasions when a major incident may have occurred which results in severe reduction in network performance. In such instances periods of congestion, during which journey times significantly increase, imposing additional costs to the travelling public.

3.2 Highway Assignment Model

3.2.1 The highway assignment model uses SATURN modelling software (Simulation and Assignment of Traffic in Urban Road Networks). It incorporates separate assignments for the AM and PM peak hour and a representative interpeak hour, each including capacity restraint mechanisms through junction simulation and speed-flow relationships.

3.2.2 Five user classes are represented in the assignment model:

- Car – employer's business trips;
- Car – commuter trips;

[1] M4 Corridor around Newport –Local Model Validation Report, Arup, August 2015
[2] M4 Corridor around Newport – Traffic Forecasting Report, Arup, January 2016

- Car – other trips;
- Light goods vehicle (LGV); and
- Heavy goods vehicle (HGV).

3.2.3 The core area of the traffic model covers the M4 between Junction 30 in the west and Junction 21 in the east, including junctions 29 and 23 that are the western and eastern ends respectively of the proposed new section of motorway. Within this core area are key roads/corridors of interest including:

- the existing M4 and proposed new section of motorway to the South of Newport;
- the M48 motorway;
- access routes to the existing M4 and M48 motorways from Cardiff, Newport, Chepstow and the hinterland north of Newport;
- the corridors on the east and west banks of the River Usk that could connect Central Newport to the M4 motorway to the south of Newport via intermediate junction(s); and
- east / west routes through Newport via Newport Bridge, George Street Bridge and the Southern Distributor Road (SDR).

3.2.4 The core area is modelled at a high level of detail (SATURN simulation network). Outside this core area is a large area-of-influence where changes in traffic flow may be experienced following opening of the M4 motorway to the south of Newport. This extends to Skewen (M4 J43) in the west, the A465 Heads of the Valleys Road and M50 in the north, and the M5 J8 to 18a in the east. The area-of-influence is modelled at a lower level of detail (SATURN buffer network).

