

Alternative Transport Scenarios for South East Wales

Building for a Sustainable Transport Future

**For the
Future Generations Commissioner for Wales**

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1 Context

This report presents an analysis and discussion of current and future alternative transport options in south east Wales. The report considers the current challenges faced as a result of high levels of private vehicle use, and examines alternative travel demand management measures that might be available to address this now and in the future.

This report is set within the context of an urgent need to address the unsustainability of the current transport system in south east Wales. To help frame the discussion that follows, below is an extract from the press-release for the recently-published report from the Institute for Welsh Affairs (IWA): *Decarbonising Transport in Wales* (IWA, 2018).

This extract neatly summarises the challenges faced, and demonstrates the pressing need to envision and build a more sustainable alternative to the current system, which remains dominated by private car travel.

A key message from the report is that Wales risks failing to meet its own targets on carbon emissions unless it changes its over-reliance on the car. Transport in Wales is dominated by the car more than in any other region or nation in the UK. Most emissions emanate from the private car. The car is also a key barrier to more people using the less polluting and more sustainable modes: active travel and public transport.

Bus services in Wales are in serious long-term decline. Rail serves only a very small part of the country and, whilst growing, has less than a fifth of the passenger journeys of buses. Despite the Active Travel (Wales) Act 2013, walking and cycling levels are generally static or declining. Given that the sale of new petrol and diesel cars is to be banned from 2040, there is a clear need for managed change in Wales' transport system.

IWA, 2018

[\(http://www.iwa.wales/click/2018/06/re-energising-wales-decarbonising-transport-wales/\)](http://www.iwa.wales/click/2018/06/re-energising-wales-decarbonising-transport-wales/)

The aim of this report is to discuss alternative transport scenarios for south east Wales, following the principle of utilising transport infrastructure development to influence future travel patterns, as opposed to purely as a response to the current road traffic congestion.

It is widely accepted that the choices made by transport authorities, planners, and other stakeholders affect the future transport choices of travellers: people will make use of the infrastructure that is provided. If new road infrastructure is built to accommodate private vehicle traffic – with the implicit effects of making car travel easier and more attractive – the outcome will be an increase in private vehicle traffic (see: SACTRA, 1994; Goodwin, 2006; Taylor et al., 2006; CPRE, 2017; Sloman et al., 2017). Extracts from the key studies providing evidence around the issue of induced traffic are presented in Appendix A.

If the objective is to facilitate a substantial increase in motorway traffic in the coming decades, then an approach of building additional motorway capacity is appropriate. However, if the objective is to facilitate accessibility, public transport and active travel infrastructure will provide solution. This will also have wider environmental and social benefits for future generations.

Appendix A contains further evidence on the above point, from a study into the outcomes of a number of prominent road-building schemes (see: Taylor *et al.*, 2006).

It is useful here to consider the long-term objectives of the Wales Transport Strategy, 2008 (see: Figure 1). To meet the largest number of these national policy objectives for Wales, it is imperative that a transport investment and development trajectory focuses on reducing private vehicle use and channelling significant effort and resource into realistic alternatives to the car.

Figure 1 - Long-term objectives of the Wales Transport Strategy (2008)

Social	<ul style="list-style-type: none"> Improve access to healthcare Improve access to education, training and lifelong learning Improve access to shopping and leisure facilities Encourage healthy lifestyles Improve the actual and perceived safety and travel
Economic	<ul style="list-style-type: none"> Improve access to employment opportunities Improve connectivity with Wales and internationally Improve the efficient, reliable and sustainable movement of people Improve the efficient, reliable and sustainable movement of freight Improve access to visitor attractions
Environmental	<ul style="list-style-type: none"> Increase the use of more sustainable materials Reduce the contribution of transport to greenhouse gas emissions Adapt to the impacts of climate change Reduce the contribution of transport to air pollution and other harmful emissions Improve the impact of transport on the local environment Improve the impact of transport on our heritage Improve the impact of transport on biodiversity

1.1 Planning for an uncertain future

An important consideration in designing new transport infrastructure is the uncertainty over the relevance of that infrastructure to future travel demand. This uncertainty has become amplified in recent decades with the development of the Internet and personal digital technology, which is rapidly changing the ways in which people can interact. Lyons and Davidson (2016), leading experts in the field, have identified five factors which emphasise the need to change our approaches to designing for the future of transport:

1. **Deep uncertainty:** Our relative inability to fully understand complex processes of change, i.e. cause and effect mechanisms. This is an important element of all of the subsequent factors below.

- 2. Uncertainty in car travel:** Long-term growth trends in car travel have been interrupted over the past decade and a half. Several high-quality studies have identified a 'decoupling' in the relationship between economic growth and car travel. Several factors have been suggested: economic drivers, technological effects, and social trends. We still only have a limited understanding of this new phenomenon, which further emphasises the point about uncertainty above, and advises caution when making assumptions about car use decades into the future.
- 3. Regime transition:** A 'regime' can be best understood simply as 'the world as we know it'. Currently we live in an automobility regime. Our society is built around car travel (physically, economically, and socially). In recent years the advance of personal digital technology, new vehicle and fuel technologies, and demographic changes provide evidence that there is uncertainty over how long the current norm of personal car travel will persist.
- 4. Changing demographics and behaviours:** Several studies have identified shifts in population demographics, in particular the spatial distribution of populations and the urban/rural divide. Age is also a key factor. Younger people have been identified as having a pronounced contribution to the levelling off of growth in car travel: fewer younger people are choosing to drive or own a car. There is significant uncertainty over how the travel behaviours of younger people will develop in the future, which challenges the assumption of continued growth in car travel at previously forecasted rates.
- 5. Technological advance and inherent uncertainty:** New transport technology often receives considerable hype in the media. The current focus on electric cars and Autonomous Vehicles are good examples of these. Whilst some transformative technologies live up to expectations, often there is a significant disconnect between the promised impacts of a new technology and the final result. In transport, this effect is often exacerbated by the interaction of other technologies with mobility, for example the Internet, refrigeration, or 3D printing. This further contributes to the uncertainty over the future of transport systems.

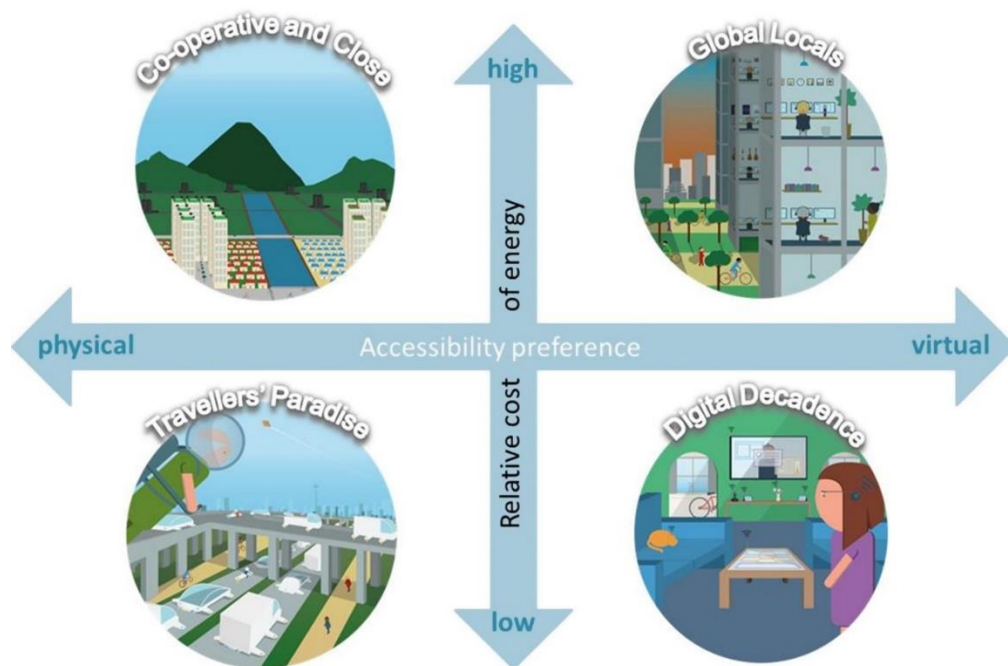
In summary: "It remains significantly uncertain how new technologies will permeate society, and the effects this may have, not only on transport but many other spheres. This socio-technical uncertainty contributes significantly to the deep uncertainty facing the future of transport. (...) **Current transport demand forecasting and strategic policymaking tools are not sufficient for the change and uncertainty we currently face in the 21st Century; car travel in particular is in a period of deep uncertainty.**" (Lyons and Davidson, 2016, p. 106-108)

1.2 Decide and provide

This report considers transport provision from a "decide and provide" perspective, as well as the traditional "predict and provide" approach that has been followed in transport planning for much of the past century.

The decide and provide approach describes a process of scenario planning, in which the principal aim is not to simply look at a current situation and work out how to best manage it, but rather to look to the future, decide what is desirable from a social, environmental, and economic perspective, and then work backwards to identify the necessary steps to achieving that aim in the context of what is likely to happen in the meantime.

Figure 2 - Future Mobility Dimensions (Lyons and Davidson, 2016)



Wales is at an important decision-making point in terms of the type of transport future it wants to lay down the foundations for in the coming decades. There are a number of possible pathways available for transport investment and development in the region. Current best evidence demonstrates consistently that investing in significant expansions to the already extensive highway network sets the foundations for increases in motorway traffic and questionable effects on congestion and its attendant issues in the coming years. On the other hand, significant investment into infrastructure to support attractive and realistic alternatives to car travel will lay the foundations for a more sustainable and inclusive transport system for south east Wales in the decades ahead.

1.3 Building a transport system for future generations

This report follows the premise that the road building approach is set within an outdated paradigm of responding to traffic and congestion by simply building more roads. This “predict and provide” approach has been shown time and time again not to work (e.g.: SACTRA, 1994; Purnell et al., 1999; Taylor et al., 2006; Goodwin, 2006; Sloman et al., 2017; CPRE, 2017). Evidence consistently demonstrates that capacity increases on highway infrastructure generate more motorway trips, and generally, new capacity simply fills up over time, often leading to further congestion on the entire corridor/network, now with even more cars on the road.

Taken together, studies into past road building schemes and the present analysis of the modelled impacts of the proposed M4 relief road scheme strongly suggest that the motorway network around Newport can expect a considerable increase in vehicle traffic if the scheme is completed.

To build a sustainable transport system for the future we first need to decide what type of future we want as a society and then build for this.

The remainder of the report is structured as follows. The next section examines the predicted traffic volumes on the M4 around Newport with and without the proposed new section of motorway. These traffic forecasts provide the platform for section 3 which considers the potential for traffic management strategies to alleviate congestion on the existing motorway around Newport, in the absence of building additional road capacity. The extent to which new

public transport interventions may accommodate and shape future travel demand is then examined in section 4. Section 5 reflects on the possible longer term implications of emerging transport technologies such as electric vehicles, platooning systems and fully autonomous vehicles. Section 6 draws the report to a close and provides conclusions based on the evidence presented.

2 Traffic forecasts for the M4 corridor around Newport

The impacts on vehicular traffic volumes and journey times of the construction of a new three lane motorway to the south of Newport have been evaluated by Arup on behalf of Welsh Government using the 'M4 Corridor around Newport transport model'. The modelled effects of the proposed new motorway on vehicular traffic volumes and journey times are now summarised. A single section of the existing M4 - the Brynglas Tunnels - is examined for illustrative purposes. The tunnels represent a significant (two lane) bottleneck along the section of the M4 around Newport¹.

