Title:
M1 Junctions 10 to 13 Managed Motorway

IA No: DfT00080

Lead department or agency:
Highways Agency

Other departments or agencies:
None

Impact Assessment (IA)

Date: 10/11/2011

Stage: Final

Source of intervention: Domestic

Type of measure: Secondary legislation

Contact for enquiries:
Andrew Hitch, Highways Agency,
Birmingham, 0121 678 8145

Summary: Intervention and Options

RPC Opinion: GREEN

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB on 2009 prices)	**In scope of One-In, One-Out?**	**Measure qualifies as**
£1065.7m	£833.3m	£0m	Yes	Zero Net Cost

What is the problem under consideration? Why is government intervention necessary?

The M1 between Junctions 10 and 13 in Bedfordshire experiences considerable congestion during peak periods due to a high traffic volume.The congestion reduces the efficiency of movement of people and goods to the detriment of business productivity and the economic and social activities of individuals. If these problems are to be alleviated, then some form of intervention is required. The intervention needs to be undertaken by government since the motorway is owned, operated and maintained by the government (through the Highways Agency (HA) and Department for Transport (DfT). The intervention forms part of the DfT's programme of major improvements to the trunk road network.

What are the policy objectives and the intended effects?

The objective is to reduce the cost of congestion to business and individuals and thereby encourage economic activity and improve social well being. The intended effects are to reduce journey times and the variability in journey times caused by congestion. In particular, the intention is to reduce congestion on the motorway at all times of day, thereby reducing journey times and making them more predictable or "reliable". There are a number of secondary social and environmental effects which have been quantified and taken into consideration as part of the DfT appraisal process. These are described in the evidence base.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

The existing situation or "Do Nothing" is a dual three lane motorway (D3M) with a hard shoulder which is available for emergency use only.

Option 1: The preferred intervention is a system called Managed Motorway. Managed Motorway involves allowing use of the hard shoulder as a running lane in congested conditions. The hard shoulder is opened when speeds reduce to approximately 60mph. At this point, a mandatory 60mph speed limit is imposed. This speed limit is subsequently reduced to 50 or 40mph if traffic levels continue to increase. A Variable Mandatory Speed Limit (VMSL) is therefore required as part of the Managed Motorway system. Secondary legislation is required in order to implement hard shoulder running (HSR) and VMS

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** 06/2014

Does implementation go beyond minimum EU requirements?			Yes / No / N/A		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro** Yes	**< 20** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded:** 0	**Non-traded:** 4.3	

I have read the Impact Assessment and I am satisfied that (a) it represents a fair and reasonable view of the expected costs, benefits and impact of the policy, and (b) that the benefits justify the costs.

Signed by the responsible Minister: Mike Penning Date: 29.03.2012

Summary: Analysis & Evidence

Policy Option 1

Description:

FULL ECONOMIC ASSESSMENT

Price Base Year 2010	PV Base Year 2011	Time Period Years 60	Net Benefit (Present Value (PV)) (£m)		
			Low: N/A	**High:** N/A	**Best Estimate:** 1065.7m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	N/A		N/A	**N/A**
High	N/A		N/A	**N/A**
Best Estimate	£180.7m		£10.2m	**£454.9m**

Description and scale of key monetised costs by 'main affected groups'

Breakdown of "Total Cost" in 2010 market prices, discounted to 2011 Present Value Year.
Govt. (Public Accounts): Installation, Enforcement, Operation, Maintenance and Renewal: £347.8m
Road Users (Economy): Reduction in Transport Economic Efficiency during Const. and Maint.: £21.6m
Road Users (Society): Increase in Accidents: £6.7m
Public (Environment): Increase in Greenhouse Gas Emissions: £78.8m

Other key non-monetised costs by 'main affected groups'

Public (Environment): Slight Adverse impact on Heritage
Wildlife (Environment): Slight Adverse impact Biodiversity

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	N/A		N/A	**N/A**
High	N/A		N/A	**N/A**
Best Estimate	£0m		£55.1m	**£1520.6m**

Description and scale of key monetised benefits by 'main affected groups'