3.2.5 The M4 CAN transport model network coverage is shown in Figures 3.2 and 3.3.

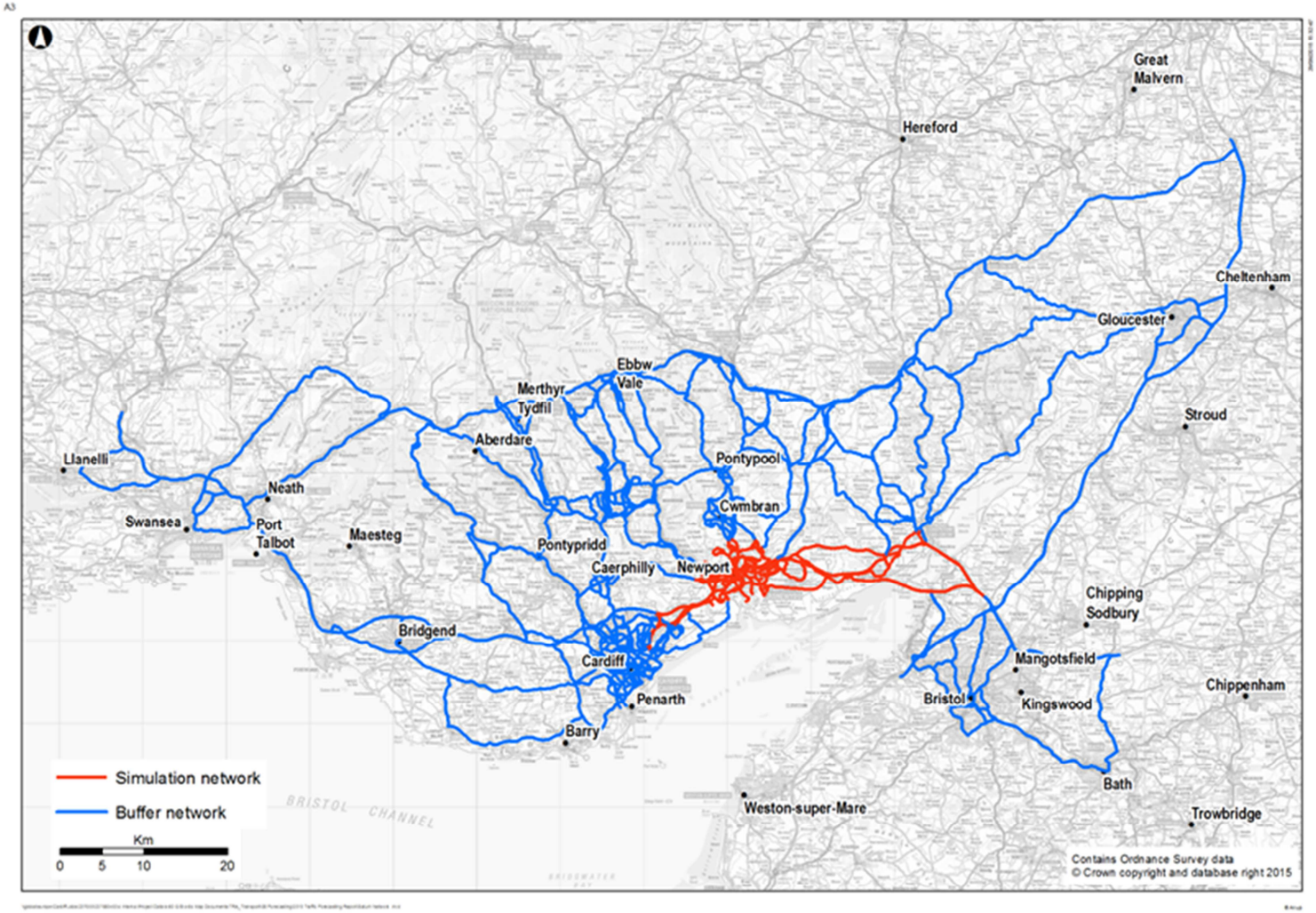

Figure 3.2 – Full Model Network

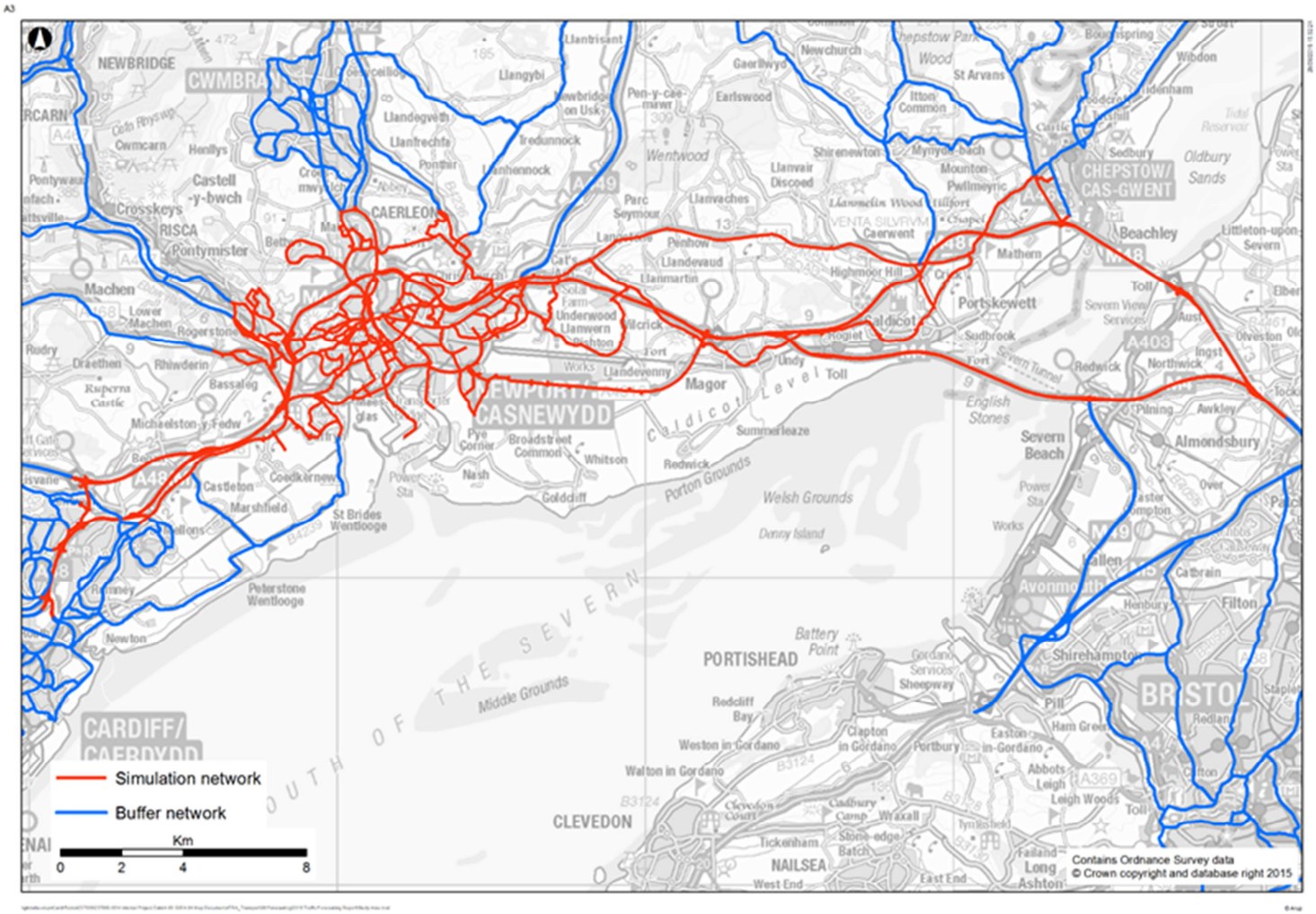

Figure 3.3 – Core Simulation Network

3.3 Public Transport Model

3.3.1 Demand and costs from the public transport model feed into the VDM to enable mode choice modelling for movements where mode switch could have a material impact on highway flows and/or the transport benefits of the proposed new motorway south of Newport. Therefore the public transport model comprises passengers who are able to switch to car and who would travel in the M4 corridor if they switched. As such the public transport model covers:

- All rail journeys in the corridor Cardiff – Newport – Chepstow / Severn Tunnel
- All bus journeys between Newport and Cardiff.

3.3.2 The public transport assignment model was developed using EMME software (version 4.1.4), where the public transport trips were loaded onto the networks to determine the public transport times and fares between all the zones in the model.

3.4 Demand Model

3.4.1 The variable demand modelling was undertaken using DIADEM software (version 5.0.9, 64-bit). The demand model is an incremental[3] multinomial logit model[4].

3.4.2 The demand model applies variable demand by using the base year costs and the Reference Case trip patterns, derived from the base year trip matrix assuming no changes in travel costs. The demand model then pivots off the base year assignment to create the Do Minimum matrix accounting for:

- Transport interventions between the base year and the forecast year;
- Increases in the value of time resulting from real increases in income;
- Increases in levels of congestion arising from increased car usage; and
- Increases in fuel efficiency that make car travel cheaper.

3.4.3 The Do Something scenario is then generated by pivoting off the converged Do Minimum Scenario.

3.4.4 Realism testing on the base year traffic model was undertaken to ensure that the M4 traffic model responds to changes in travel costs in a realistic way. Further details of the base year realism testing are given in the LMVR.

3.4.5 A systematic approach has been adopted in building up the Variable Demand Model (VDM) forecasts. The Core Scenario Reference Case matrices were developed first and changes in travel patterns compared with the 2014 base year. The Core Scenario Do Minimum forecasts were then produced and changes in travel patterns compared with the respective Reference Case for each of the two modelled years 2022 and 2037. Finally, the Core Scenario Do Something forecasts were produced and changes in travel patterns compared with the Do Minimum.

[3] An *incremental* demand model compares generalised costs of travel of a scenario against those of another model scenario in order to estimate how the *change* will affect travel demand and travel patterns. This process is referred to as *cost pivoting* or *pivoting off* another scenario.

[4] A *logit model* is the conventional form of demand model used when a discrete choice is available, such as the choice between travelling by car or public transport. Its *multinomial* variant is used where numerous discrete choices are available. The key application of the *multinomial* model is when people decide to change their trip destination, for example the location where they work or shop, as a result of the improved generalised costs of travel provided by the Scheme.

3.4.6 Variable Demand Modelling is carried out for car trips but not for freight trips, as it is assumed that while freight traffic is susceptible to re-routeing the total demand for freight traffic is fixed[5]. For car trips, the variable demand parameters can vary significantly between different trip purposes, reflecting the likelihood that the demand for more essential travel, such as employer's business trips, may be less affected by congestion than discretionary travel demand, such as leisure trips.

3.5 Traffic Forecasts and Sensitivity Tests

3.5.1 The validated 2014 base model has been used to develop forecast reference demand matrices for two future years: 2022 (the Scheme opening year) and 2037 (the design year).

3.5.2 Figure 1 of TAG Unit M4 Forecasting and Uncertainty describes the methodology to be followed to produce a set of forecasts. This figure is reproduced as Figure 3.4.

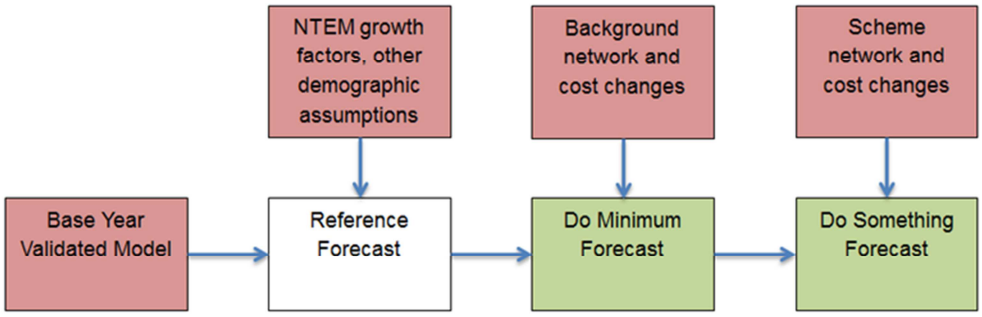

Figure 3.4 – Basic Approach to Forecasting Using a Transport Model

3.5.3 The guidance in TAG Unit M4 defines a 'Core Scenario' for forecasting as *"a scenario based on the most unbiased and realistic set of assumptions that will form the central case that is presented in the Appraisal Summary Table (AST)"*

3.5.4 The forecast core scenario for the M4 CAN has been identified based on the above guidance and comprise:

- Growth assumptions from the National Trip End Model (NTEM) for car trips and National Transport Model (NTM) for freight trips
- Inclusion of proposed developments in Newport, Monmouthshire and Cardiff, which have been deemed to be 'near certain' or 'more than likely' to occur
- Inclusion of transport schemes which have been deemed to be 'near certain' or 'more than likely' to occur
- Removal of the Severn Crossing Tolls in accordance with the Severn Bridges Act 1992.

3.5.5 Details of the developments and transport schemes which have been included in the M4 CAN forecast scenarios are given in Appendix A.

3.5.6 The Severn Bridges Act 1992 enables the Secretary of State, once in public ownership, to retain tolls on the Severn Crossings until no later than 2027. The opening year for the Scheme is 2022 such that tolling could feasibly be in place for the first five years of the appraisal period.

[5] Transport Analysis Guidance Unit M2 Variable Demand Modelling, Department for Transport, January 2014

3.5.7 In addition to the central growth reference demand, low and high growth forecasts have been prepared in accordance with TAG Unit M4. The economic appraisal has also been undertaken for these scenarios to test the sensitivity of the appraisal result under higher or lower than expected traffic growth.

4 Approach to Economic Appraisal

4.1 Principles of Appraisal

4.1.1 Guidance on undertaking economic appraisals for transport schemes is given in WebTAG[6,7]. The economic appraisal considers the costs and benefits of a transport scheme that are accrued over a 60 year period in monetary terms. In order to ensure consistency, all monetary values are discounted to a common price base to give 'present values'. The current price base year for economic assessments stipulated by the Guidance is 2010.

4.1.2 Benefits relating to the 'economic efficiency' of the transport system are presented in the form of a Transport Economic Efficiency (TEE) table. These benefits are made up of the following:

- journey time savings;
- vehicle operating cost savings;
- user charges, such as tolls; and
- additional costs to travellers due to disruption during construction and maintenance works.

4.1.3 The TEE table also includes private sector impacts, such as revenue, operating and investment costs and any grants or subsidies.