2.1 Motorway traffic volumes

The 'M4 Corridor around Newport Transport Model' applied industry standard modelling techniques to compare the performance of the highway network under two scenarios:

- (i) A 'Do Minimum' scenario which reflects the current highway network with the inclusion of committed highway, land use and public transport (considered as offering a viable alternative to the M4) schemes that are expected to be taken forward over the forecasting period. And
- (ii) A 'Do Something' scenario which includes the addition of the proposed three lane motorway to the south of Newport

¹ Note that this summary is based on an assessment of secondary evidence presented in reports prepared in support of the public inquiry (including the local model validation report (Welsh Government 2015), the traffic forecasting report (Welsh Government 2016), and the transport proof of evidence (Whittaker 2016)). The primary data used as inputs and outputs from the modelling and appraisal exercise have not been reviewed. Any new quantifications noted here are therefore provisional and subject to further analysis and should be interpreted accordingly.

Future year forecasts were prepared for (i) the expected opening year (2022), (ii) 15 years after opening (2037) and (iii) 2051 which relates to the current cut-off point for current national road traffic forecasts.

To forecast forward requires assumptions to be made about how travel demand is likely to alter in future years. For the M4 analysis, the future year matrices accounted for:

1. Estimates of additional trips generated by committed land use developments specified in the Newport, Cardiff and Monmouthshire Local Development Plans; and
2. Expected background growth in car, freight and public transport trips.

Growth factors derived from the Department for Transport's National Trip End Model (NTEM) were applied to account for background growth in vehicular and public transport traffic. These growth factors are based on assumed relationships between trip rates and key *historic* drivers of travel demand such as income, population growth and cost.

Assumptions used to produce future year forecasts are inevitably open to challenge, and indeed there is a great deal of uncertainty in relation to how travel demand might alter over the medium to long term. This uncertainty is driven firstly by significant recent deviations from the historic long term trend towards increasing travel demand per person observed over the second half of the 20th century (see examples presented in Box 1) and secondly by recognition that it is impossible to predict how various converging socio-technical trends (e.g. mobile ICTs, automation), will shape economies, working practices, lifestyles and hence travel practices into the future.

Box 1: Recent changes in travel demand trends

- There have been reductions in the number of trips per person since the turn of the century. Between 2002 and 2014, the number of trips per person fell by 13 per cent overall (Department for Transport 2016).
- Generational differences in travel behaviour have also been observed. The proportion of young adults holding driving licences is in decline. In 1992, 75 per cent of 21 to 29 year olds held driving licences, falling to 63% of 21 to 29 year olds in 2014 (Chatterjee et al 2018). It is uncertain as to whether the current generation of young adults will maintain lower levels of car access and use as they age.

This uncertainty is acknowledged in the transport proof of evidence presented at public inquiry (Whittaker 2016), but it is explained that “the DfT are of the view that there is reason to believe the [observed] decline will not continue at its current rate in the long term”. Hence the central NTEM growth scenario used in the M4 modelling “assumes a declining trend in trip rates between its base year of 2011 and 2016 and then constant [growth] rates thereafter”.

The transport model ‘assigns’ the assumed growth in vehicular traffic to a representation of the highway network with and without the new section of motorway. According to the traffic forecasting report, the resulting predictions indicated that “in 2037, around 61,000 vehicles per day (AADT) will use the Brynglas Tunnels compared to around 89,000 vehicles per day (AADT) for the Do Minimum Scenario; whilst around 70,000 vehicles per day (AADT) are forecast to use the Usk River Crossing on the proposed new section of motorway south of Newport.” (Welsh Government 2016)

To summarise again:

- 89,000 vehicles per day are predicted to travel through the tunnels in the Do Minimum scenario in 2037.
- This is modelled to reduce to 61,000 vehicles per day with inclusion of the relief road: a reduction of 28,000 vehicles or 31%.
- A further 70,000 vehicles per day are predicted to be using the new section of motorway.

In other words, *motorway trips overall* are anticipated to increase from 89,000 vehicles per day in the do minimum scenario for 2037 to approximately 131,000 trips per day in do something scenario: the relief road is modelled to be associated with an increase in *motorway traffic* (not traffic overall) of close to 50%.

2.2 Journey times

The model is also able to provide predictions of vehicle journey times for journeys between different origins and destinations with and without the new motorway. The biggest modelled journey times savings (comparing the highway network with and without the new motorway) are offered to 'through traffic' that would divert onto the new motorway, as indicated in Table 1.

Table 1 - Predicted journey time savings

Time period	2022	2037
Inter-peak	2.5 mins	3 to 4 mins
Peak	3.5 to 5 mins	5.5 to 8 mins
Source: Welsh Government (2016, paragraph 10.6.5)		

The larger journey time savings predicted for 2037 are a function of the increased congestion that will arise in the model, as a consequence of the assumed increases in traffic volumes (which may or may not be a fair reflection of the future – something that cannot be known). The journey time saving of between 2.5 and 5 minutes (for the opening year) is significant when considered in aggregate across the sum of individual travellers and this aggregate time saving will contribute to monetised benefits in the economic appraisal. On the other hand, the extent to which individual travellers would value or even notice a potential time saving of 2.5 to 5 minutes is open to question. What is not in doubt is that the *quality* of the journey experience *by car* will certainly be improved by the addition of the new motorway. However, what is rarely considered in such appraisals is whether travellers perceive the benefits to them *as individuals* are sufficient to justify the environmental and opportunity costs of a new road scheme.

3 Potential for motorway traffic management strategies

Evidence of the efficacy of potential motorway traffic management strategies and their applicability to the M4 motorway around Newport are now considered in turn.

To set the context for this review, the transport model indicates that about 12% of trips travelling through the Brynglas Tunnels (without the new motorway) is local traffic (joining and leaving the M4 between junctions 23 and 29) (see figure 10.15 of the traffic forecasting report (Welsh Government 2016). This is equivalent to approximately 10,000 vehicular trips per day given the 2037 forecast of 89,000 vehicles per day using the tunnels. This offers an estimate of potential for traffic and demand management strategies to reduce vehicular traffic through the Brynglas Tunnels without building a new road.

3.1 Smart motorway measures

The concept of the 'smart motorway' refers to the application of variable speed limits and / or hard shoulder running to improve traffic throughput during peak periods. A Highways England (2018) evaluation of the first section of smart motorway – deployed along the M42 in 2006 – indicated that journey time reliability² improved by 22 percent and collisions involving injuries reduced by 50 per cent.

Smart motorway measures: Opportunities for the M4 corridor around Newport

Smart motorway measures have already been introduced along the M4 corridor around Newport and there is limited potential for further intervention in this regard, beyond extending the length of the smart motorway zone:

- Variable Speed Limits were introduced in 2011, between junctions 24 and 28
- The Westbound Brynglas tunnel has a speed limit of 50mph (Whittaker 2016).

3.2 Ramp metering

Ramp metering involves installing traffic signals on motorway slip roads to control the rate at which traffic joins a motorway. When used during busy periods, ramp metering reduces the

² Department for Transport (2013) note that: "The reliability of journeys on Highways Agency's motorway and A road network is measured by the percentage of 'journeys' that are 'on time'. For this measure, a 'journey' represents travel between adjacent major junctions on the network. An 'on time journey' is defined as one which is completed within a set reference time, drawn from historic data on that particular section of road."

potential for high volumes of joining traffic to interrupt traffic flow, hence preventing the onset of 'stop start' flow conditions

The Highways Agency (2007) conducted a monitoring study of 30 ramp metering sites located in the West Midlands and the North of England (all of which opened in the period leading up to March 2007). Observed benefits included: increases in traffic flow of between 1 to 8 percent; increases in traffic speeds downstream of the ramp metered junction of between 3.5 and 35 per cent; and average journey time savings of 13 per cent.

Ramp metering: Opportunities for the M4 corridor around Newport

- Ramp metering is not currently installed on any of the junctions either side of the Brynglas Tunnels (according to a desk review using Google Street Maps).
- It is likely, for example, that traffic merging at junction 26 in the eastbound direction (on the approach to Brynglas Tunnels) causes the onset of, or at least exacerbates problems associated with stop start traffic through Brynglas Tunnels. Hence ramp metering *could be* considered as a possible motorway traffic management measure.
- The interim advice note on ramp metering (Austin 2008) recommends that ramp metering is suitable when merging flows are between 400 and 1,250 vehicles per hour, and the merging flow is at least 5 per cent of the upstream flow.
- The traffic forecasts for 2022 predicted an eastbound merging flow of 1,700 vehicles per hour. This is 40 per cent of the predicted upstream flow (of 4,700 vehicles per hour).
- In this instance, further work is required to establish whether the application of ramp metering at junction 26 would be effective, given that the merging flows are higher than 1,250 vehicles per hour. In such circumstances, the ramp metering queue override mechanism may be triggered to prevent slip lane queues blocking accesses on the local road network.
- Ramp metering could nevertheless be considered as a package of complementary measures, given a demand management scenario in which merging flows were to be reduced below 1,250 vehicles per hour.

3.3 Junction closure

Compared to ramp metering, closing junctions is a 'harder' measure to restrict the opportunity for traffic to join the motorway network.

Junction closure: Opportunities for the M4 corridor around Newport

There is no precedent for using junction closures as a motorway management measure in Great Britain. But there is potential to consider removing the westbound access to the M4 at junction 24, where the A449 from the north (serving traffic from Celtic Manor, Abergavenny and Monmouth) joins the motorway. This is because the A48 Southern Distributor Road (SDR) offers a dual two lane alternative route across the south of Newport running east to west.

- In 2022, 1,200 vehicles per hour are predicted to use the SDR in a south / westbound direction (Welsh Government 2016). The traffic forecasting report (Welsh Government 2016) does not indicate expected flows joining the M4 westbound from the A449.
- In the absence of this forecast, the AADT count for 2017 on the A449 can be used as the next best means of estimating traffic volumes joining the M4 at junction 24. This suggests a peak hour flow of about 1,800 vehicles (given an observed AADT of 29,699, applying a peak hour factor of 2.925 and assuming equal flows in either direction).
- There are three major turning movements from the A449 southbound: (i) M4 westbound (ii) M4 eastbound and (iii) SDR southbound. If one were to assume that there is an even distribution across these turning movements, then closing the M4 westbound access at junction 24 would (i) remove 600 vehicles per hour from the westbound direction (a reduction of about 14%, given the predicted westbound flow of 4,400 vehicles per hour) and (ii) add 600 vehicles per hour to the SDR.
- The flow on the SDR southbound would then be 1,800 vehicles per hour - an increase of 50%, given the predicted southbound flow of 1,200 vehicles per hour. This is within the expected capacity of 3,350 vehicles per hour specified in the Design Manual for Roads and Bridges for urban all-purpose dual two lane roads (Highways Agency 1999).
- The SDR passes through a series of at-grade, non-signalised roundabouts with typically two lanes on entry approaches. A peak hour flow of 1,800 vehicles per hour is considered to be within the potential capacity limits of a 2-lane roundabout, although detailed junction analyses would be required to examine the specific capacity of each junction.

3.4 Diversion of local motorway traffic

As noted earlier, around 12% of vehicular traffic using the Brynglas Tunnels is local traffic, joining or leaving the motorway between junctions 23 and 29. A previous assessment of public transport potential, based on a variant of the same M4CaN model, indicated that this traffic starts or ends in Newport and Cardiff (Welsh Government 2013). There is therefore credible potential to develop targeted high quality public transport services to encourage modal shift away from motorway travel for these local trips (discussed in further detail in section 4).