Breakdown of "Total Benefit" in 2010 market prices, discounted to 2011 Present Value Year.
Road Users (Economy): Improvement in Transport Economic Efficiency: £618.1m
Road users (Economy): Improvement in Journey Time Reliability: £329.5m
Public (Environment): Decrease in road traffic Noise: £13.3m
Govt. (Public Accounts): Additional Indirect Tax Revenue: £559.7m

Other key non-monetised benefits by 'main affected groups'

None

Key assumptions/sensitivities/risks **Discount rate (%)** 3.5/3

The majority of the benefits are based upon the outputs of a traffic model : in particular, the differences between model outputs for the without and with scheme scenarios in the opening year and future years. The estimated benefits are therefore dependent upon the accuracy of the models and future traffic forecasts. To minimise the risk of error in this regard, the traffic models and forecasts have been prepared following DfT guidance. The traffic model meets DfT performance requirements.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			In scope of OIOO?	Measure qualifies as
Costs: £0.2m	**Benefits:** £31.43	**Net:** -£31.23m	Yes	Zero net cost

Evidence Base

1. Problem under Consideration

The M1 motorway is a heavily used route that connects London with the Midlands and the North. It was designed and built in the 1950's and currently operates well over capacity, resulting in queues and delays at peak times. The two-way daily flows exceeded 130,000 on 250 days of the year and flows of 160,000 vehicles per day have been recorded. These flow levels are at least 40% higher than the Congestion Reference Flow (CRF) of around 90,000 vehicles per day. The CRF represents the daily flow level at which a road is likely to be congested during peak hours.

The daily flow profile for the J10-13 section of the M1 is such that speeds fall below free-flow conditions throughout the majority of peak and inter-peak periods. This situation has been exacerbated by the widening of the J6A-10 section to the south and the opening of the A421 (J13 to Bedford) to the north, which will increase traffic demands on the motorway.

2. Rationale for Intervention

The current congestion reduces the efficiency of movement of people and goods to the detriment of business productivity and the economic and social activities of individuals. If these problems are to be alleviated, then some form of intervention is required. The intervention needs to be undertaken by government since the motorway is owned, operated and maintained by the government through the Highways Agency (HA) and Department for Transport (DfT). The intervention forms part of the DfT's programme of major improvements to the trunk road network for the 2010-15 Spending Review period. The programme is delivered by the HA.

3. Policy Objective

The Department for Transport's Business Plan 2011-15 set out a vision for a transport system that is an engine for economic growth and one that is also greener and safer and improves quality of life in our communities. By improving the links that help to move goods and people around, the Department can help to build the balanced, dynamic and low-carbon economy that is essential for future prosperity.

The primary objective of the DfT's programme of trunk road improvements is to reduce the cost of congestion to business and individuals and thereby encourage economic activity and improve social well being. The Managed Motorway scheme seeks to achieve this by reducing congestion and improving journey time reliability on the M1 between Junctions 10-13. In particular, the intention is to reduce congestion on the motorway at all times of day, thereby reducing journey times and making them more predictable or "reliable".

Although the objective for the scheme is to reduce congestion and improve reliability, there are a number of secondary social and environmental effects which have been quantified and taken into consideration as part of the DfT appraisal process. These are described in the following paragraphs.

4. Description of Options

4.1 Do Nothing Baseline ie Existing

The Do-Nothing Baseline, or existing, is a dual three lane carriageway to motorway standard (D3M) with the MIDAS system (Motorway Incident Detection and Automatic Settings). MIDAS is a system comprising of inductive loops buried in the carriageway surface which detect the presence of stationary or slow moving traffic. This information is transmitted to computers which will then provide written warnings and advisory speed limits upstream of the congestion event. The warnings and advisory speed limits are provided via variable message signs which are mounted on cantilevered mast arms above the carriageway. The purpose of the system is to minimise the risk of collisions between fast moving upstream traffic and the slow moving or stationary traffic detected by the loops.

4.2 Option 1 (Preferred): Managed Motorway

The existing MIDAS system described above is the simplest application of motorway control technology. It is solely a safety feature designed to protect queues by providing a warning of their presence to upstream traffic. The next level of control is a system called Controlled Motorway (CM). This system includes MIDAS to protect against queues, but also uses Variable Mandatory Speed Limits (VMSL) to assist in preventing the development of queues. The next and highest level of control is the Managed Motorway (MM) system. This system includes MIDAS and Controlled Motorway, but also includes a facility to open the hard shoulder as a running lane in order to provide additional traffic capacity in situations where traffic flow traffic levels are high enough to require it. Managed Motorway is the preferred option.