4.1.4 The 'public accounts' table relates to the costs faced by Government (either local or central) to implement the Scheme. They include the following:

- revenue (for example through the introduction of tolls);
- operating costs;
- investment costs;
- developer and other contributions (not applicable);
- grant/subsidy payments (not applicable); and
- indirect tax revenues to Central Government through, for example, fuel duty that result from the Scheme.

4.1.5 The overall Analysis of Monetised Costs and Benefits table also includes benefits or impacts due to changes in greenhouse gas emissions, and changes in the rate of accidents. These benefits would be negative if the situation were to worsen. Revenues to Government are also included. Such revenues typically relate to changes in tax revenues as a result of the Scheme. Changes in tax revenues are directly linked to changes in fuel expenditure, which is a function of speed and distance of travel.

4.1.6 The total benefits are compared with the 'Broad Transport Budget' from the public accounts identified above, in order to determine the value for money of the Scheme. The outputs of the economic assessment are summarised in the Net Present Value (NPV) for the Scheme – the sum of discounted costs and benefits – and the Benefit Cost Ratio (BCR) – the ratio of benefits to costs.

4.1.7 An assessment of 'Wider Impacts' has also been undertaken. Wider Impacts is the term given to a range of economic impacts of transport improvements that are additional to the

[6] Transport Analysis Guidance, Cost-Benefit Analysis, TAG Unit A1.1, Department for Transport, November 2014
[7] Transport Analysis Guidance, User and Provider Impacts, TAG Unit A1.3, Department for Transport, November 2014

transport user benefits listed above. An 'adjusted BCR' is provided which should also be taken account of in the overall assessment of value for money.

4.1.8 It should be noted that the economic appraisal captures costs and benefits that can be feasibly monetised. A range of other impacts of the Scheme that are not monetised may also be taken into account in assessing the value for money of the Scheme.

4.1.9 The calculation of transport user benefits is based on outputs from the M4 CaN transport model. As noted, the model represents typical operational conditions on the highway network in terms of average flows and speeds on a normal day of operation. The model does not reflect those occasions when a major incident may have occurred which results in severe reduction in network performance. In such instances periods of congestion, during which journey times significantly increase, imposing additional costs to the travelling public.

4.1.10 As a result benefits of the Scheme that relate to improvements journey time reliability or network resilience have not been quantified and are excluded from the BCRs presented in this report.

4.2 Software

4.2.1 TUBA (**T**ransport **U**ser **B**enefit **A**ppraisal) software (version 1.9.5) has been used to undertake the economic assessment for the motorway to the south of Newport. This software has been produced by the Department for Transport (DfT) to carry out transport scheme economic appraisal using a 'willingness to pay' approach with fixed or variable demand. The economic impacts of a scheme are derived by comparing the future year situation with the Scheme (Do Something scenario) to the situation without the Scheme (Do Minimum).

4.2.2 TUBA uses data taken from the traffic model forecasts on the number of trips, average journey times and average distances to calculate the TEE and greenhouse gas impacts in accordance with the WebTAG methodology. The Scheme investment and operating costs are also input to the TUBA software such that an overall comparison of costs and benefits can be made.

5 Costs

5.1 Investment Costs

5.1.1 There are three main elements of the Scheme cost estimate:

- the base cost – the basic costs of constructing the Scheme before allowing for risks;
- adjustment for risk – which covers all the identified risks as assessed and quantified through a Quantified Risk Assessment resulting in the risk-adjusted cost estimate; and
- adjustment for optimism bias – to reflect the systematic bias for estimated scheme costs and delivery times to be too low and too short respectively. This results in an increase to the cost estimate.

5.1.2 For the purposes of the economic appraisal, costs are included to account for the reclassification of the existing route and for the reconfiguration of Caerleon which form part of the M4 CaN proposal and are included in the traffic modelling.

Table 5.1: Scheme Budget (Q4 2015 prices)

Component	Estimate
Preliminaries including Traffic Management	£212,000,000
Roadworks	£268,000,000
Structures	£290,997,000
Landscaping and environmental works	£44,751,316
Works by other authorities	£38,281,191
Land and Compensation costs	£91,965,717
Risk and Optimism Bias	£147,158,658
Project Estimate excluding VAT and Inflation	**£1,093,153,881**
Key Stage 4 Costs	£22,000,000
Reclassification and reconfiguration of Caerleon Junction[8] (including Optimism Bias)	£16,189,217
Total Costs for Economic Appraisal	**£1,131,343,098**

5.1.3 The investment costs (ie capital costs) are distinguished from operating costs. The main components of the investment costs for the Scheme that are input to the TUBA software are:

- **Construction costs,** including main works, ancillary works, statutory undertakings, site supervision and testing;
- **Land and property costs,** including compensation; and
- **Preparation and Supervision costs**, including project management, design, public consultation, Public Inquiry, gaining statutory powers, surveys, compensation, supervision and testing.

5.1.4 In the context of the appraisal, there is likely to be some difference between what is expected and what actually happens. This may be due to bias, which may be unwittingly inherent in the appraisal, as well as risks and uncertainties that might materialise during

[8] These costs are not being delivered as part of the contract to construct the proposed new motorway.

the course of the project. It is thus important to identify and mitigate risks and make allowances for "optimism bias".

5.1.5 In order to adjust the base cost for the risks associated with the cost of the Scheme, a Quantified Risk Assessment has been undertaken.

5.1.6 An assessment of the appropriate level of optimism bias for the Scheme has been undertaken in accordance with WebTAG (Unit A1-2) and the HMT Green Book Supplementary Guidance on Optimism Bias.

5.1.7 The resultant optimism bias level for the new motorway is an uplift of 4.87% which equates to approximately £51m. In addition to this, complementary measures – for which early stage cost estimates (excluding risk) are available – are subject to optimism bias of 44%.

5.1.8 The Scheme cost estimates that are input to the appraisal software are shown in Table 5.2, based on 2015 prices. The allowance for VAT is excluded from the cost estimates input to the economic appraisal.

Table 5.2: Scheme Cost Estimate (2015 Prices)

Item		Cost (£)	Optimism Bias (£)	Total (£)
New section of motorway	Construction	941,402,149	45,846,285	987,248,434
	Land	91,965,717	4,478,730	96,444,447
	Preparation	22,000,000	1,071,400	23,071,400
	Supervision	8,000,000	389,600	8,389,600
	Total	**1,063,367,87**	**51,786,015**	**1,115,153,881**
Reclassification Works	Construction	10,680,572	4,699,451	15,380,023
	Land	-	-	-
	Preparation	481,836	212,008	693,844
	Supervision	80,104	35,246	115,350
	Total	**11,242,512**	**4,946,705**	**16,189,217**
Total Scheme Costs	Construction	952,082,721	50,545,736	1,002,628,457
	Land	91,965,717	4,478,730	96,444,447
	Preparation	22,481,836	1,283,408	23,765,244
	Supervision	8,080,104	424,846	8,504,950
	Total	**1,074,610,378**	**56,732,720**	**1,131,343,098**

5.2 Maintenance Costs

5.2.1 In addition to the investment costs, it is necessary for the economic assessment to take account of the cost of maintaining both the new section of motorway and the existing M4 during the 60-year assessment period.

5.2.2 Following discussions with the Welsh Government, a draft maintenance schedule has been devised for two scenarios:

- Do Minimum: the cost of maintaining the existing M4 between Junction 23 and Junction 29; and
- Do Something: the cost of maintaining both the existing M4 and the proposed scheme.

5.2.3 The maintenance schedules include a recurring cycle of resurfacing / overlay / reconstruction of different sections of the motorway, together with major maintenance of structures and annual routine maintenance.

5.2.4 The maintenance costs included in the economic assessment, which have been estimated by the Welsh Government, are shown in Table 5.3.

Table 5.3: Estimated 60-Year Maintenance Costs (2014 Prices)

	Maintenance Costs (£)		
	Existing M4	Proposed Scheme	Total
Do Minimum	308,864,170	-	308,864,170
Do Something	279,336,610	247,467,510	526,804,120

6 Estimation of Benefits

6.1 Economic Parameters

6.1.1 WebTAG Guidance[9] provides details of the default economic data that should be adopted for the economic appraisal of transport schemes. TUBA has a standard economics file that contains the default data from WebTAG which includes the following:

- Present value discount rates;
- Values of time and estimated rates of change;
- Tax rates and estimated rates of change;
- Carbon dioxide emission rates;
- Monetary values of carbon dioxide emissions;
- Proportion of petrol and diesel within vehicle fleet and estimated rates of change;
- Parameters for fuel consumption (related to travel distances and times);
- Fuel costs and estimated rates of change;
- Rates of change in fuel efficiency;
- Non fuel vehicle operating cost parameters (related to travel distance and times) and estimated changes;
- Trip purpose proportions; and
- Vehicle occupancies.