Diversion of local traffic: Opportunities for the M4 corridor around Newport

To give one example:

- The trip matrix included as Appendix C of the public transport overview (Welsh Government 2013) shows that around 2,000 vehicular trips per day (in 2016) travel to and from Newport East – the location of the Celtic Manor complex.
- A large proportion (30%) of these originate in the self-contained settlement of Bettws (to the north west of Newport) and a further 28% originate in Cardiff centre/bay. In total, these journey origins contribute about 1,300 motorway car trips per day in total, equivalent to 1,500 person trips per day (assuming a vehicle occupancy of 1.2).
- This equates to around 20 express coach journeys per day, based on the assumption that each coach can carry 70 passengers.
- If successful, such a service could potentially remove nearly 2% of car trips using the Brynglas Tunnels every day.

Note that express coach services have considerable potential to provide competitive, direct connections between activity centres that are displaced from the rail network. An example of this is the Kings Ferry commuter service that operates a direct service between residential areas in north Kent and Canary Wharf – an equivalent journey by rail requires several changes via central London.

3.5 Employment site travel demand management measures

Privately operated bespoke transport services (such as employer bus or coach services) can be effective when they are designed to serve geographically focussed trip generators including major employment sites like Celtic Manor. They can be particularly successful when delivered as part of a coordinated package of measures implemented through *site based travel plans*.

Site based travel plans are tailored packages of measures to enhance the potential for staff to commute to work by non-car modes. Travel plans typically involve offering staff incentives such as access to employer buses, discounted public transport tickets and bicycle purchase schemes, coupled with disincentives to commute by car such as constraints on parking availability, which may often be imposed naturally by constraints on land availability in urban areas. When used in the appropriate context, site based travel plans have been shown to reduce single occupancy car commuting by between 4% and 18% (Bartle 2016).

Travel Plans: Opportunities for the M4 corridor around Newport

- There are a number of large employers located in close proximity to the motorway network that will generate motorway trips during peak periods and which are well suited for tailored travel plans. These include, for example, Celtic Manor, Office for National Statistics, Cardiff Bay (including Welsh Government administration), the Principality Stadium, as well as Newport and Cardiff town centre employment sites (including the passport office).
- A broad brush estimate indicates, for example, that up to 1,300 car trips per day could potentially be served by an express coach service calling between Cardiff centre, Betwss and destinations in east Newport, including the Celtic Manor complex.

3.6 High Occupancy Vehicle (HOV) lanes

HOV lanes are road lanes dedicated specifically to vehicles with more than one occupant. This can include shared cars and public transport vehicles (most commonly bus lanes). There is mixed evidence about the effectiveness of HOV lanes. Some studies suggest that when underutilized, these lanes extend congestion, particularly in the context of a bottleneck such as the Brynglas tunnels (e.g.: Dahlgren, 2002; Daganzo and Cassidy, 2008). Other studies however have shown that the reallocation of road space away from single occupancy vehicles has had the effect of reducing traffic levels without impacting adversely on levels of congestion. For example, the M4 bus lane is a high profile example of a scheme which had positive impacts on levels of congestion and journey times. The scheme improved journey times by three minutes for bus users and one minute for car users, whilst no adverse effects were observed on peak traffic or the surrounding network (see: Highways Agency, 2005).

3.7 Freight management strategies

The observed changes in personal travel in recent decades, have been accompanied by quite significant changes in the way in which goods are moved around the UK. For example, light commercial vehicle traffic increased by 67% over the 20 year period to 2017 (DfT 2017), driven in part by the move to online shopping and home delivery. The volume of *HGV traffic* in Great Britain tracks the performance of the economy: reductions in HGV traffic between 2007 and 2009 of 4.6% (a period of recession) were followed by increases in HGV traffic of 11.7% between 2012 and 2017 (DfT 2017). However, the overall volume of HGV traffic in Great Britain (17bn miles) remains below the peak reached in 2007 (about 18bn miles). Over the longer term, the consolidation of goods into larger HGV vehicles means that “fewer vehicle miles are being driven to transport the same weight of goods” (DfT 2017, p.14). This consolidation process will act to reduce the rate at which HGV traffic increases over time.

Arup (2016) conducted an investigation in the future potential for the *rail freight market* in the UK. They identified a 22% increase in ‘billion tonne km’ moved by rail over the 18 year period between 1998-2016, but noted that this has been followed by a sharp recent decline in tonnes lifted (since 2013), attributed to “the collapse of the coal market”. On the one hand, this changing market condition represents a threat to the rail freight sector, but on the other hand it presents an opportunity, given that rail freight network capacity will be available for other purposes. In their assessment of potential for modal shift from road freight to rail freight, Arup (2016) suggest that ‘each freight train removes the equivalent of up to 76 HGVs’ from the road network.

Although *maritime freight* handles predominantly international movements, Manghan (2017) observes in his analysis for the DfT, that “domestic traffic accounted for 22 per cent (108 million tonnes) of all UK maritime freight traffic in 2015”. Movements between Northern Ireland and the mainland accounted for one fifth of this. *Given the coastal location of South Wales, and proximity to at least one major port (at Bristol), future opportunities for increases in the proportion of domestic freight moved by shipping should not be discounted.*

Freight: Opportunities for the M4 corridor around Newport

- Traffic count data for the Brynglas Tunnels indicates that the tunnels carried 7,500 daily HGV movements (equivalent to 15,000 cars, assuming that HGVs have the equivalent impact on capacity as 2 cars) in 2014. Note that this has reduced from 9,500 HGV movements in the year 2000. To some extent this is offset by increasing numbers of LGVs using the highway network: 10,100 LGV movements per day in 2014, increasing from 8,000 LGV movements per day in 2000.

Opportunities:

- The south east of Wales is well connected to the freight networks and the international port at Bristol.
- The Central Park rail freight distribution centre at Bristol Port (Western Approach) provides W10 gauge connections to Cardiff, and beyond with gauges less than W10.
- The South Wales main line is capable of handling significant volumes of freight. The 2008 Wales Freight Strategy noted that “over 8 million tonnes of freight [used] the South Wales main line between Newport and Swansea” (Welsh Government 2008).
- Arup (2016) estimated that a single freight train removes 76 HGVs from the road. A broad brush estimate would suggest then that 10 additional rail freight services could reduce HGV movements through the Brynglas tunnels by 10% (750 vehicles per day, equivalent to 1500 cars).
- But to fully understand potential for modal transfer to rail requires a detailed assessment of capacity available on the South Wales mainline (during the day and at night). Arup (2017) noted limited spare capacity on the Great Western Mainline for freight during the daytime, and suggested that future growth “will require intermodal access to terminals in South Wales and the South West”.

3.8 Road user charging

Road space is generally perceived to be free at the point of use i.e. the costs of fuel and fuel duty are not really ‘felt’ by the user before and during the trip. There are compelling economic arguments that road capacity ought to be *dynamically priced* such that road users pay the full ‘marginal social cost’ of their journey i.e. under a dynamic road pricing regime, the cost to the user would take into account their contributions to congestion and other externalities such as air and noise pollution, as well as the extent of their use of the road asset (priced by distance).

Road user charging: Opportunities for the M4 corridor around Newport

- Evidence shows that tolls and road pricing measures are highly effective means of managing road space. For example, one assessment of the impact of removing / retaining the tolls from the Severn Crossings indicated that an increase in toll of 50 per cent would reduce traffic by nearly 5 per cent (Welsh Government 2012).
- Hence, under the 'alternative transport scenario' tolls or road user charging offer an effective policy lever to manage traffic levels on the existing M4.
- Although road pricing is not currently popular with the public or politicians, the case for some form of road pricing will strengthen given that a full transition to an electric vehicle fleet (discussed in section 5) will entirely eliminate tax receipts from fuel duty.

3.9 Summary

To summarise the findings of the review to this point, the M4CaN model predicted that building a new motorway could potentially reduce traffic volumes through the Brynglas Tunnels by 28,000 vehicles per day in 2037 compared to not building the new motorway. However, the true future impacts of the proposed scheme cannot be known and evaluations of relief road schemes have shown congestion levels on existing networks to return to current levels more quickly than predicted due to the effects of induced traffic.

In the absence of constructing a new relief road, it is unlikely to be possible to achieve equivalent capacity increases through traffic management alone. Nevertheless, it is credible to consider providing high quality alternatives to motorway travel, whilst maintaining a reliable level of service on the existing motorway network through effective *traffic management*.

The review of traffic management strategies summarised in this section suggests that the combined effects of the 'marginal gains' achieved through individual interventions could offer improvements to flow conditions along the existing motorway. For example, some very broad brush estimates (which require further examination and validation) indicated that express coach services, junctions closures and freight management strategies together have potential to remove up to 7,700 daily car trips from the M4 (at 2016/17 figures). This is around 28% of the effect of building the new motorway (noting also that the 2016/17 estimates provided here have not been forecasted forwards to the design year of 2037).

4 Public transport potential

This section considers possible future public transport provision in south east Wales, and provides a high-level critique of studies examining the potential of public transport to contribute to providing accessible, attractive, sustainable travel options for people in the region.

This section is in three parts:

1. A brief overview of current public transport provision in the region, and a description of future infrastructure that is planned in the coming years (in particular, the South Wales metro scheme).
2. Critique of studies examining the potential future impacts of new public transport infrastructure and services.
3. Case-studies of potential future public transport systems which could build on the foundations of existing and planned infrastructure.

4.1 Existing public transport infrastructure and the South Wales Metro

This report presents a brief summary of the existing public transport infrastructure in south east Wales. This has been taken directly from two reports: The M4 Corridor Enhancement Measures: Public Transport Overview report (M4CEM-PT, 2012); and The M4 Corridor around Newport: Updated Public Transport Overview report (M4CaN-PT, 2016).

4.1.1 Existing infrastructure

The existing public transport network in south east Wales is comprised primarily of bus and rail services:

- Newport bus services
 - Predominantly radial into bus station
 - Current lack of cross-city services
 - Express services to the north and west
- Cardiff bus services
 - Mainly radial routes with some orbital
 - Most cross-city journeys require transfer

- City centre bus priority measures
- Cardiff-Newport bus services
 - X30: Express service between Cardiff and Newport city centres (40min journey, 30min frequency)
 - 30: Non-express service via A48 (50min journey; 20min frequency)
- Valley Lines rail network
 - Highly popular radial commuter routes
 - Serve the densely-populated south Wales valleys
 - Services converge on Cardiff (no direct services to Newport – Ebbw vale services stop at Pye Corner and Rogerstone in suburban Newport)
- Regional and mainline rail services
 - Great Western Mainline east-west routes through Cardiff and Newport
 - Other regional services
 - Combination of mainline and regional services gives approximately 9 trains per hour between Cardiff and Newport

The current public transport networks of south east Wales provide a reasonable level of accessibility for a proportion of the journeys made in the region, however there are evident deficiencies in this, for example, a lack of good cross-city services in both Newport and Cardiff, relatively infrequent express bus services between Newport and Cardiff, no direct rail services from the Valley Lines to Newport, and a general lack of integration between modes and systems.

4.1.2 South Wales Metro scheme

A number of significant improvements to public transport are planned in the region over the coming years. Most of these improvements fall under the banner of the South Wales Metro (SWM) scheme.

The South Wales Metro is a large-scale upgrade project which focuses on many different elements of the public transport network, including infrastructure, services, and information.