The operation of the MIDAS component of MM is described above in paragraph 4.1. Like MIDAS, the Controlled Motorway (CM) component uses the same carriageway loops to detect vehicles and also sets speed limits on variable message signs. The difference is that CM also sets speed limits at higher speeds when information on traffic density from the loops indicates that ‘bunching’ may be occurring. It does not therefore wait until a queue develops. Instead, CM sets variable mandatory speed limits of 60mph and 50mph to reduce bunching and thereby reduce the likelihood of a queue occurring. However, if traffic still becomes slow moving or stationary then, like MIDAS, it will set a 40mph limit. The only difference in these circumstances is that the 40mph limit is a mandatory limit rather than the advisory limit used by MIDAS.

In more detail, the CM system uses VMSL to slow down upstream traffic. This reduces the likelihood of it ‘catching up’ with a pocket of slower moving traffic and causing traffic density to reach a level at which flow breakdown occurs. Whilst the reduction in speed limit increases journey times upstream of the high density region, these are cancelled out by journey time savings arising from a reduced incidence of flow breakdown and associated queuing. The net effect on average journey times in neutral but the range or variation in journey times is reduced, thereby improving reliability. This is measured in the assessment process by predicting changes in the standard deviation of journey times of trips using the Controlled Motorway as part of their route.

Managed Motorway (MM) takes CM a stage further by reducing congestion and journey times, as well as improving journey time reliability. It is being pursued on the M1 because of the daily congestion which occurs during both peak and inter-peak periods.

In essence, the MM system operates as in the same way as the CM system, but with a facility for control room operators to open the hard shoulder as a running lane. Hard Shoulder Running (HSR) provides additional traffic capacity and this reduces the density of traffic (the number of vehicles per unit length of road). This reduced density allows traffic to travel at higher speeds whilst still maintaining a safe headway distance between themselves and the vehicle in front. The higher speeds mean reduced journey times.

When operating MM, the aim is to open the hard shoulder when traffic volume on the three normal lanes reduces average speeds to around 60mph. It should then be closed (and the 60 limit removed) when the volume has reduced to the extent that speeds on the normal three lanes would be in excess of 60.

A secondary benefit of MM is a reduction in accidents and the associated queues, thereby reducing queuing delays and further improving reliability. The reduction in accidents which has been observed in

conjuction with MM is believed to be the result of imposing lower mandatory speed limits and requiring drivers to stay in lane.

In order for MM to be successful, it is essential that the variable speed limits which form part of the system are complied with. This requires the speed limits to be mandatory. Secondary legislation is required to allow mandatory variable speed limits to operate. Secondary legislation is also required for the introduction of hard shoulder running."

It should be noted that the mandatory speed limit signs used as part of a controlled motorway are matrix signs which can display either 40, 50, 60 or the national speed limit sign. Being a mandatory sign, they are required to have a red outer ring in order to comply with the traffic signs regulations. They are also required to be displayed over each lane. Advisory signs used for MIDAS are also matrix signs, but do not have the red ring, nor is it a requirement to display them over every lane (though HA standards require this for carriageways of four or more lanes, making gantries a necessity).

Enforcement of the VMSL is planned to be carried out using a combination of gantry-mounted speed enforcement cameras and traditional enforcement by the Police. The Highways Agency Detection Enforcement Camera System (HADECS) will be used to automatically monitor compliance with VMSL.

The MM scheme also includes improvements to Junctions 11 and 12. The purpose of these is to provide additional traffic capacity at the junctions in order to prevent queues on the off slips extending on to the main carriageway and blocking the running lanes. These improvements will enable the full benefits of the Managed Motorway scheme to be realised. The improvements are as follows:

- At Junction 11, the carriageways of the slip roads used for leaving the motorway and the carriageway of the roundabout is being widened. Traffic signals will be improved, with crossings provided to aid pedestrians.
- At Junction 12, a new junction is being constructed to the north of the existing junction, to increase the traffic capacity of the junction and to increase its separation from the Toddington Motorway Service Area.