6.1.2 The economic parameters file also includes default journey purpose splits for each vehicle type. However, as the output from the traffic model was given by journey purpose, this was used in preference to the default values.

6.1.3 We are aware that Department for Transport has been out to consultation on new Values of Time. They are still to advise of the outcome of the consultation and whether the new Values of Time will be incorporated into WebTAG. It will be up to Welsh Ministers to decide whether to adopt any changes.

6.2 Appraisal Period and Modelled Years

6.2.1 The proposed opening year for the Scheme is 2022. It is assumed that construction of the Scheme would commence in 2018. The appraisal covers a 60 year period, starting with the Scheme opening year, 2022, up to 2081.

6.2.2 The TUBA appraisal has taken data from the traffic model forecasts, which have been prepared for 2022 and 2037. TUBA calculates the benefits for each of the modelled forecast years and then interpolates to calculate the benefits for the intervening years. After the last modelled year, the default TUBA assumption is that there is no change in traffic patterns and so the benefits do not change, but they are discounted back over a longer period of time to the economic base year of 2010.

[9] Transport Analysis Guidance: TAG data book, Department for Transport, November 2014

6.3 Annualisation Factors

6.3.1 Annualisation factors have been calculated to convert the traffic model output from the modelled time periods up to annual values. The annualisation factors were calculated from MIDAS data on the M4 motorway, and are shown in Table 6.1.

Table 6.1: Annualisation Factors

Description	Annualisation Factor	Modelled Time Period
AM peak hour to total annual hours during AM peak	719	AM Peak Hour
Interpeak hour to total annual hours during interpeak	1518	Interpeak Hour
PM peak hour to total annual hours during PM peak	708	PM Peak Hour
Interpeak hour to total annual hours during weekends	1503	Interpeak Hour
Interpeak hour to total annual off-peak hours	915	Interpeak Hour

6.4 Traffic Data

6.4.1 TUBA requires matrices to be input containing data from the Do Minimum and Do Something traffic models, to enable the software to calculate benefits to transport users. The following matrices are required as input:

- trip matrices, which give the number of trips travelling between each origin and destination zone in the traffic assignment model;
- time matrices, which represent the average time for travel between each of the origin and destination zones; and
- distance matrices, which represent the average distance of trips travelled between each of the origin and destination zones.

6.4.2 These matrices were extracted from the traffic assignment model for 2022 and 2037 and used as input to TUBA.

6.5 User Classes

6.5.1 As noted in Section 3.3.2, the traffic assignment model has five user classes:

- Car – employer's business;
- Car – other;
- Car – commute;
- Light Goods Vehicles; and
- Heavy Goods Vehicles.

6.6 Benefits During Construction and Maintenance

6.6.1 Traffic management works during construction and maintenance works tend to result in changes in journey times and vehicle operating costs. These impacts need to be taken into account in the economic assessment for a scheme. Generally, the presence of roadworks results in increased travel costs and hence the benefits due to construction works are normally negative. The net benefits associated with maintenance works can be positive where the maintenance schedule for an unimproved route is more frequent and more costly than that for an improved route.

6.7 Scheme Construction

6.7.1 For the proposed scheme, roadworks will be required during the construction of the tie-ins between the new and existing M4 motorway corridor to the west of junction 28 and to the east of junction 23. The traffic management associated with the construction of these tie-ins would result in dis-benefits to traffic travelling on this section of the highway network.

6.7.2 TUBA has been used to assess the cost of the disruption to road users during the construction of the tie-ins. Traffic forecasts have been prepared by coding the traffic management works into the 2022 Do Minimum network and assigning a trip matrix for the year relating to each construction phase. Table 6.2 outlines the assumed traffic management arrangements that were coded into the model network.

Table 6.2: Traffic Management Schedule during Construction

Phase	Months	Castleton	Magor
A	15	(1) M4, west of J29 to west of J28:- 50mph speed limit (2) A48(M) near J29:- 50 mph speed limit (3) A48 at Pound Lane:- 1 lane each way , 40mph speed limit	(1) M4, J23A to mainline railway bridge:- 50mph speed limit (2) M48, east of J23:- 1 lane each way, 50mph speed limit (3) A4810, J23A to Llandevenny rbt:- 30mph speed limit (4) B4245, Undy to Rogiet:- 30mph speed limit
B	4	(1) M4 e/b diversion onto new link, with 5 lanes between J29 and J28, 50mph speed limit (2) M4 w/b, J28 to west of J29, 50mph speed limit (3) A48(M) e/b near J29:- 50 mph speed limit (4) A48(M) w/b diverge at J29 relocated, 1 lane, 50mph speed limit (5) A48 at Pound Lane:- 1 lane each way , 40mph speed limit	(1) M4, J23A to mainline railway bridge:- 50mph speed limit (2) M48, east of J23:- diversion onto new link and new rbt, 1 lane each way, 50mph speed limit (3) A4810, J23A to Llandevenny rbt:- 30mph speed limit
C	11	(1) M4 e/b diversion onto new link, with 5 lanes between J29 and J28, 50mph speed limit (2) M4 w/b, J28 to west of J29, 50mph speed limit (3) A48(M) e/b near J29:- 50 mph speed limit (4) A48(M) w/b diverge at J29 relocated, 1 lane, 50mph speed limit	(1) M4, J23A to mainline railway bridge:- 50mph speed limit (2) M48, east of J23:- diversion onto new link and new rbt, 1 lane each way, 50mph speed limit
D	9	(1) M4 e/b diversion onto new link, with 5 lanes between J29 and J28, 50mph speed limit (2) M4 w/b, diversion onto new link, 3 lanes between J28 to west of J29, 50mph speed limit (3) A48(M) e/b near J29:- 50 mph speed limit (4) A48(M) w/b:- 2 lane diverge from new w/b M4 link, 50mph speed limit	(1) M4, J23A to mainline railway bridge:- 50mph speed limit (2) M48, east of J23:- diversion onto new link and new rbt, 1 lane each way, 50mph speed limit

6.7.3 Traffic forecasts have been prepared for each phase between 2018 and 2021, with the trip matrices being interpolated between the 2014 base year matrices and the 2022 forecast matrices. The model results were input to TUBA, and the resulting disbenefits were factored from the four-year appraisal period to the duration assumed for each phase as shown in Table 6.2. The output from this TUBA appraisal of the impact of the construction works was then incorporated into the overall results for the economic appraisal.

6.7.4 For the appraisal of the effects during construction for the low and high growth sensitivity tests, the results of the central growth tests were factored on a pro-rata basis from the main TUBA results.

6.8 Maintenance

6.8.1 In addition to the cost of construction, it is necessary for the economic appraisal to take account of disruption during maintenance of both the new road and the existing M4 during the 60-year appraisal period.

6.8.2 As noted in Section 5.2.2, a draft maintenance schedule was devised for two scenarios following discussions with the Welsh Government:

- Do Minimum: the cost of maintaining the existing M4 between Junction 23 and Junction 29; and
- Do Something: the cost of maintaining both the existing M4 and the proposed scheme.

6.8.3 The maintenance schedules include a recurring cycle of resurfacing / overlay / reconstruction of different sections of the motorway, together with major maintenance of structures and annual routine maintenance.

6.8.4 Table 6.3 summarises the assumed maintenance schedule used to calculate overall benefits in the Do Minimum Scenario, and Table 6.4 shows the equivalent for the Do Something scenario.

6.8.5 Future year traffic forecasts have been used to estimate the impact of each maintenance schedule. The Do Minimum maintenance model results were input to TUBA for comparison with the standard Do Minimum model results, and the resulting disbenefits were factored down to the duration assumed for each scheme as shown in Table 6.3.

6.8.6 Similarly, the Do Something maintenance model results were compared with the standard Do Something model in TUBA, and the Do Something maintenance disbenefits factored to the duration assumed for each scheme, also shown in Table 6.3.