The aims of South Wales Metro (SWM) scheme are below. These link back to the aims of the Wales Transport Strategy (2008) presented in the first section:

- Deliver a high quality, reliable, efficient, economically sustainable transport network

- Improve connectivity enabling the region to function as a single coherent economic entity
- Improve accessibility to public transport within city and town centres
- Provide comparable journey times across public and private transport modes, offering realistic transport mode choices
- Cater for increasing demand for public transport
- Reduce the impact of transport on the environment
- Encourage active travel and social inclusion initiatives

The South Wales Metro is split into three phases, an overview is provided below, taken from information in the M4CaN-PT report (M4CaN-PT, 2016). Figure 3 presents a map of the possible form of the future network if all of the improvement through to the end of phase three of the South Wales Metro are implemented.

4.1.2.1 SWM Phase 1:

- Comprised of schemes either complete, underway, or at the detailed planning stage
- Includes new rail stations, upgraded stations, new station facilities, and limited bus and rail infrastructure upgrades

4.1.2.2 SWM Phase 2:

- Modernisation of the Valley Lines infrastructure
- More frequent, reliable, and faster services, with lower operating costs and better facilities
- Delivery expected 2018-2023

4.1.2.3 SWM Phase 3:

- Dependent on outcomes of preceding phases and the availability of future funding
- Addition/extension to the existing network alongside wholly new routes
- BRT schemes linking Newport, Monmouth, and the Valleys
- New rail lines in and around Cardiff, and a link between the Rhymney Valley Line and Newport
- Numerous new and upgraded stations and interchanges

If realised, the South Wales Metro improvements to the current public transport infrastructure in the region have the potential to significantly increase accessibility for people living and working in south east Wales. An upgraded South Wales Metro network will provide a firm foundation upon which further developments can be made in the future.

There is a wide range of additional public transport measures which might be suitable to augment the future South Wales Metro network, including but not limited to:

- Light rail schemes
- Park and Ride
- Link and Ride
- Improved local bus services (including additional cross-town services)
- Express coach services/interchanges

Figure 3 - South Wales Metro Phase 1 schemes

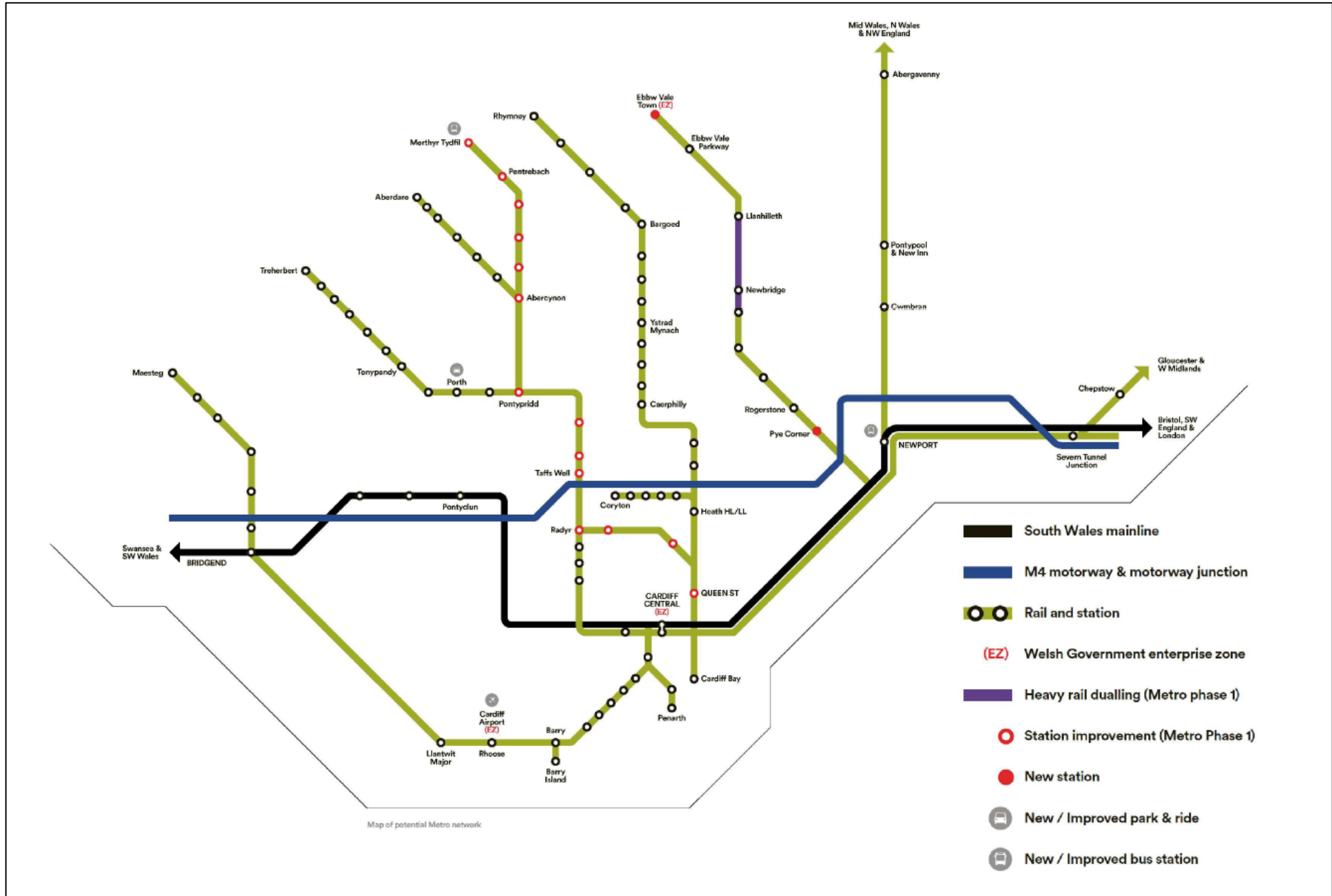
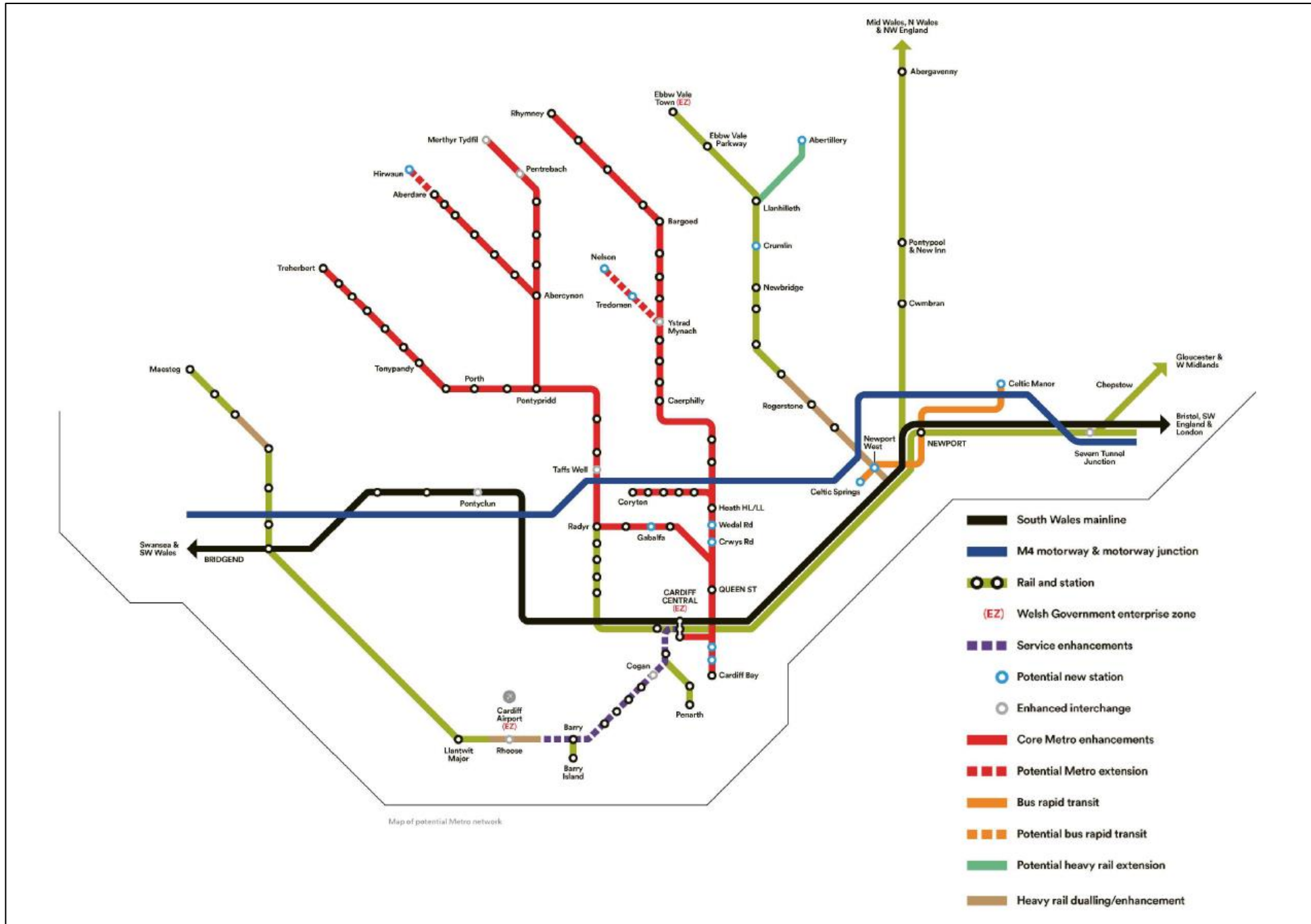


Figure 4 - South Wales Metro Phase 2 schemes



4.2 Limitations of existing public transport analysis/reporting

As a part of the evaluation of the potential contribution of public transport to addressing capacity issues on the M4 corridor around Newport, two main studies have been conducted to assess the scale of impact of the public transport measures outlined above.

The M4 Corridor Enhancement Measures: Public Transport Overview report (M4CEM-PT, 2012) provides a thorough overview of the potential for public transport improvements in the local area to contribute to traffic reductions on the M4 corridor around Newport.

Following directly from this, the [M4 Corridor around Newport: Updated Public Transport Overview](#) report (M4CaN-PT, 2016) updates the M4CEM-PT report in the context of the planned South Wales Metro public transport development, and is the most current examination of the short-medium term future impacts of public transport investment on traffic using the M4 corridor around Newport.

Where the M4CEM-PT report covers a wider range of transport infrastructure improvements, M4CaN-PT report focusses specifically on the impacts of (a selection of) the proposed South Wales Metro measures.

Both reports provide a detailed examination of the potential for public transport modes to ease capacity demands on the M4 corridor, with a focus on the new public transport improvements currently planned as a part of the South Wales Metro programme.

A subsequent [Public Transport Note \(ID/073\)](#) provides an additional piece of public transport analysis, examining the potential impacts of a Bus Rapid Transit (BRT) corridor from Celtic Manor to Celtic Springs.

Whilst being thorough examinations within their defined scopes, these reports do have a number of limitations, summarised as follows:

4.2.1.1 *Supporting car travel with public transport*

The M4CEM report arrives at the conclusion that public transport can play a *supporting role* in facilitating travel in the region, but that significant upgraded road capacity is also needed.