4.3 Other Options

The MM scheme is now under construction and, as such, a decision has already been made that MM is the best option. However, prior to this decision being made, the option of widening was explored. This option involves widening the carriageway to four lanes in each direction and retaining the hard shoulder for emergency use only. In effect, the existing hard shoulder becomes a permanent running lane and a new hard shoulder is built next to the existing hard shoulder. In addition, CM is introduced and this operates together with MIDAS in the same way as described above for MM.

The advantage of a widened carriageway over MM is that the additional lane can operate at 70mph rather than 60mph. In particular, hard shoulder running cannot be brought into use until flow levels on the three normal lanes have reduced speeds to 60mph. On a widened carriageway however, the same flow levels could have an average speed of up to 70mph. This means that a widened carriageway will generate greater journey time benefits under normal operating conditions. Furthermore, a widened carriageway with an emergency only hard shoulder will not be blocked by incidents that are confined to the hard shoulder. A widened carriageway will therefore have greater incident related journey time variability and delay benefits for the same reduction in accident rate.

The costs and benefits of the widening option were appraised using the same methodologies used to appraise the MM scheme. These methodologies are prescribed in DfT appraisal guidance and are described in detail in Section 5 below which discusses the costs and benefits of the MM scheme. The conclusion from the appraisal of the widening option was that although it generated additional benefits, these were more than cancelled out by the additional costs: in particular, the costs of widening the carriageway. At the time a decision was made to proceed with MM rather than widening, the Benefit Cost Ratio (BCR) of the proposed MM scheme was 9.43, compared with a BCR of 3.24 for the widening scheme.

In addition to being better value for money, the proposed MM scheme is also more affordable than widening: the cost of implementation being only 40% of the cost of the widening. Thus, with several motorway projects in the roads programme, the implementation of MM across a number of projects has allowed more motorway improvement projects to proceed in the current Spending Review period than

would otherwise have been the case. This was a key factor in the decision of the Secretary of State to proceed with MM rather than widening.

5. Details of Costs and Benefits

5.1 Do Nothing Baseline ie Existing

The “Do-Nothing” represents the baseline against which the proposed managed motorway is assessed.

5.2 Option 1 (Preferred): Managed Motorway

The impacts of the Managed Motorway, including costs and monetised benefits, have been appraised using the Department for Transport’s (DfT) WebTAG (Web-based Transport Analysis Guidance) which is based upon HM Treasury Green Book principles. WebTAG identifies a wide range of possible impacts that transport schemes can have and prescribes detailed methodologies for quantifying these impacts and monetising them wherever possible. The range of impacts which must be considered come under the three main headings of Economy, Environment and Society which are then subdivided into sub-impacts such as journey times, reliability, noise, air quality, landscape, greenhouse gas emissions and accidents etc. Scheme promoters are required to assess all these impacts using the prescribed methodologies (links to the relevant sections of WebTAG are provided below) and to summarise the results of the analysis in an Appraisal Summary Table (AST). The AST forms a summary of the economic case for a scheme and is used by Highways Investment Board to inform all decisions relating to the selection of a preferred scheme option and the decision to ultimately invest in that option. The Managed Motorway scheme has been subject to these processes.

Because WebTAG relates to transport schemes generally, there is a second tier of more detailed appraisal guidance which relates specifically to trunk road schemes and which is contained within the DfT/HA’s Design Manual for Roads and Bridges (DMRB). In particular, Volumes 11 to 14 of the DMRB contain supplementary appraisal guidance on a number of issues including traffic model building, the assessment of accident impacts and environmental assessment.

It is important to appreciate that the cornerstone of the appraisal process for road schemes is a traffic model. The model is a computer based representation of the physical characteristics of the road network, the behaviour of different types of traffic using the network and the origins and destinations of that traffic. The model is built and calibrated to represent the road network (the “supply”) and the traffic “demand” upon it at the current time “the base year”. A set of independent traffic count and journey time data not used in the calibration process is then used to “validate” the base year predictions of the model.

Using the behavioural relationships between supply and demand contained within the model, it is possible to alter the network to represent a new road scheme, or a change the traffic demand (to represent traffic growth), and identify how traffic flows and speeds change as a result. This provides the information necessary to identify changes in journey times, journey time reliability, vehicle operating costs, tax revenues and accidents across the network in any modelled future year. The information is also used to assess the environmental impact of a scheme in terms of greenhouse gas emissions, air quality and noise.