6.8.7 The Do Something maintenance disbenefits were then subtracted from the Do Minimum maintenance disbenefits to give the net impact on maintenance arising from the Scheme. The output from this TUBA assessment of the impact of the maintenance works was then incorporated into the overall results for the economic assessment.

6.8.8 For the appraisal of the maintenance effects for the low and high growth sensitivity tests, the results of the central growth tests were factored on a pro-rata basis from the main TUBA results.

Table 6.3: Traffic Management Maintenance Schedule

Description	Year	Do Minimum Scenario Traffic Management	Do Something Scenario Traffic Management
Waterproofing of River Usk Bridge and Malpas Viaduct	2025 2065	Complete closure of eastbound carriageway between J26 and J25a for 6 weeks followed by complete closure of westbound carriageway between J25a and J26 for 6 weeks.	Complete closure of eastbound carriageway between J26 and J25a for 6 weeks followed by complete closure of westbound carriageway between J25a and J26 for 6 weeks.
Major refurbishment of Brynglas Tunnels	2047 2077	18 months of overnight closures (not modelled) 40mph speed limit eastbound between J26 and J25a for 12 months 40mph speed limit westbound between J25a and J26 for 12 months	Complete closure of eastbound carriageway between J26 and J25a for 2 months followed by complete closure of westbound carriageway between J25a and J26 for 2 months.
Structural maintenance at Magor Junction	2032 2042 2052 2062 2072 2082	N/A	Complete closure of eastbound on-slip from Magor junction to M4 eastbound for 1 month.
Structural maintenance to Usk Bridge and Viaduct	2032 2042 2052 2062 2072 2082	N/A	2 lanes @ 50mph between Glanllyn and Docks Way junctions for 3 months.
Structural maintenance to Duffryn rail, Ebbw River and Castleton Structures	2032 2042 2052 2062 2072 2082	N/A	2 lanes @ 50mph between Docks Way Junction and Castleton Interchange for 1 month.
Structural maintenance to Llandevenny rail structure	2032 2042 2052 2062 2072 2082	N/A	2 lanes @ 50mph between Magor Junction and Glan Llyn Interchange for 1 month.

6.9 Accident Benefits

6.9.1 The safety impacts of the Scheme have been assessed quantitatively and monetised to be incorporated into the overall economic appraisal for the Scheme. Accident saving benefits have been calculated separately using Cost and Benefit to Accidents – Light Touch (COBA-LT[10]), a spreadsheet application developed by the Department for Transport (DfT) to undertake the analysis of the impacts on accidents as part of the economic appraisal of road schemes.

6.9.2 COBA-LT compares accidents by severity and associated costs across the network in the Do Minimum Scenario with those in the Do Something scenario, using details of link and junction characteristics and forecast traffic volumes. Accident rates and costs used in COBA-LT are consistent with those defined in the TAG data book[11].

6.9.3 The resulting accident benefits calculated by COBA-LT were then added to the main TUBA benefits for the Scheme.

[10] COBALT (**CO**st and **B**enefit to **A**ccidents – **L**ight **T**ouch), Department for Transport, December 2013
[11] Transport Analysis Guidance: TAG data book, Department for Transport, November 2014

7 Economic Appraisal Results

7.1 Results

7.1.1 This Chapter presents the results of the conventional economic appraisal, excluding Wider Impacts. Results are provided for the central traffic growth forecasts as well as for sensitivity tests under low and high traffic growth scenarios.

7.2 Core Scheme

7.2.1 The 'Transport Economic Efficiency' (TEE) benefits are made up of the monetary journey time benefits, vehicle operating cost savings and benefits during construction and maintenance. When combined with the carbon and accident benefits and the indirect taxation revenues, these give the Present Value of Benefits (PVB) in 2010 prices. The quantified benefits exclude any benefits of the Scheme in relation to improved journey time reliability or minimising disruption caused by major incidents.

7.2.2 The 'Public Accounts' are made up of the costs incurred by Government as a result of the Scheme, including investment and operating costs. The Present Value of Costs (PVC) is the 'Broad Transport Budget' from the public accounts table.

7.2.3 The Analysis of Monetised Costs and Benefits compares the PVB and the PVC to give the Net Present Value (NPV) and Benefit to Cost Ratio (BCR) for the Scheme. The NPV is calculated by subtracting the present value of costs (PVC) from the total present value of benefits (PVB). The BCR is calculated by dividing the PVB by the PVC.

7.2.4 A positive NPV and a BCR greater than unity indicate that the benefits due to the Scheme outweigh its costs and so it is positive in economic terms. The higher the NPV and BCR, the better the value for money of the Scheme.

7.2.5 A summary of the economic assessment results for the Scheme is shown in Table 7.1, while the full results are given in Appendix B.

Table 7.1: Summary of Economic Assessment (Central Growth)

		Results (£000) (2010 prices, discounted to 2010)
User Benefits	Consumers	887,892
	Business	1,032,212
Construction Benefits	Consumers	-23,179
	Business	-22,532
Maintenance Benefits	Consumers	24,777
	Business	29,515
Accident Benefits		14,615
Greenhouse Gas Benefits		4,431
Indirect Tax Revenues		-14,939
Present Value of Benefits, PVB (£000)		**1,932,792**
Present Value of Costs, PVC (£000)		**975,929**
Net Present Value, NPV (£000)		**956,863**
Benefit-to-Cost Ratio, BCR		**1.98**

7.2.6 The BCR takes into account transport user benefits and accident benefits over a 60 year period. It also takes into account disruption caused as a result of construction work and the net maintenance benefits during the assessment period.

7.2.7 The results indicate that, assuming central growth predictions, the Scheme has a positive NPV of £1.0bn and a BCR of 1.98. This indicates that the Scheme would represent value for money as the Scheme costs will be more than offset by the improvements in transport economic efficiency, safety and carbon emissions.

7.3 Low and High Growth

7.3.1 In addition to the central growth forecasts, sensitivity tests were carried out for low and high growth assumptions. The results of the economic assessment for these forecasts are shown in Appendices C and D and summarised in Table 7.2.

Table 7.2: Economic Assessment, Low and High Growth Forecasts

	Results (£000) 2010 Prices, Discounted to 2010	
	Low Growth	High Growth
Present Value of Benefits, PVB (£000)	1,299,566	3,040,082
Present Value of Costs, PVC (£000)	975,929	975,929
Net Present Value, NPV (£000)	323,636	2,064,152
Benefit-to-Cost Ratio, BCR	1.33	3.12

7.3.2 The results show that even under Low Growth forecast assumptions, the benefits of the Scheme would outweigh the costs, with a BCR of 1.33. Under High Growth, the NPV is estimated to increase to over £2bn with a BCR of 3.12.

8 Wider Impacts

8.1 Overview

8.1.1 The inclusion of Wider Impacts in the economic appraisal of transport schemes recognises that transport improvements can result in economic impacts that are additional to the transport user benefits that are captured in Chapter 6 of this report.

8.1.2 A framework for the calculation of Wider Impacts has been established by the Department for Transport and is formalised in WebTAG[12]. Wider Impacts are relevant to the assessment of the overall value for money of the Scheme. However, Wider Impacts can be quantified with less certainty than user benefits and therefore the results of the economic appraisal are shown both with and without Wider Impacts.

8.1.3 There are three types of Wider Impacts which are assessed:

- **Wider Impact 1 – Agglomeration effects:** The term agglomeration refers to the density of economic activity in an area. Firms derive productivity benefits from being located close to other firms and from being located in large labour markets. Transport improvements can increase the 'effective density' of an economy by reducing transport costs, thereby improving accessibility between firms in an area, and between firms and the workforce. Therefore, transport schemes that improve accessibility can deliver productivity benefits over and above the direct user benefits.
- **Wider Impact 2 – Output change in imperfectly competitive markets:** Transport improvements can result in lower transport costs for firms. Firms tend to respond to lower costs by reducing prices and increasing output of goods and services. This results a welfare benefit to consumers that is not captured in the assessment of user benefits. This is because, under conditions of imperfect competition (which is the prevailing state of the economy), consumer's willingness to pay for the additional output will exceed the cost of producing it.
- **Wider Impact 3 – Labour market impacts:** Transport costs can act as a barrier to entry into the labour market, given that individuals will weight up the costs of travelling to work against the wages they will earn. Lowering transport costs can improve access to employment opportunities and increase the overall level of employment in an economy. While some of these benefits are captured in the main economic appraisal (in the form of user benefits for commuters) the changes in tax revenues resulting from increased employment are not. Wider Impact 3 is calculated by estimating the impact of changes in the labour market on tax revenues.