There is an argument to be made that most often whenever road building is “supported” by public transport improvements, this is actually to the detriment of public transport. New road schemes are relatively “straightforward” to implement: many people are already drivers, the new infrastructure can be built, and people can use it. On the other hand, encouraging a modal/behavioural shift towards public transport use is more challenging, complex, and a long-term process. Indeed, insufficient road capacity is one of the factors that encourages greater public transport use.

In short, if you make driving more attractive to people (by building more road capacity), this makes public transport less attractive, having the opposite effect to that intended, particularly as new road infrastructure will most often be constructed *before* the supporting public transport infrastructure is completed. This entrenches car-oriented travel habits and so perpetuates excessive private car use.

4.2.1.2 Limitations in scope

The M4CEM and M4CaN reports are limited in their scope, and do not attempt to model the potential contributions of public transport infrastructure beyond that which is already under consideration. There is no modelling in the current analyses of the potential impacts of considerable additional funding for public transport measures, beyond the funding that would be required to satisfy current transport strategies.

The M4CEM report develops an illustrative public transport scenario from short-medium term infrastructural programmes that have been described in strategy documents, and provides a “high level appraisal” of the potential future impacts of these on key routes in the region. The report does not consider the long-term potential of public transport investment in the region, noting: *“A longer term regional strategy would require considerable investment, and is not currently within the scope of this project.”* (M4CEM, p. 18).

The M4CaN report explicitly limits the analysis of public transport impacts in the region to any infrastructure that is currently planned or underway as a part of the South Wales Metro scheme. Therefore essentially there is no consideration in the modelling exercise in this report of the impacts of any public transport infrastructure in the coming decades which is not yet already conceived of and agreed upon. The report also excludes from the modelling exercise

all future South Wales Metro elements with the exception of rail schemes and the proposed Llanwern Park and Ride scheme: *"As a result of the modelling methodology used only the effects of rail and strategic Park and Ride schemes will be considered."* (M4CaN, p. 25). This means for example that bus-based schemes such as the Bus Rapid Transit (BRT) corridors planned for the South Wales Metro Phase 3 are not considered in the M4CaN analysis.

This report contends that the two above points limit the analysis in terms of its ability to fully quantify the potential of public transport to contribute to travel in the region over longer term.

In addition to the above point, the public transport analysis focusses only on public transport in the context of problem links of the M4, introducing a number of assumptions and caveats to the analysis, and excluding a large proportion of proposed new public transport infrastructural development from specific analysis in the modelling that cannot be directly linked to travel on that stretch of road. However, the M4 corridor sits inextricably entwined within the broader transport networks of south east Wales, and it would be more useful to think holistically about the contribution of public transport to facilitating movement across the region. Transport networks and their effects are interlinked, and it is artificially limiting to suggest that developing a fully integrated, attractive, and accessible public transport and active travel network for south east Wales will have no additional effect on M4 traffic.

Whilst these exclusions are defensible within a narrow scope, nonetheless the effect of this is that the representation of the new infrastructure developments in the analysis is incomplete, which at best can be said to provide an underestimation of the potential benefits that public transport infrastructure upgrades can offer the region.

To illustrate, Table 2 provides a high-level comparison of the full range of planned elements of the South Wales Metro project with the elements of the South Wales Metro considered suitable for inclusion in the analysis of the impacts of this scheme on the M4 corridor, demonstrating the proportion of the new public transport infrastructure which is excluded from the analysis.

Table 2 - Comparison of new infrastructure and service improvements included in South Wales Metro plan and M4CaN-PT analysis of impacts of plan

<p>New infrastructure and service improvements included in the South Wales Metro (SWM) plan</p>	<p>New infrastructure and service improvements considered in the M4CaN-PT analysis of the impacts of the SWM</p>
<ul style="list-style-type: none"> • An electrified rail system • Integrated transport hubs • Park and ride facilities • New light rail routes • New bus rapid transit routes • Better integration of services across modes and operators • Active travel interventions 	<ul style="list-style-type: none"> • New rail infrastructure • A new Park and Ride facility at Llanwern

The subsequent Public Transport Note (ID/073) updates this analysis, and additionally looks at the impact of one proposed BRT scheme (between Celtic Manor and Celtic Springs); however, other BRT schemes which are proposed for the Newport area in Phase 3 are not considered (for example the Monmouth link, the Blaenavon link, the Newport East link). This means, for example, that much of the extensive new bus-based infrastructure isn't modelled in the analysis.

The public transport evaluations make no attempt to envision a more sustainable public transport future for the region, in which a large scale shift to public transport from private car use is realised. This was not their purpose and so this is not really a surprise, however in general there is a lack of ambition in the current consideration of the role public transport can play in the region in the coming decades. It is evident that the M4CEM and the M4CaN analyses were conducted in relation to a singular objective to 'solve' congestion on the M4. We would argue that the alternative package and the M4 scheme ought to be judged against a much broader range of objectives that take into account the wider geographic, social, and environmental contexts (e.g. Figure 1).

Essentially, this goes back to one of the main points being made in this report, which is that we have to design and build the transport systems for the type of future that we want as a society. South east Wales is currently at one of those big decision points. If the people of south east Wales want more car journeys and more road infrastructure over the coming 30 years, then the solution most definitely is to build another large road. If the people of south east Wales want to begin to move more towards a more sustainable and efficient transport system then the solution is to continue to build upon the solid foundation that the South Wales Metro scheme will provide, and develop public transport and active travel in the region much further.

4.3 Contributions of potential future public transport options to accessibility

This section presents a series of future case-studies created to examine the accessibility of public transport infrastructure in south east Wales and the surrounding region. This is useful in providing an overview of the potential for public transport to provide realistic, accessible alternatives to the private car for travel to, from, and around Newport.

These schemes are intended to take the South Wales Metro project and use this as a solid foundation for further public transport development in the region.

This section provides an analysis of accessibility of case studies of potential future schemes. These are for illustration purposes only, but serve to further elaborate on the point that there is a potential to develop an ambitious public transport network in the south east Wales region, one which goes some way to achieving to objectives of the Wales Transport Strategy (2008).

The M4CEM-PT report includes a set of calculated costs of public transport schemes in the south Wales region, and this list includes schemes similar to the case-studies below (Figure 6). The costs calculated for the M4CEM report have been included here as illustrative examples, indicative of the possible costs of similar public transport infrastructure upgrades in the future. It is useful to consider these costs within the context of the £1.4billion proposed for upgrades to road infrastructure in the region.

Figure 6 - Public Transport Measures Infrastructure Costs (Source: M4CEM-PT, 2012, p. 30)

Mode	Public Transport Measures	Cost (£M)
Bus	Improved Bus / BRT services	160
Rail	New/enhanced P&R railway stations and associated infrastructure	25
Rail	New railway stations	70
Rail	Bus rail interchange station	10
Rail	New rail service (with a half-hour frequency); upgrade railway infrastructure, including turn-back facilities	35
Rail	Provide additional freight loops and associated infrastructure	20
Bus / Rail	Introduce cross-ticketing measures (e.g. Common Cardiff/Newport bus passes; Improved PlusBus system (for transfer between rail and bus across Cardiff / Newport))	5
Bus / Rail	Establish non-central interchange points on the bus and railway network where routes cross, and to provide focal points for feeder buses.	10
Total		£335M

Note: (1) Costs are preliminary estimates for initial budgeting purposes only (2) Costs are for infrastructure only, and do not include operational and rolling stock or vehicle costs or fare income

4.3.1 Case-study 1: Further improvements to rail accessibility

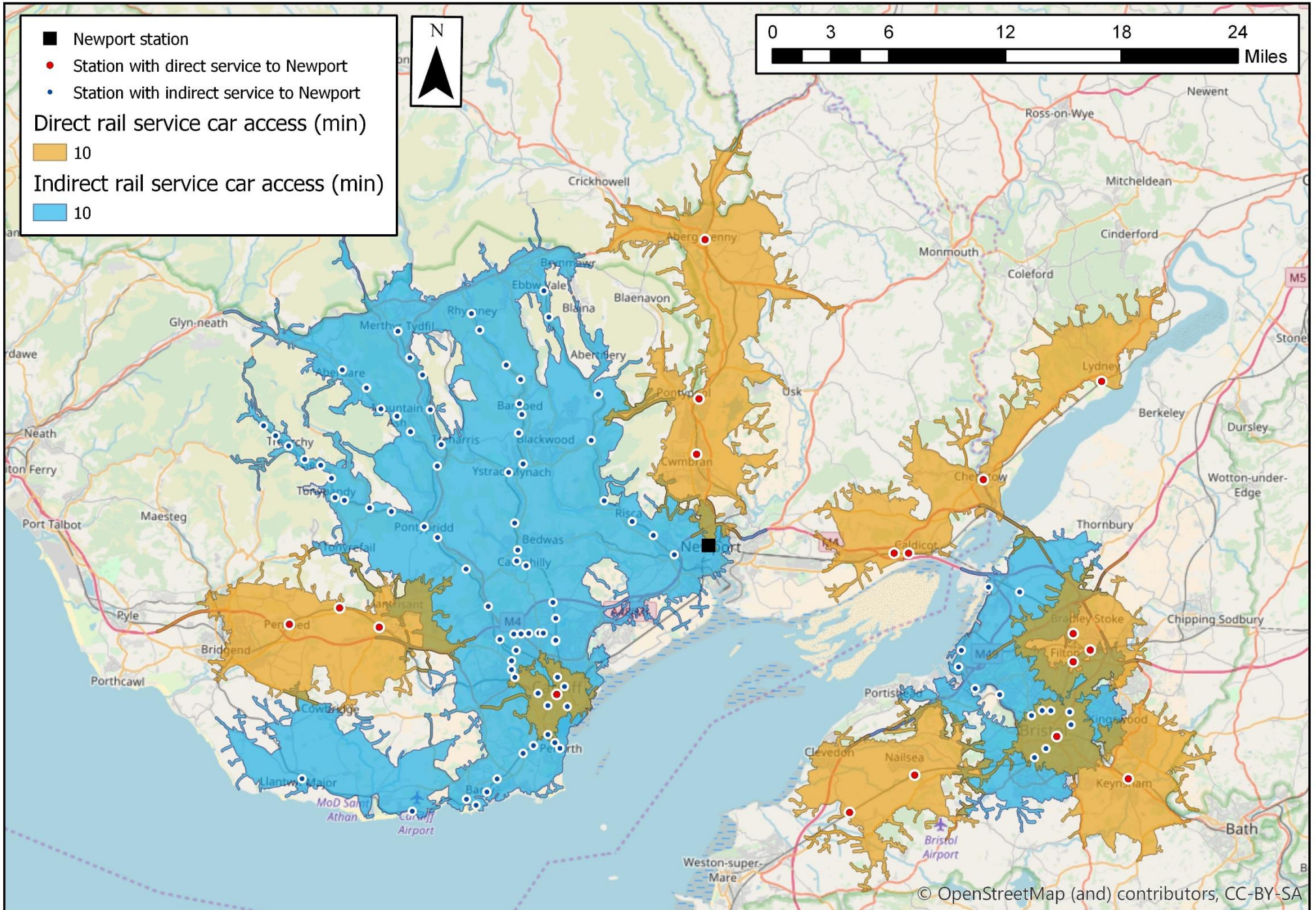
A number of the local rail services in south east Wales, for example the Valley Lines, have proven to be extremely popular: “of the 20 busiest stations in Wales, over half are part of the Valley Lines network” (Welsh Government, 2018, p. 1). There is an opportunity to increase the number of people using these lines for travel to Newport. In the future, it could be possible to build on the foundations of the planned rail improvements in the South Wales Metro scheme and extend these improve the frequency and connectivity of these lines so that they more directly serve Newport, either through improved interchange in Cardiff, or direct connections to Newport. Indeed, the South Wales Metro includes at least one upgrade to link the Ebbw Vale valley line directly to Newport.