The proposed scheme uses the M1 J10-13 Local Area transport Model (LAM) which broadly covers the area from the M1 Newport Pagnell services and the A5/A422 Junction in the north of the area to the M1/M10 interchange in the south. The LAM included the M1 between Junction 8 and Junction 14. Along the ‘axis’ of the scheme, from northwest to southeast, the LAM area included the settlements of Milton Keynes, Leighton Buzzard, Dunstable, Luton and Hemel Hempstead. The traffic demands for the LAM study area were extracted from the East of England regional model, which has a decreased level of spatial representation for the remainder of the East of England region and, in turn, the rest of the UK. The models have been developed and fully validated using a series of traffic surveys, journey time surveys, road side and household interview surveys in addition to data already available from the Highways Agency and Local Authorities.

Naturally there is some uncertainty in relation to forecasts of future traffic levels when modelling future years. These forecasts are made at a national level through the DfT’s National Transport Model and are based upon certain assumptions regarding household growth, income growth, changes in fuel price and how these affect the level of car ownership and usage. Changing these core assumptions can affect the

level of future year benefits and it is now a requirement of WebTAG that different scenarios of future traffic growth are modelled, in addition to the most likely or "Core Scenario". However, definitive WebTAG guidance on the treatment of uncertainty in forecasting was not available at the time the modelling work was undertaken. As a result, it was only possible to produce a most likely or Core Scenario forecast which has then been used to produce a "Best Estimate" of the benefits. Results for the Lowest and Highest Benefits Scenarios are not therefore available.

WebTAG does not require the production of Highest and Lowest Costs scenarios as part of the economic assessment. A single "Best Estimate" is used which includes a Risk Allowance (based upon a Quantified Risk Assessment) and Optimism Bias. The estimate is refined (and the level of Optimism Bias reduced) as the scheme progresses towards implementation and design work allows more accurate quantification of the costs. At the end of each scheme stage, the net present value and benefit cost ratio of the scheme are recalculated on the basis of the latest scheme costs before a decision is made by the Highways Investment Board to proceed to the next stage.

It is worth noting that WebTAG and the DMRB require that the costs and benefits of transport projects are valued at 2002 prices and discounted to 2002. However, for the purpose of the Impact Assessment these have been converted to 2010 Prices (representing a recent year for which HM Treasury GDP inflation factors are available) and discounted to a present value year of 2011.

Monetised Costs

All Managed Motorway schemes have the following types of costs. All costs are incurred by government.

- TRANSITION: Cost of Installation;
- RECURRING: Cost of Enforcement of VMSL;
- RECURRING: Cost of Maintenance and Operation;
- RECURRING: Cost of Renewing electronic equipment at 15 year intervals.

Individual Managed Motorway schemes are appraised in terms of a range of potential impacts as set out in WebTAG. Where monetised, these impacts are deemed benefits or disbenefits depending upon whether the monetised impact is positive or negative: they are then dealt with on the benefits side of the equation for purposes of calculating the Benefit Cost Ratio metric used by the DfT. However, for purposes of the Impact Assessment, it is understood that negative benefits are considered as "costs" rather than disbenefits.

The proposed scheme has the following negative monetised impacts, or costs. With the exception of climate change, all costs are incurred by road users. The term "Transport Economic Efficiency" refers to journey times and the fuel and non fuel costs of operating vehicles.

- TRANSITION: Cost of disbenefits to Transport Economic Efficiency during installation;
- RECURRING: Cost of disbenefits to Transport Economic Efficiency during maintenance.
- RECURRING: Cost to Road Safety through an increase in accidents;
- RECURRING: Cost to Climate Change through an increase in greenhouse gas emission

Transition: Installation Costs

The current capital cost of installing the Managed Motorway scheme is derived through a standardised cost estimation process designed and undertaken by the Highways Agency. The designer supplies details of the scheme to the Highways Agency Commercial Team who apply standard rates and return the cost estimate to the designers. This estimation process is refined as the scheme preparation process proceeds. The numbers below are based upon the costs at Works Commitment stage.