8.1.4 A Wider Impacts model has been constructed for the assessment of Wider Impact 1 (agglomeration effects) and Wider Impact 3 (labour market effects). This is based on a study area comprising 22 zones covering South Wales and the West of England. Zones correspond to local authority areas, whilst in closer proximity to the Scheme, local authority areas have been split in two to provide additional detail. For the purposes of the agglomeration impacts assessment, the model includes a 'buffer area' comprising 13 zones (corresponding to local authority areas) surrounding the study area. Agglomeration benefits within these zones are not assessed but the buffer areas serve to provide a more accurate assessment of the 'effective density' of zones within the study area.

8.1.5 The Wider Impacts model takes outputs from the M4 CaN traffic model. Calculations are based on the economic data provided in the Department for Transport's Wider Impacts

[12] Transport Analysis Guidance Unit A2.1 Wider Impacts, Department for Transport, January 2014

Dataset. This has been supplemented by more disaggregated employment statistics from the Business Register and Employment Survey.

8.2 Wider Impact 1: Agglomeration Impacts

8.2.1 The calculation of agglomeration effects is a two stage process. Firstly, the 'effective density' of each zone is calculated – under do something and do something scenarios – based on the average generalised costs of travel between zones. Effective density is measured in each modelled year for each of four sectors (manufacturing, construction, consumer services, and producer services). The overall weighted average change in effective density across the Wider Impact model area are given in Table 8.1. Results are presented at a local authority level.

Table 8.1: Modelled Changes in Effective Density

Local Authority	Weighted Average Change in Effective Density (Do Something vs Do Minimum)	
	2022	2037
Newport	1.1%	4.0%
Cardiff	1.1%	0.7%
The Vale of Glamorgan	1.0%	1.1%
Swansea	0.5%	0.7%
Neath Port Talbot	0.2%	0.1%
Bridgend	1.2%	1.6%
Rhondda, Cynon, Taff	0.8%	0.7%
Merthyr Tydfil	0.2%	0.1%
Caerphilly	0.6%	0.7%
Blaenau Gwent	0.2%	0.1%
Torfaen	0.0%	0.2%
Monmouthshire	1.3%	3.3%
Bristol	0.4%	0.5%
South Gloucestershire	0.7%	1.0%
North Somerset	0.6%	0.8%
Bath & NE Somerset	0.6%	0.7%

8.2.2 The second stage is to calculate changes in GDP per worker across the four sectors, for employment in each zone based on empirical relationships between effective density and productive (GDP per worker).

8.2.3 GDP impacts are calculated by multiplying the change in GDP worker by the number of employees in each sector. Across the study area, the total agglomeration benefits are predicted to be £21.0m in 2022 and £38.8m in 2037 (2014 prices).

Table 8.2: Changes in GDP

Local Authority	Change in GDP (Do Something vs Do Minimum) 2010 Prices, Discounted to 2010	
	2022	2037
Newport	1.8	8.8
Cardiff	4.5	0.6
The Vale of Glamorgan	0.5	0.7
Swansea	0.5	1.0
Neath Port Talbot	0.1	0.1
Bridgend	0.9	1.6
Rhondda, Cynon, Taff	0.7	0.7
Merthyr Tydfil	0.0	0.0
Caerphilly	0.6	0.9
Blaenau Gwent	0.1	0.0
Torfaen	0.1	0.3
Monmouthshire	0.6	2.7
Bristol	3.2	6.2
South Gloucestershire	3.2	6.8
North Somerset	1.4	3.0
Bath & NE Somerset	1.3	2.7
TOTAL	**19.5**	**36.0**

8.2.4 GDP impacts for the overall 60 year appraisal period are calculated by interpolating the results of the 2022 and 2037 assessments. From 2037 onwards, GDP impacts are assumed to grow in line with growth rates for values of time provided in the WebTAG databook.

8.2.5 Over the 60 year appraisal period, agglomeration impacts are estimated to generate a GDP impact and net economic benefit of £728.3m (2010 prices)

8.3 Wider Impact 2: Output Change in Imperfectly Competitive Markets

8.3.1 As noted, this benefit arises through the cost savings experienced by business users. WebTAG guidance recommends that this wider impact is calculated by applying a 10% uplift to the business user benefits given in Table 7.1.

8.3.2 Over the 60 year appraisal period, Wider Impact 2 results in additional benefits of £103.9m (2010 prices).

8.4 Wider Impact 3: Labour Market Impacts

8.4.1 Impacts on labour supply (individuals entering the labour market as a result of reduced costs of commuting) have been calculated. Tax revenues arising from these impacts are expected to result in additional benefits of £1.7m (2010 prices) over the 60 year appraisal period.

8.5 Summary of Results

8.5.1 A summary of the economic assessment results, including Wider Impacts, are shown in Table 8.3 for the central traffic growth scenario.

8.5.2 The Wider Impacts of the Scheme are calculated as £833.9m (2010 prices). This represents an increased in scheme benefits of 43%. The addition of Wider Impacts results in a BCR of 2.83.

Table 8.3: Summary of Economic Assessment (Central Growth)

		Results (£000) (2010 prices, discounted to 2010)
User Benefits	Consumers	887,892
	Business	1,032,212
Construction Benefits	Consumers	-23,179
	Business	-22,532
Maintenance Benefits	Consumers	24,777
	Business	29,515
Accident Benefits		14,615
Greenhouse Gas Benefits		4,431
Indirect Tax Revenues		-14,939
Convention Transport Benefits, PVB (£000)		**1,932,792**
Wider Impact 1: Agglomeration Impacts		728,274
Wider Impact 2: Increased Output in Imperfectly Competitive Markets		103,920
Wider Impact 3: Labour Market Impacts		1,731
Total Wider Impacts, PVB (£000)		**833,925**
Adjusted Present Value of Benefits, PVB (£000)		**2,766,717**
Present Value of Costs, PVC (£000)		**975,929**
Wider Net Present Value, NPV (£000)		**1,790,788**
Wider Benefit-to-Cost Ratio, BCR		**2.83**

9 Summary and Conclusions

9.1.1 This report has described the work undertaken to assess the economic impact of the Scheme. The appraisal has encompassed the direct economic impact on transport users over a 60-year period.

9.1.2 The economic appraisal has been undertaken using TUBA software in order to take account of the effects of the variable demand modelling. As TUBA does not calculate accident benefits, these have been estimated separately using COBA-LT. The assessments have been carried out over a 60-year period, in accordance with the Department for Transport Guidance (WebTAG). An assessment of Wider Impacts has also been undertaken in accordance with WebTAG Unit A2.1.

9.1.3 The assessment of user benefits is based on outputs from the M4 CaN transport model. The model represents typical operational conditions on the highway network in terms of average flows and speeds on a normal day of operation. The model does not reflect those occasions when a major incident may have occurred which results in severe reduction in network performance. In such instances, the improved network resilience and capacity offered by the M4CaN scheme would minimise the disruption caused by the incident and reduce the additional costs imposed on the travelling public, resulting in a net economic benefit. Such benefits are not included in the quantified economic appraisal of the Scheme.

9.1.4 The results have indicated that the Scheme would provide value for money, with a core benefit to cost ratio (BCR) of 1.98 under the central growth scenario. Taking wider economic benefits into account, under the central growth scenario, the BCR is 2.83.

9.1.5 In addition to a central growth forecast scenario, which has formed the basis for the main assessment, low and high growth scenarios have been tested. These tests have been undertaken excluding Wider Impacts. If low growth were to occur, the assessment suggests a BCR of 1.33, whilst, if high growth were to occur, a BCR of 3.12 has been predicted.

9.1.6 This assessment has shown that, for a range of assumed future conditions, the provision of a new section of motorway to the south of Newport is likely to represent value for money in respect of the investment needed to deliver the Scheme.