Improving connectivity, interchange, and frequency of services between the Valleys and Newport area would be a challenging infrastructural task, particularly considering that the Cardiff-Newport mainline is already operating near capacity. However, as the benefits for the region could be significant, it warrants examination of how this might be possible – either through line capacity upgrades between Newport and Cardiff Central (e.g. in a similar fashion to that currently underway on the Bristol mainline, which is undergoing an upgrade from two to four tracks, doubling capacity to support mainline and local services, at a cost of £33million³).

Map 1 shows stations in the region, and also a spatial analysis of car access to these stations. Car access for this analysis has been set at a 10 minute drive at the start of the morning peak on a Monday (7:30am). What Map 1 clearly shows is that by building on the popularity of the Valley Lines, and upgrading the connectivity and frequency of these services into Newport, there is the potential for a large proportion of the urban areas of the region to have improved access to high quality rail links. A number of the Valley Lines stations already operate as P&R services for drivers to interchange and transfer to PT, and it would be possible to further extend this provision. Linking people to an accessible, attractive public transport service would have the benefits of encouraging greater use of sustainable alternatives to the car. Public transport accessibility for communities would be significantly improved, and this would be of benefit to all travellers, not only those in car-owning households.

³ http://www.taylorwoodrow.com/news-and-downloads/news_article.asp?articleid=96

Map 1 – Stations with direct or indirect services to Newport



4.3.2 Case-study 2: Newport – Monmouth Link and Ride

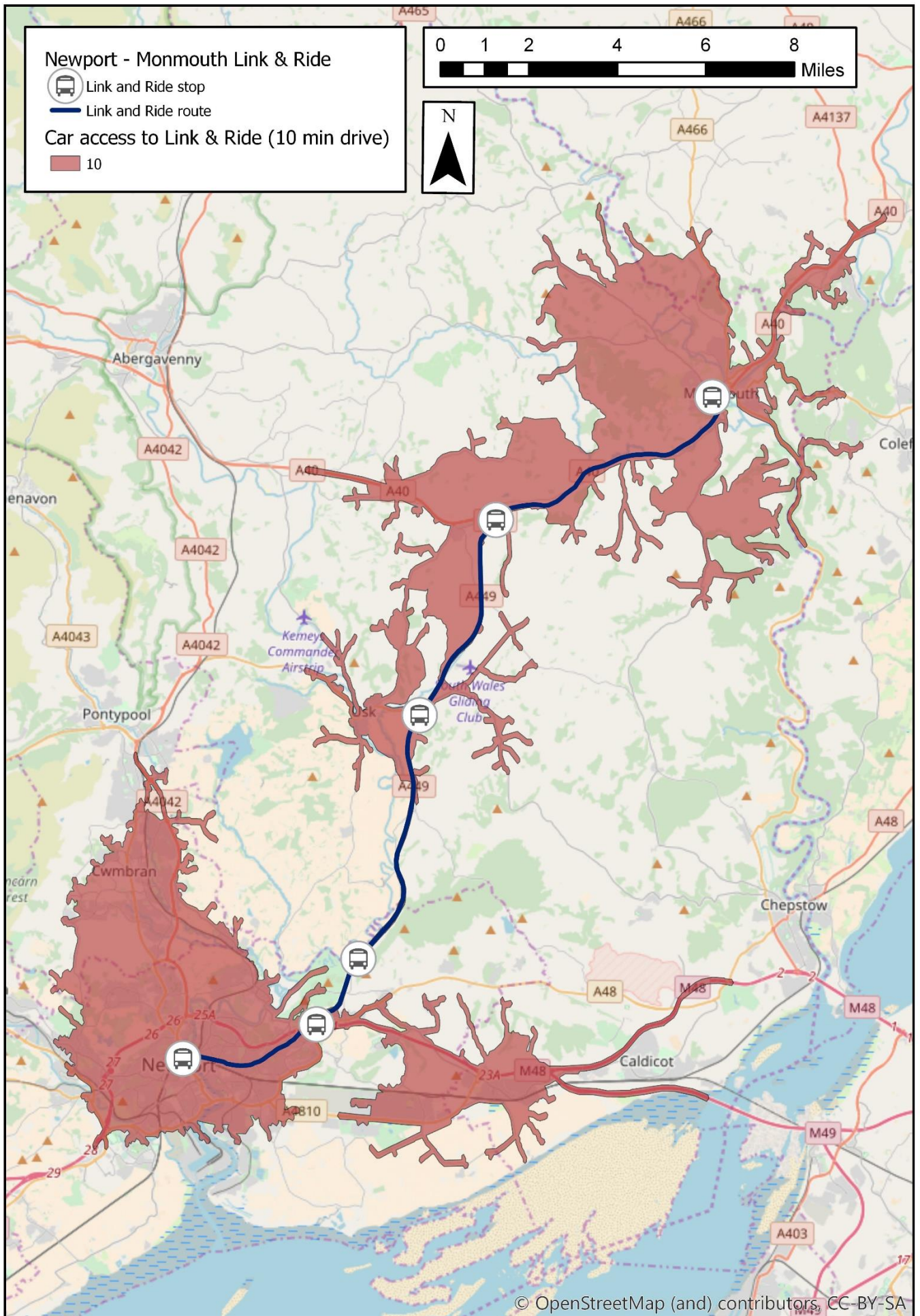
Link and Ride (L&R) is a form of public transport similar to Park and Ride (P&R). The service consists of a series of interchanges between an express public transport corridor (typically bus or train), and feeder modes (typically car, bicycle, walking) (Parkhurst, 2000). L&R is unique in that rather than using a large car park/interchange on an urban periphery (as in traditional P&R), it uses a series of smaller car parks located at points along a public transport route.

The benefit of a Link and Ride system is that it can intercept drivers earlier in their journey than traditional P&R, meaning that people are conducting a larger proportion of their trip using the public transport mode, which has both environmental and network benefits (reductions in private vehicle emissions and reductions in traffic and congestion). Indeed, a Bus Rapid Transit (BRT) system linking to Monmouth is one of the proposed elements of the South Wales Metro Phase 3 (see: Figure 3).

In Map 1 from the previous case-study, there is a gap in accessibility to rail stations along the route between Newport and Monmouth, a result of the fact that there is no rail service along this corridor. A L&R service is proposed to fill this accessibility gap, and provide people in this area with an attractive alternative to driving into Newport. The L&R service consists of a series of small-medium sized car-parks strategically sited at the junctions along the A449/A40. This is to allow for quick access to the interchange stations and maintain a competitive journey time.

The benefits of a L&R service to this area would be to provide people with accessibility to a direct, attractive public transport option. There is currently a bus service along this route, however having an express L&R option could be more attractive to drivers looking to interchange easily and still have a competitive journey time into Newport. Public transport options also have the benefit of having a better environmental and social sustainability than private vehicle use. For example, the vehicles on the L&R service could be low-emission hybrid or fully electric buses, which could help to address carbon emissions and improve air quality in the urban areas served. Public transport is accessible to everyone, and therefore this service would be of benefit to all that want to use it, as opposed to only car-owning households.

Map 2 – Link and Ride service between Newport and Monmouth



4.3.3 Case-study 3: Proposed express coach/P&R facility on eastern side of the Severn Bridge, to facilitate trips from the West of England sub-region into Newport and south east Wales

This consists of a new express coach service linking Newport and Cardiff with people travelling from the West of England region. Vehicle flow data from the M4CEM-PT report shows a significant flow of traffic using the M4 that originates in the Greater Bristol/Bath area, and if some of this traffic can be intercepted and transferred onto an express coach service, it would have a positive effect on congestion and vehicle emissions.

Express commuter coach services are already operating with considerable success in other locations, for example the popular [Kings Ferry service](#) in London, which connects commuters in Kent into Central London on coaches with leather seating, Wi-Fi, and refreshments.

The service includes five express coach terminals:

1. On the eastern shore of the Severn Estuary, near to the current M4 motorway crossing at the Lower Severn Bridge (large express coach terminal with car park, PT, and cycle interchange)
2. Newport
 - a. On the outskirts of Newport (terminal with limited parking and public transport and cycle interchange)
 - b. In the centre of Newport (terminal with public transport and cycle interchange)
3. Cardiff
 - a. On the outskirts of Cardiff (terminal with limited parking and public transport and cycle interchange)
 - b. In the centre of Cardiff (terminal with public transport and cycle interchange)

The benefits of this scheme would be a reduction in levels of traffic congestion on the M4 corridor, reduced vehicle emissions from private vehicle use (supported by the use of low-emission coaches), and improved accessibility for people in both the south east Wales and West of England regions.

There are further opportunities for developing express coach services across the region, to provide competitive, direct connections between activity centres that are displaced from the rail network. A further analysis of the pattern of demand for this local motorway traffic

indicates a significant desire line between Cardiff centre / bay, the settlement of Bettws to the north west of Newport and destinations in east Newport, including Celtic manor. This market could potentially be served by a high quality express coach service, removing up to 1,300 daily car trips from the M4 (2016 figures).

5 Future trends

Evidence from a number of sources demonstrates that there is significant uncertainty about the persistence of current “transport norms” in the coming decades. Recent academic literature highlights the uncertainty faced in the context of accelerating technological development and changing population demographics and trends. For example, long-term data trends show that driving license holding amongst younger people has currently levelled off, which could mean that a decoupling is occurring in the long-established link between levels of car use and economic output. The coming decades are likely to see a continuation and intensification of this uncertainty (Lyons and Davidson, 2016). It is suggested that we are moving into a period of “regime change”, away from the current regime of private vehicle ownership and use, and towards collective mobility (public transport, shared vehicles) and virtual (digital) connectivity as the norms.

This uncertainty means that it is challenging or even impossible to make useful forecasts to inform whether building new road infrastructure is the “right” thing to do. To make this decision requires some form of value judgement about what sort of future transport scenario is most desirable.

Below are some examples of future uncertainties which make the predicting future trends in traffic and modal share challenging. These examples have varied and sometimes conflicting effects on traffic and congestion, however presented together they serve to demonstrate a set of likely future developments which mean that we now face more uncertainty in our forecasts than in previous decades. They challenge the wisdom of using traditional traffic forecasting approaches to understanding the effects (and estimating benefits) of a large new road scheme in the context of the complex changes in technology and travel behaviour likely to unfold in the coming decades.

5.1 Electric and alternative fuel vehicles

Alternative fuel vehicles are growing in popularity in UK, in particular, electric and hybrid-electric vehicles.

The UK Government has committed to banning all petrol and diesel cars and vans by 2040, meaning that there must be a significant shift towards EVs and alternative fuel vehicles in the vehicle fleet in the coming decades. More recent calls from The Green Alliance (an environmental think-tank) have urged that the ban should be brought forward to 2030 (see: [The Guardian](#), 2018).

This shift in vehicle fuel type away from petrol and diesel is important from an economic perspective. Currently the UK Government receives significant amounts of fuel duty from the sale of petrol and diesel, and also collects Vehicle Excise Duty (VED) on petrol and diesel vehicles, whilst zero tailpipe emission vehicles are charged no VED.

A study by the Institute for Fiscal Studies (IFS) (2012) into the effects of a move towards the electrification of the UK vehicle fleet concluded that in the context of a significant loss of tax revenue from fuel duty and VED, one of the likely pathways to maintaining tax revenues available to a future UK Government will be road pricing.