Table 1 provides a breakdown of the Works Commitment estimate. Preparation costs cover the balance of expenditure on the scheme design and preparation of tender documentation. Supervision costs cover the cost of the HA's design agent supervising the contract on behalf of the HA. Works expenditure is the cost of materials and labour for constructing the scheme. Finally, lands expenditure includes an allowance for third party Claims and the compulsory purchase of land to improve Junctions 11 and 12. Historic or "sunk" costs incurred to the end of September 2011 are excluded.

Table 1: Installation Costs (2010 Constant Market Prices – Undiscounted – in £m)

Cost in 2010 market prices	2011	2012	2013	Total
Works Expenditure Outturn Profile	£40.951	£100.564	£24.072	£165.589
Total Outturn Expenditure Forecast (All costs included)	£40.951	£100.564	£24.072	£165.589
Total Outturn expenditure Forecast@ 2011 discount base	£40.951	£97.160	£22.470	£160.581

Note: The 'Do-Minimum' maintenance costs saved by the Scheme are subtracted from the above.

Recurring: Enforcement Costs

The average annual enforcement cost of **£0.1m** over 60 years (2010 Constant Market Prices – Undiscounted), includes costs paid by the HA to cover the costs incurred by the Home Office in processing fixed penalty notices or prosecuting offenders.

Recurring: Maintenance and Operating Costs

Maintenance and operating costs have been derived using the Highways Agency Managed Motorways Operational Cost Model spreadsheet.

The average annual maintenance and operating costs are **£2.7m** over 60 years (2010 Constant Market Prices – Undiscounted), These include the costs associated with the maintenance of gantries, signs, loops and cabinets, together with the additional costs associated with the use of the hard shoulder, including additional winter gritting, lighting, markings, loops and CCTV systems, plus specialist IT hardware and software. It also includes the cost of such items as additional control room staff and the power consumption of the various items of electronic equipment.

Recurring: Renewal Costs

The average annual renewal cost of **£4.0m** over 60 years (2010 Constant Market Prices – Undiscounted), is based on replacing all electronic equipment at expiry of a 15 year operational life. Gantries will require replacement after 30 years.

Transition: Transport Economic Efficiency Costs during Installation

The cost of disbenefits to transport economic efficiency, summed over the remaining years of installation, is **£15.1m** (2010 Constant Market Prices – Undiscounted). These costs are primarily the result of the traffic delays caused by the roadworks necessary to complete the construction of the scheme. In brief, WebTAG identifies a value of time for different types of vehicles and trip purposes and these values are multiplied by the number of additional hours of delay which are incurred during the roadworks (when a lower 50mph speed limit is in operation over specific lengths of the scheme). These road works have been ongoing since 2009 and are due to be complete in 2013: only costs not already incurred have therefore been included ie costs from Q4 2011 onwards.

WebTAG values of time vary by vehicle type and trip purpose and increase over time in line with forecast growth in GDP. Details of the values and how they are calculated can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Recurring: Transport Economic Efficiency Costs during Maintenance

The average annual cost of disbenefits to transport economic efficiency during maintenance is **£0.3m** over 60 years (2010 Constant Market Prices – Undiscounted). These costs are primarily the result of traffic delays caused by the roadworks that will be required to undertake maintenance of the Managed Motorway scheme. The costs are additional to the delay costs involved in maintaining the Do Nothing Baseline.

Recurring: Road Safety Disbenefit

The average annual cost of the disbenefit to road safety is **£0.2m** over 60 years (2010 Constant Market Prices – Undiscounted). The cost arises as a result of an increase in accidents across the network as a whole. On the scheme section itself, there is a decrease in accidents.

The information required to calculate the accident impact is extracted from the traffic model in the form of the physical characteristics of the road network in the model area and the daily traffic flows on links and junctions. The information is extracted for various future modelled years for both the with and without scheme cases. In addition, the numbers of existing accidents at links and junctions within the network

are obtained from police records. All the data is then entered into a DfT sponsored computer program called COst Benefit Analysis (COBA) which calculates an accident rate for each link and junction and hence produces the number of accidents in the whole network for the with and without scheme cases in each year of the DfT's 60 year appraisal period. COBA attaches a monetary valuation to accidents and sums the total accident costs for each network. The difference in accident costs between the with and without scheme scenarios is the accident benefit of the scheme. In this case, COBA has predicted an increase in accident costs across the network as a whole. However, on the scheme section itself, there is a reduction in accidents.