Appendix A

A1 Developments and Transport Schemes Included in Core Scenario

A1.1 Development Proposals

A1.1.1 Information regarding the detailed proposals and planning status of future developments in the study area was obtained from the local planning authorities in Newport, Monmouthshire and Cardiff. This takes on board information contained in:

- the Newport Local Development Plan, placed on deposit in April 2012 and subsequently adopted in January 2015; and
- the Monmouthshire Local Development Plan, which was placed on deposit in September 2011 and subsequently adopted in February 2014.
- the Cardiff Local Development Plan, which was placed on deposit in September 2013 and submitted for examination in August 2014. The Plan was adopted on 28th January 2016.

A1.1.2 Developments outside Newport, Cardiff and Monmouthshire were deemed to be too far from the study area to have a direct impact on the M4 South of Newport scheme and as such were not considered for explicit inclusion in the traffic forecasting.

A1.1.3 The planning departments at each of these local authorities were consulted regarding the proposed developments and any feedback that was provided has been incorporated. During these consultations it was confirmed that there are no 'dependant developments' within any of the programmes that would only go ahead if the new M4 motorway to the south of Newport was constructed.

A1.1.4 A 'screening' process was applied to determine which of the listed developments in Newport, Cardiff and Monmouthshire should explicitly be included in the model traffic forecasts. This removed housing sites of less than 100 units, so that traffic generated by these sites would be included within the background traffic growth as forecast by NTEM.

A1.1.5 For Cardiff and Monmouthshire, only those developments situated within or adjacent to the Core Simulation Area were explicitly included within the Reference Case matrices. For any developments beyond this, it was assumed that the development traffic will be encapsulated within NTEM growth forecasts.

A1.1.6 Each proposed development was considered in turn and classified in accordance with Table A2 of TAG Unit M4. Those developments which were the subject of a planning application or had been approved were classified as 'more than likely' and 'near certain' and were therefore taken into account in the future year Reference Case matrices.

A1.1.7 The land use and quantum of each development was used to determine the total number of trips generated by each development. These were estimated using the Trip Rate Information Computer System (TRICS) database or, where available, were taken from development specific transport assessments.

A1.1.8 The TRICS database contains over 2,100 site locations, 4,700 survey counts and 98 land use sub-categories, and is widely used for trip rate estimates for future year developments. In order to obtain a reasonable representation of future development generated trips, average trip rates were used for the relevant development land uses. The distribution of trips in such cases was based on that from the base year model for nearby 'reference' zones with a similar land use.

A1.1.9 Table A1 lists the development proposals included in the forecast traffic models, together with the assumed proportion completed in each of the modelled forecast years.

Table A1: Development Proposals

Development		Land Use	Size	Completion	
				2022	2037
Newport					
1	East Newport, north of railway line (Llanwern)	Housing	1100 units	65%	100%
2	Former Pirelli Works	Housing	250 units	100%	100%
3	Glebelands	Housing	153 units	100%	100%
4	Former Tredegar Park Golf Course	Housing	150 units	100%	100%
5	Allt yr Yn Campus	Housing	125 units	100%	100%
6	Monmouthshire Bank Sidings	Housing	575 units	42%	100%
7	Victoria Wharf	Housing	130 units	20%	100%
8	Penmaen Wharf	Housing	160 units	100%	100%
9	Former Sainsbury's site	Housing	140 units	96%	100%
10	City Vision	Housing	464 units	52%	68%
11	Lysaght Village (Orb Works)	Housing	517 units	46%	65%
12	Former Bettws Comprehensive	Housing	229 units	55%	55%
13	Lysaght Parc	Housing	100 units	100%	100%
14	East Newport, south of railway line (Glan Llyn)	Housing	4000 units	43%	100%
15	Whiteheads Works	Housing	400 units	45%	83%
16	Old Town Dock	Housing	350 units	60%	100%
17	Jubilee Park (Alcan Works)	Housing	1,064 units	50%	87%
18	Jigsaw site, Hartridge	Housing	200 units	80%	100%
19	Opposite Belmont Lodge	Housing	122 units	100%	100%
20	Panasonic	Housing	250 units	100%	100%
21	Duffryn	Industry	154,000m^2 GFA	-	100%
22	East of Queensway Meadows	Industry	108,000m^2 GFA	-	100%
23	Celtic Springs Business Park	Offices	16,200m^2 GFA	100%	100%
24	Gwent Europark	Warehousing	80,000m^2 GFA	100%	100%
25	East Newport, south of railway line (Glan Llyn)	Industry	142,000m^2 GFA	-	100%
26	Phoenix Park (former Pirelli works)	Industry	8,000m^2 GFA	100%	100%
27	Newport City Centre redevelopment, Friars Walk	Mixed use	30,612m^2 retail 2,314m^2 cinema 3,440m^2 restaurants	100%	100%

Development		Land Use	Size	Completion	
				2022	2037
Monmouthshire					
28	Crick Rd, Portskewett	Housing Offices	285 units 2,700m^2 GFA	100%	100%
29	Fairfield Mabey, Chepstow	Housing Offices	350 units 8,100m^2 GFA	100%	100%
30	Rockfield Farm, Undy	Housing Offices	270 units 5,600m^2 GFA	100%	100%
31	Vinegar Hill, Undy	Housing	225 units	100%	100%
32	Sudbrook Paper Mill	Housing	190 units	100%	100%
33	Wales One, Magor	Offices	21,739m^2 GFA	-	100%
34	Quay Point, Magor	Offices Industry Warehousing	10,584m^2 GFA 23,520m^2 GFA 49,000m^2 GFA	-	100%
35	Gwent Europark, Magor	Warehousing	66,500m^2 GFA	-	100%
36	Newhouse Farm, Chepstow	Industry	16,000m^2 GFA	-	100%
37	Pill Row, Severnbridge Ind Est	Industry	4,000m^2 GFA	-	100%
38	Beaufort Park, Chepstow	Offices	1,134m^2 GFA	-	100%
Cardiff					
39	NE Cardiff (west of Pontprennau)	Housing	4,500 units	66%	100%
40	East of Pontprennau Link Road (St. Edeyrns)	Housing	1,300 units	82%	100%
41	St Mellons Business Park	Offices	124,000m^2 GFA	-	100%
42	Areas 9-12, St Mellons	Housing	150 units	-	100%
43	Cardiff Gate International Business Park	Offices	13,362m^2 GFA	100%	100%

A1.2 Transport Schemes

A1.2.1 In addition to proposed developments, the treatment of uncertainty in model forecasting also needs to include any proposed transport schemes.

A1.2.2 Firmly proposed network improvements which are likely to be in place by the year that is being modelled are included in both the Do Minimum and Do Something networks. The future year highway networks were developed for the years 2022 and 2037.

A1.2.3 The definition of the Do Minimum network requires the identification of any committed or probable transport schemes within the study area that should be included in the traffic model. The Welsh Government, together with Newport, Cardiff and Monmouthshire councils, were consulted to ascertain what transport schemes are likely to be implemented within the timeframes of the M4 Corridor around Newport traffic forecasts.

A1.2.4 It was confirmed that there are no transport schemes that would be dependent on the M4 Corridor around Newport scheme being constructed.

- Following this consultation, the schemes described below were included in the Do Minimum network: Tredegar Park Roundabout (Junction 28) – Junction improvement comprising an enlarged at-grade signalised gyratory, incorporating a through link from the M4 (west) to the A48 Southern Distributor Road.
- A467 Bassaleg Roundabout – Junction improvement which would convert the existing A467 Bassaleg roundabout into a signalised roundabout.
- A48 Pont Ebbw Roundabout – Junction improvement which would convert the existing signalised roundabout into a signalised 'throughabout', with a new link connecting the eastern and western arms of the A48 Southern Distributor Road.
- A465 Heads of the Valleys Dualling (Abergavenny to Hirwaun) – The A465 trunk road forms an alternative east-west strategic route to the M4, particularly for traffic travelling between the Midlands and West Wales. Dualling of all six sections of this scheme were assumed to be complete by 2022.
- Newport Eastern Expansion Area – Additional infrastructure is proposed to serve the major residential developments planned on the former Llanwern steelworks site and the area north of the railway line. This comprises a new north-south link over the mainline railway line to connect the A48 SDR and Llanwern Village to the improved Steelworks Access Road and an upgrade of the A48 SDR/Cot Hill junction to an all-movement signal controlled junction (by 2037).
- Cardiff Eastern Bay Link, Phase 1 - Construction of Phase 1 of the Eastern Bay link is due to commence in 2015. This will provide an at-grade dual two-lane all-purpose road connecting the Queensway roundabout at the southern end of Central Link with the existing roundabout at the southern end of Ocean Way. There is currently no formal commitment to deliver the remainder of the Eastern Bay Link scheme.
- Electrification of the Valley Lines and Great Western Mail Line
- New railway stations at Pye Corner, Energlyn and Ebbw Vale Town.