Introducing road pricing could have the effect of reducing congestion on problem routes, by increasing the cost of travel on over-utilised sections of the network, and encouraging people to travel either by a different route or alternate mode.

Given the UK Government's commitment to decarbonising the vehicle fleet in the coming decades, coupled with the resultant reductions in tax revenue, this likely future scenario of road pricing means that in the medium-long term this could be implemented in south east Wales as an additional method to better manage some of the challenging congestion issues faced on the road network.

Recent media reports demonstrate more of the uncertainty surrounding future tax revenues from petrol and diesel vehicles.

- The UK Government has recently announced that it is considering lifting the current fuel duty freeze to help fund the NHS and manage other spending priorities. This demonstrates that fuel prices could be set to rise further in the short-medium term, which could have a restrictive effect on traffic volumes ([The Guardian](#), 2018).
- A report by consulting firm AlixPartners has suggested that diesel car sales will fall to 5% of the market by 2030, which further reinforces the above point about the likelihood of a relatively imminent change in the tax regime surrounding private vehicle travel ([BBC News](#), 2018).

5.2 Platooning

Over the longer term, there is potential for technologies that enable 'platoons' or chains of vehicles to form behind a lead vehicle, with automation systems taking over to control the speed of, direction of and vehicle spacing within the platoon. Platooning is anticipated to increase the capacity of a motorway lane since vehicles can: (i) follow each other much more closely and (ii) the automatic cruise control features remove the potential for flow breakdown to occur (which is caused by the acceleration / deceleration reaction times of human drivers).

Platooning: Opportunities for the M4 corridor around Newport

- Simulation studies have indicated, for example, that lane capacities could be increased from typically 2,000 vehicle per hour to as much as 9,000 vehicles per hour (at a running speed of 72 km/hr given platoons of 8 vehicles, spaced at 30 meters apart) (Fernandes and Nunes 2012).
- Although it is by no means certain that such technologies will become widely adopted and simulation studies are themselves subject to uncertainty, such lane capacities would comfortably be able to accommodate the predicted 89,000 vehicles per day through the Brynglas Tunnels.
- Other anticipated benefits of platooning systems include: fuel savings and reduced emissions due to aerodynamic effects (particularly when applied to platoons of HGVs); and reduced collision rates, given that the majority of collisions involve some form of human error (DfT Truck Platooning study).

The Department for Transport is currently preparing for the first road trial of platooning in the UK, which will use heavy goods vehicles. An £8.1million investment has been made in this trial, and self-driven truck platoons are expected on UK roads by the end of 2018 (DfT, 2017).

5.3 Fully Autonomous Vehicles

5.3.1 Private autonomous vehicles

Autonomous Vehicle (AV) technologies are currently of significant interest to transport providers and policymakers. AVs are relevant to this analysis because they are suggested to offer the potential to reduce congestion and journey times.

A number of studies have looked at the potential impacts of AVs on congestions and journey times on different types of road network (e.g. Greenblatt and Saxena, 2015; Greenblatt and Shaheen, 2015). The Department for Transport (DfT) (2016a) modelled the potential effects of AV adoption on the UK Strategic Road Network (SRN). The analysis concludes that the impact of AVs is dependent on the levels of adoption within the wider vehicle fleet, with the effects being larger at higher levels of fleet penetration. The analysis found that at higher levels of AV use (75% - 100% of the vehicle fleet), there were significant reductions in delay on the modelled SRN (17% - 40%). This also resulted in improvements in journey times to both individuals and at the network level:

"High penetration of highly capable CAVs [Connected AVs] could lead to improvements in the reliability of journey times of around 50%. (...) Improvements offered by CAVs could potentially provide journey time benefits of more than 10% to all motorists in peak times."
(DfT, 2016a, p. 39)

There have been a large number of studies into the emergence of these new technologies, and these have produced a range of predictions for when we might see these on the roads. These predictions range from longer-term adoption: 65% of the U.S. vehicle fleet by 2050 (Litman, 2014); to medium-short-term adoption: 90% of all vehicle trips by 2030 (Hars, 2014). There are more predictions within this range (for example, see: Bansal and Kockelman, 2017; Alexander and Gartner, 2014).

An important caveat to note here is that there are many commentators in the field of AVs, and as many varying views on the future as a result of autonomy, both in terms of the final outcomes, and the trajectory for reaching those final outcomes. While technology is moving on rapidly, it must be recognised that AVs will be entering an extremely challenging set of circumstances and it is not at all clear that many of these challenges have been either fully understood, or are indeed in the process of having solutions found for them. It is likely that, whatever the forecasts, the path towards autonomy will remain challenging, and as a consequence, currently proposed timescale could be difficult to achieve.

It is evident that AVs have the potential to have a significant impact on the performance of highway networks in the coming decades. There is uncertainty in the predictions surrounding this, however current studies suggest that this will be in the form of improvements to journey times and levels of congestion. The main point here is that rapid changes in vehicle technology in the medium-long term could render obsolete current prediction about future demand and travel patterns.

5.3.2 Public transport autonomous vehicles

Another important area of AV technology is in public transport vehicles – in particular buses and trains.

A number of public transport services already utilise driverless vehicles (for example, the Docklands Light Railway), and improvements in vehicle technology mean that these are likely to become more common in the future.

Autonomous public transport has the potential to be significantly cheaper to operate than the current model of driven vehicles, as drivers represent up to ~40% of the operating costs of public transport modes. If this cost can be reduced, then public transport operators will have the opportunity to transfer a proportion of that saving on to the passengers, meaning that there is the potential for a significant reduction in public transport fares in an autonomous system. This would have the effect of making public transport more attractive from a cost perspective relative to car travel.

6 Conclusion

This report has examined the options available to the people of south east Wales in terms of what sort of transport future they want built for their region in the coming decades. Emerging developments in vehicle technology and changing trends in the travel behaviours of different demographic groups mean that we currently face significant uncertainty both in terms of how the transport system will operate in the years ahead, and what future travel demand for different modes will be.

To encourage the most desirable environmental, social, and economic outcomes, it is important to envisage and plan for the future, then design for this, as opposed to simply reacting to the conditions of the present-day.

Excessive private vehicle use has been shown to have a large number of negative outcomes: high levels of congestion, excessive carbon and other pollutant emissions, poor air quality, poor health as a result of a sedentary population, community degradation through road infrastructure, transport and access inequalities, to name just some.

If we simply respond to one of the main symptoms of the current situation of excessive car use – traffic congestion – by building more road capacity, then this has the perverse outcome of further entrenching the root cause of these problems that we are seeking to address.

It is near impossible to build out of the problem of excessive private vehicle travel. Evidence consistently demonstrates that soon enough, a significant increase in highway traffic is almost certain, new capacity will simply fill up as driving becomes more attractive, and the challenges that the new infrastructure was designed to solve will re-emerge, now on an even more crowded network.

To address the challenge of excessive private vehicle travel, people must be provided with options to encourage them to use their private vehicles less. One of the main options for achieving this is to create attractive alternatives to the car in the form of accessible, integrated public transport systems.

South Wales currently has a number of public transport options, principally comprised of rail and bus services, however these do not currently form a fully accessible and integrated system for the region.

The South Wales Metro project is a series of significant infrastructural upgrades to the existing public transport network, structured into three phases of delivery. If the full investment is made into completion of all three phases, then the South Wales Metro will represent a substantial improvement on the current public transport options available to people for travel in the region. The South Wales Metro therefore represents a strong foundation upon which future public transport investment can be made, to continue developing the network with the aim of arriving at a fully accessible, integrated system in the coming decades.

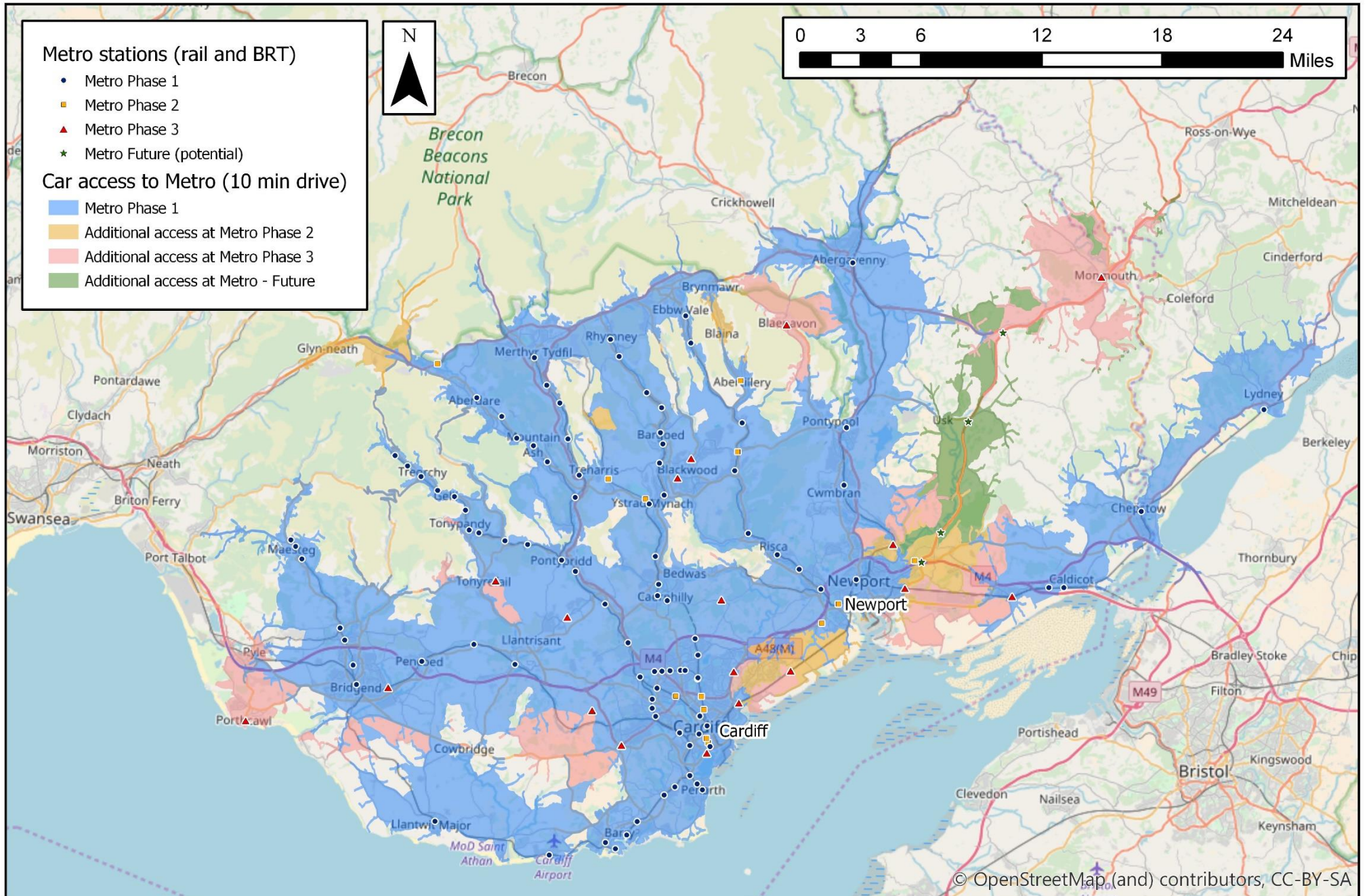
6.1 Future public transport accessibility in south east Wales

This report concludes with a spatial analysis that brings together all of the potential future public transport improvements discussed in the preceding sections. The map output of the analysis is shown on the following page (Map 3). The aim of this is to show the potential accessibility of the future phases of the South Wales Metro (if realised), and also of the proposed Newport-Monmouth Link and Ride described in the previous section.