WebTAG values of accidents vary by road and junction type and increase over time in line with forecast growth in GDP. Details of the values and how they are calculated can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Based upon past deployment of the Controlled Motorway system, it is assumed that Managed Motorway schemes reduce the existing accident rate by 15%. This figure is recommended in the published HA Interim Advice Note (IAN) 111/09 Managed Motorways Implementation Guidance and also in the draft IAN "Appraisal of Technology Schemes". The reduction is believed to be the result of a number of factors (a) imposing mandatory rather than just advisory speed limits in the event of incidents and congestion (b) a requirement for drivers to stay in lane when the speed limits are in operation (c) the presence of speed enforcement cameras which discourages speeding even when reduced speed limits are not in operation.

In addition to accident reductions on the scheme section, there are also accident reductions on parallel local roads. This is the result of traffic reassigning from these routes to the motorway as a result of the increase in traffic capacity provided by opening of the hard shoulder ie the reduced journey times attract traffic to the motorway. There are however increases in accidents further afield which are slightly greater in total than the reductions in accidents on the scheme section and surrounding network. The increases are the result of additional traffic generated by the scheme ie the demand response to the reduced road based travel costs resulting from the scheme.

Recurring: Climate Change Disbenefit

The average annual cost of the climate change disbenefit is **£2.9m** over 60 years (2010 Constant Market Prices – Undiscounted). The cost arises as a result of an increase in non-traded CO_2 emissions from vehicle traffic within the road network. The increases are the result of additional traffic generated by the scheme ie the demand response to the reduced road based travel costs resulting from the scheme.

Carbon benefits are an output of the TUBA program which is described above under the Transport Economic Efficiency benefit. In particular, TUBA needs to calculate the total volume of fuel burned by vehicles in the road network in order to calculate the change in vehicle operating costs which form part of the transport economic efficiency benefit. Having calculated the volume of fuel used, it is straightforward for TUBA to then calculate total carbon emissions over the 60 year appraisal period for the with and without scheme scenarios.

WebTAG values of non-traded carbon for all future years and fuel types can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Non-Monetised Costs

The Managed motorway Scheme would have a slight adverse impact on eight archaeological sites including the setting of three Scheduled Ancient Monuments, and eleven listed buildings in the vicinity of the new gantries. Slight adverse impacts on undesignated woodland, hedgerows and scrub habitat in the soft estate. Slight adverse impacts on bats, reptiles and terrestrial great crested newt.

Monetised Benefits

The proposed scheme has the following monetised benefits.

- RECURRING: Benefits to Transport Economic Efficiency through a net reduction in journey times and vehicle operating costs.
- RECURRING: Benefits to Journey Time Reliability through a reduction in day to day journey time variability;
- RECURRING: Benefits from reduced Noise;

- RECURRING: Benefits from an increase in Indirect Tax Revenue

Reducing accidents on the scheme section leads to the following additional benefits:

- RECURRING: A reduction in incident related journey time variability as a result of fewer accidents;
- RECURRING: A reduction in delay as a result of reducing the time spent queuing at an accident site;

Recurring: Transport Economic Efficiency Benefit

The average annual transport economic efficiency benefit is **£22.4m** over 60 years (2010 Constant Market Prices – Undiscounted). This benefit comprises of the following elements (negative values represent disbenefits):

- Reductions in Journey Times: £38.1m
- Increases in Vehicle Operating Costs: -£15.7m

The reductions in journey time arise as a result of the additional traffic capacity provided by allowing use of the hard shoulder. In congested periods, the additional capacity reduces traffic density and increases speeds on the motorway. It also allows additional traffic to reassign to the motorway from other slower routes to reduce its journey time. This in turn reduces journey times on other routes in the network.

The increase in vehicle operating costs is the sum of changes in both the fuel and non-fuel related costs of all vehicle trips in the network. These will increase if the scheme results in traffic reassigning to a longer (but quicker route), or if vehicle speeds move in either direction away from the optimum speed for fuel efficiency for the type of vehicle concerned. The converse applies as well, so the overall change in vehicle operating costs is the sum of many increases and decreases over the area of the traffic model.