Appendix B

B1 Results for Core Scenario

B1.1 TEE Table

Economic Efficiency of the Transport System (TEE) - M4 CAN Core Scenario

Non-business: Commuting	**ALL MODES**		**ROAD**	**BUS and COACH**	**RAIL**	**OTHER**
User benefits	**TOTAL**		**Private Cars and LGVs**	**Passengers**	**Passengers**	
Travel time	225853		225853			
Vehicle operating costs	13010		13010			
User charges	0		0			
During Construction & Maintenance	421		421			
NET NON-BUSINESS BENEFITS: COMMUTING	239284	*(1a)*	239284			

Non-business: Other	**ALL MODES**		**ROAD**	**BUS and COACH**	**RAIL**	**OTHER**
User benefits	**TOTAL**		**Private Cars and LGVs**	**Passengers**	**Passengers**	
Travel time	652508		652508			
Vehicle operating costs	-3479		-3479			
User charges	0		0			
During Construction & Maintenance	1178		1178			
NET NON-BUSINESS BENEFITS: OTHER	650207	*(1b)*	650207			

Business							
User benefits			**Goods Vehicles**	**Business Cars & LGVs**	**Passengers**	**Freight**	**Passengers**
Travel time	896998		450622	446376			
Vehicle operating costs	135214		106718	28496			
User charges	0		0	0			
During Construction & Maintenance	6983		6440	543			
Subtotal	1039195	*(2)*	563780	475415			
Private sector provider impacts						**Freight**	**Passengers**
Revenue	0						
Operating costs	0						
Investment costs	0						
Grant/subsidy	0						
Subtotal	0	*(3)*					
Other business impacts							
Developer contributions	0	*(4)*					
NET BUSINESS IMPACT	1039195	*(5) = (2) + (3) + (4)*					

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	1928685	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, w hile costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

B1.2 Public Accounts Table

Public Accounts (PA) Table - M4 CAN Core Scenario

	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
Local Government Funding	TOTAL		INFRASTRUCTURE			
Revenue	0					
Operating Costs	0					
Investment Costs	0					
Developer and Other Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	0	(7)				
Central Government Funding: Transport						
Revenue	0					
Operating costs	79299					
Investment Costs	896630					
Developer and Other Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	975929	(8)				
Central Government Funding: Non-Transport						
Indirect Tax Revenues	-14939	(9)				
TOTALS						
Broad Transport Budget	975929	(10) = (7) + (8)				
Wider Public Finances	-14939	(11) = (9)				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

B1.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits - M4 CAN Core Scenario

Noise		(12)
Local Air Quality		(13)
Greenhouse Gases	4431	(14)
Journey Quality		(15)
Physical Activity		(16)
Accidents	14615	(17)
Economic Efficiency: Consumer Users (Commuting)	239284	(1a)
Economic Efficiency: Consumer Users (Other)	650207	(1b)
Economic Efficiency: Business Users and Providers	1039195	(5)
Wider Public Finances (Indirect Taxation Revenues)	-14939	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	1932792	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	975929	(10)
Present Value of Costs (see notes) (PVC)	975929	(PVC) = (10)
OVERALL IMPACTS		
Net Present Value (NPV)	956863	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.98	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Appendix C

C1 Results for Low Growth scenario

C1.1 TEE Table

Economic Efficiency of the Transport System (TEE) - M4 CAN Low Growth

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	133762		133762			
Vehicle operating costs	10488		10488			
User charges	0		0			
During Construction & Maintenance	283		283			
NET NON-BUSINESS BENEFITS: COMMUTING	144533	(1a)	144533			

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	423858		423858			
Vehicle operating costs	-2121		-2121			
User charges	0		0			
During Construction & Maintenance	792		792			
NET NON-BUSINESS BENEFITS: OTHER	422529	(1b)	422529			

Business							
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers
Travel time	609192		296730	312462			
Vehicle operating costs	125854		101028	24826			
User charges	0		0	0			
During Construction & Maintenance	4695		4330	365			
Subtotal	739741	(2)	402088	337653			
Private sector provider impacts						Freight	Passengers
Revenue	0						
Operating costs	0						
Investment costs	0						
Grant/subsidy	0						
Subtotal	0	(3)					
Other business impacts							
Developer contributions	0	(4)					
NET BUSINESS IMPACT	739741	(5) = (2) + (3) + (4)					

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	1306802	(6) = (1a) + (1b) + (5)

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

Public Accounts (PA) Table - M4 CAN Low Growth Scenario

	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
Local Government Funding	TOTAL		INFRASTRUCTURE			
Revenue	0					
Operating Costs	0					
Investment Costs	0					
Developer and Other Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	0	*(7)*				
Central Government Funding: Transport						
Revenue	0					
Operating costs	79299					
Investment Costs	896630					
Developer and Other Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	975929	*(8)*				
Central Government Funding: Non-Transport						
Indirect Tax Revenues	24424	*(9)*				
TOTALS						
Broad Transport Budget	975929	*(10) = (7) + (8)*				
Wider Public Finances	24424	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

C1.2 Public Accounts Table

C1.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits - M4 CAN Low Growth Scenario

Noise		*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	7362	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents	9826	*(17)*
Economic Efficiency: Consumer Users (Commuting)	144533	*(1a)*
Economic Efficiency: Consumer Users (Other)	422529	*(1b)*
Economic Efficiency: Business Users and Providers	739741	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-24424	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	1299566	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	975929	*(10)*
Present Value of Costs (see notes) (PVC)	975929	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	323637	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.33	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Appendix D

D1 Results for High Growth scenario

D1.1 TEE Table

Economic Efficiency of the Transport System (TEE) - M4 CAN High Growth

Non-business: Commuting	ALL MODES		ROAD		BUS and COACH	RAIL		OTHER
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time	386342		386342					
Vehicle operating costs	20630		20630					
User charges	0		0					
During Construction & Maintenance	662		662					
NET NON-BUSINESS BENEFITS: COMMUTING	407634	(1a)	407634					

Non-business: Other	ALL MODES		ROAD		BUS and COACH	RAIL		OTHER
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time	1060748		1060748					
Vehicle operating costs	5088		5088					
User charges	0		0					
During Construction & Maintenance	1852		1852					
NET NON-BUSINESS BENEFITS: OTHER	1067688	(1b)	1067688					

Business								
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
Travel time	1392071		717449	674622				
Vehicle operating costs	158529		122481	36048				
User charges	0		0	0				
During Construction & Maintenance	10984		10130	854				
Subtotal	1561584	(2)	850060	711524				
Private sector provider impacts						Freight	Passengers	
Revenue	0							
Operating costs	0							
Investment costs	0							
Grant/subsidy	0							
Subtotal	0	(3)						
Other business impacts								
Developer contributions	0	(4)						
NET BUSINESS IMPACT	1561584	(5) = (2) + (3) + (4)						

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	3036906	(6) = (1a) + (1b) + (5)

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

Public Accounts (PA) Table - M4 CAN High Growth Scenario

	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
Local Government Funding	TOTAL		INFRASTRUCTURE			
Revenue	0					
Operating Costs	0					
Investment Costs	0					
Developer and Other Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	0	*(7)*				
Central Government Funding: Transport						
Revenue	0					
Operating costs	79299					
Investment Costs	896630					
Developer and Other Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	975929	*(8)*				
Central Government Funding: Non-Transport						
Indirect Tax Revenues	26684	*(9)*				
TOTALS						
Broad Transport Budget	975929	*(10) = (7) + (8)*				
Wider Public Finances	26684	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D1.2 Public Accounts Table

D1.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits - M4 CAN High Growth Scenario

Noise		*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	6871	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents	22989	*(17)*
Economic Efficiency: Consumer Users (Commuting)	407634	*(1a)*
Economic Efficiency: Consumer Users (Other)	1067688	*(1b)*
Economic Efficiency: Business Users and Providers	1561584	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-26684	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	3040082	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	975929	*(10)*
Present Value of Costs (see notes) (PVC)	975929	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	2064153	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	3.12	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.