The spatial analysis was conducted in ArcGIS using the Network Analyst tool to create service areas for the public transport stations/stops (rail and Bus Rapid Transit) in the three phases of the South Wales Metro development. The accessibility areas were calculated to include a ten minute drive to the stations, and the analysis was set to represent a typical Monday morning rush hour scenario (08:00am). The

This analysis demonstrates that a large proportion of the inhabited areas of the region are within a reasonable car drive of public transport interchanges. The analysis suggests that if sufficient investment is made to developing the public transport infrastructure, it should be possible to have a public transport system which reliably and efficiently links people to key destinations in the region, and if interchange facilities are provided at public transport stations/stops, these can serve as an attractive alternative to using the car for the entire journey.

Map 3 – South Wales Metro public transport hubs with 10 minute car access



South Wales Metro public transport hubs with 10 minute car access

Appendix A – Evidence of unintended outcomes of road building schemes

The extracts below are taken from a number of robust studies into the effects of road building schemes on levels of traffic.

**Extract from: "Induced Traffic Again. And again. And again."
Professor Phil Goodwin, 2006**

In 1994 SACTRA, the Standing Advisory Committee on Trunk Road Assessment, published its best-known report, on what it renamed 'induced' traffic. The average traffic flow on 151 improved roads was **10.4% higher than forecasts that omitted induced traffic and 16.4% higher than forecast on 85 alternative routes that improvements had been intended to relieve**. In a dozen more detailed case studies **the measured increase in traffic ranged from 9% to 44% in the short run and 20% to 178% in the longer run**. This fitted in with other evidence on elasticities and aggregate data. The conclusion was:

*"An average road improvement, for which traffic growth due to all other factors is forecast correctly, will see **an additional [i.e. induced] 10% of base traffic in the short term and 20% in the long term.**"*

Fast forward to July this year. CPRE published a report by Lilli Matson, Lynn Sloman, Ian Taylor and John Elliott. The authors were known to me - I worked with Lilli on the Ten-Year Plan for Transport, with a report we called Running to Stand Still; with Lynn on Smarter Choices and also the West Midlands TIF programme; and with John (who did the original 1985 GLC study, with Jill Beardwood and Steve Purnell) on the Thames Gateway Bridge. They are a serious group of engaged professionals and I opened their report with interest.

It's called Beyond Transport Infrastructure and what they have done is look in detail at three big schemes on the A27, A34 and M65, and a further ten schemes on the A5, A6, A41, A43, A46, A66, A500 and A1033. These were schemes undertaken after SACTRA's 1994 report had been finished and accepted.

They reported:

"Careful scrutiny of the traffic flow data suggests that traffic growth after the scheme opened has been significantly higher than growth on other nearby road corridors or national traffic growth."

They also said that:

"In all three case studies the current traffic flows are near or already in excess of what was predicted for 2010. In towns with bypasses, such as Newbury and Polegate, the new roads did significantly reduce the town centre traffic levels. However, these reductions are not as great as originally forecast

*and there has subsequently been regrowth in traffic levels on the bypassed roads. **The net effect in combination with the new road is generally a considerable overall increase in traffic.***"

Their final conclusion is remarkably restrained. After noting the Highways Agency's own explanations for the extra traffic growth (which were intriguingly similar to those rejected by SACTRA 12 years earlier), they write:

"Nevertheless, in view of the fact that many of the schemes reviewed have demonstrated significant increases in traffic volumes (in the range of 10-35%, within a period of one to two years after opening), there would seem a strong case to consider the issue of induced traffic in more detail in future evaluations."

So 1925, 1937, 1958, 1963, 1968, 1985, 1987, 1988, 1994, 1996, now 2006: for 80 years, every eight years on average, there has been the same experience, the same conclusions - even, for goodness sake, more or less the same figures. **The evidence has been consistent, recurrent, unchallenged by serious countervailing evidence but repeatedly forgotten.** CPRE have done us a service, I think, but really it should just not have been possible for them to find, 12 years after SACTRA, the same mistakes.

**Extracts from: "The end of the road? Challenging the road-building consensus.
Learning from previous road schemes for a better future"
Campaign to Protect Rural England (CPRE), 2017**

Despite the large and consistent body of evidence, successive governments, and the bodies that advise them, have **repeatedly found it convenient to forget or deny that new roads generate more traffic independently of changes arising from growth in population or the economy.**

In order to investigate the credibility of the claims being made for the new roads programme, CPRE commissioned consultants at Transport for Quality of Life (TfQL), to produce an independent report.

Reviewing over 80 official evaluations of road schemes, as well as carrying out four detailed case studies of older road schemes, this research examined if road-building:

- delivered the congestion relief promised
- damaged the landscape as much as feared
- boosted local economies as hoped

With a much larger body of evidence now available, we have been able to publish an even more authoritative rebuttal of official claims over the benefit of building roads.

The new TfQL research shows that road schemes:

- Induce traffic, that is, **generate more traffic** – often **far above background trends** over the longer term
- Lead to **permanent and significant environmental and landscape damage**
- Show **little evidence of economic benefit** to local economies

The results are particularly damning in terms of economic impacts, for which there was insufficient evidence available to come to conclusions in 2006.

Despite a thorough investigation of wider economic data, such as job creation and registration of new businesses, **few or no economic benefits from building roads (depending on the scheme in question) were found by the new research.**

Unsurprisingly, evidence from the 13 cases analysed in detail for traffic impact concluded that road schemes generate more traffic. **On average, traffic grew 47% more than background levels, with one scheme more than doubling traffic within 20 years.**

None of the four schemes assessed in the longer-term showed the promised reduction in congestion; all put pressure on adjoining roads.

As for economic impact, **of 25 road schemes justified on the basis that they would benefit the local economy, only five had any direct evidence of economic effects at all.** Even then there was **no evidence the road was responsible for them, or hadn't simply moved economic activity from elsewhere.**

And as regards the longed-for congestion relief, **median journey times hardly changed**, with savings of 90 seconds during peak periods.

What was sacrificed for these marginal gains? **Sixty-nine out of 86 road schemes examined had an adverse impact on the landscape** – not just **obliterating views**, but **destroying ancient woodland and mature hedgerows**. More than half **damaged an area with national or local landscape designations** for landscape, biodiversity or heritage.

Extracts from: "An analysis of the 'Five-Years After' Post-Opening Project Evaluation for the A34 Newbury Bypass."

Taylor, Elliot, Sloman, and Matson (2006)

The most sensible interpretation of the available data is that **construction of the [Newbury] bypass has resulted in substantial induced traffic.**

We identified **a number of shortcomings in the appraisal and evaluation processes for road schemes**, as well as **failures of transparency and failures of the evaluation process to impact on policy**. Taken together, these have led to **a failure of the Government's roads programme, which continues to deliver schemes which have, at best, unproven benefit.**

Studies such as those of the Westway in west London have shown that with the advent of a new road, considerable volumes of completely new traffic can be generated within a year of construction. In the case of the Westway, generated traffic (traffic that could not be attributed to reassignment) amounted to **17,000 vehicles per day within a few months of opening**, over one third of traffic flow on the new road. The same study showed that when the new bore of the Blackwall tunnel was built, **traffic leapt 42% in three months, over 9,000 extra vehicles**, with 'no significant reassignment of traffic to the Blackwall Tunnels from the other river crossings'.

[On surrounding roads] "The (...) evaluation shows that **when the bypass was built, traffic on the Newbury-Basingstoke A339 rose dramatically**. The initial increase in traffic was 20%, and by 2003 traffic volumes on this road were **26% above pre-bypass levels**. It is clear that traffic was generated on this road as soon as the bypass made it an attractive route. **This was not predicted to happen.**

The data on road casualties are alarming. The evaluation shows that **crashes causing deaths and serious injuries have risen by 50% as a result of the bypass**. The trend is even worse for fatalities considered separately, which have risen 67%. (...) **This was not meant to happen**. The official prediction was that there would be 17 fewer deaths over a 30 year assessment period (equivalent to a 47% reduction), but on present trends there will be 24 more deaths over this time."

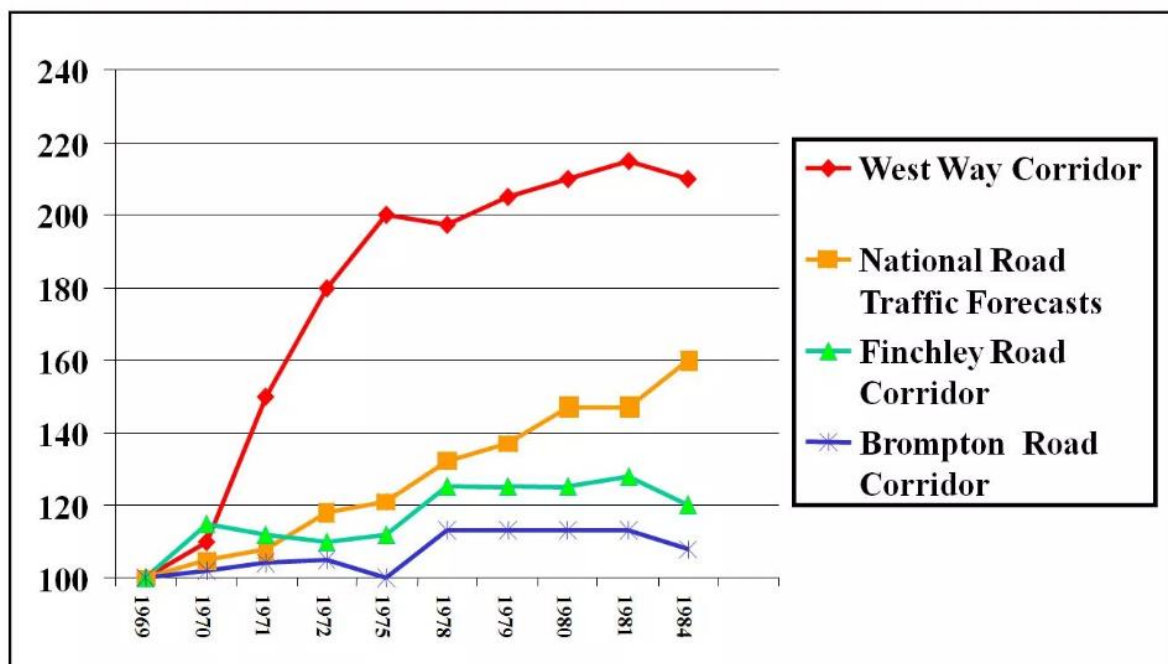
In the five years from its opening until 2003, eight people died on the short 13.5 km of bypass – **a heavy price to pay for what the report estimates to be just four to 11 minutes of drivers' journey time saved.**

**Meeting on East London River Crossings
Presentation at: No Silvertown Tunnel Public Meeting Oct. 2013, Greenwich
John Elliott, independent transport consultant**

https://www.youtube.com/watch?v=GdNx3aA_0MI

<https://silvertowntunnel.co.uk/2013/11/09/october-16th-public-meeting-part-4-john-elliott-independent-transport-consultant/>

Figure 7 – Traffic effects of road widening and improvements on the Westway road in London (Purnell et al., 1999)



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