The information required to calculate the benefits is extracted from the traffic model in the form of matrices of trip numbers, travel times and distances between every origin and destination. Matrices are extracted for the with and without scheme scenarios and for different time periods, vehicle type and trip purpose in various future modelled years. The matrices are then fed into a DfT sponsored computer program called Transport User Benefit Appraisal (TUBA) which calculates the total journey times, vehicle operating costs, user charges, carbon emissions, fares and tax revenues in each year of the DfT 60 year appraisal period. All the components are monetised within TUBA and the with scheme costs are subtracted from the without scheme costs to determine the benefit or disbenefit.

WebTAG values of time and vehicle operating costs vary by vehicle type and trip purpose and increase over time in line with forecast growth in GDP. Details of the values and how they are calculated can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Recurring: Journey Time Reliability Benefit

The average annual journey time reliability benefit is **£11.9m** over 60 years (2010 Constant Market Prices – Undiscounted). This benefit comprises of the following elements (negative values represent disbenefits):

- Reductions in Journey Time Variability: £8.7m
- Reductions in Incident Related Delay: £3.2m

The reductions in journey time variability arise as a result of making journey times on the scheme section more uniform (day to day variability) and reducing accidents (incident related variability). In particular, congestion, flow breakdown and accidents generate significant variability in journey times which makes them less predictable or “reliable”. The reductions in incident related delay arise from reducing the number of accidents on the scheme section.

The information required to calculate the benefits is extracted from the traffic model in the form of the numbers of trips per day using the scheme section, the length of these trips and which routes they use. The information is extracted for various future modelled years for both the with and without scheme scenarios. It is then entered into a DfT sponsored computer program called INcident Cost benefit Analysis (INCA) which calculates the change in standard deviation of the average journey time for each route at different times of the day. The calculations are undertaken for both the with and without scheme scenarios and repeated for each year of the DfT 60 year appraisal period. A monetary valuation is attached to the changes in standard deviation which are then multiplied by the number of vehicles on each route. A reduction in standard deviation (or “variability) is a benefit and an increase is a disbenefit.

The WebTAG value for the standard deviation of journey time in minutes is equal to 80% of the WebTAG values of time. More details can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

INCA is also used to calculate the reductions in incident related delay. INCA does this by using the traffic flow inputs and traffic capacity of the carriageways to calculate the total queuing delay generated by accidents in both the with and without scheme scenarios on the scheme section. The user supplies the with and without scheme accident rates. A reduction of 15% is used for Managed Motorway schemes.

Recurring: Noise Benefit

The average annual noise benefit of **£0.5m** over 60 years (2010 Constant Market Prices – Undiscounted) arises primarily as a result of the reassignment of traffic from local roads to the motorway. The benefits at these locations outweigh the disbenefits arising from the increase in traffic flow and speed on the motorway. Also, low-noise surfacing materials are being used where reconstruction of the motorway is required.

Within the appraisal, changes in noise levels are ascribed a monetary value that varies in line with how loud the noise level is. At the quieter 45 dB(A) level, an increase of 1 decibel is valued at £10.34 per household. This increases until at a level of 80 dB(A), a one decibel increase would be valued at £120.58 per household. More detail about how WebTAG values changes in noise can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Recurring: Indirect Tax Revenue Benefit

The average annual increase in indirect tax revenue of **£20.3m** over 60 years (2010 Constant Market Prices – Undiscounted) arises as a result of changes in the volume, speed and distance travelled on the road network by vehicles. In particular, the scheme provides additional traffic capacity which results in traffic redistributing across the network to reduce its journey time. This can mean some traffic will travel a longer distance (eg via the managed motorway), or at a less fuel efficient speed. The tax revenues concerned are VAT and fuel duty.

The increase in tax revenues reflects the fact that the scheme results in an overall increase in the cost of operating vehicles. This is taken account of as a cost to road users and reduces the Transport Economic Efficiency benefit (see above). Although a cost to road users, the additional revenue is a benefit to wider society since it can be used by government to the benefit of society.

Non-Monetised Benefits

The proposed scheme has no unmonetised benefits.

6. Rationale and Evidence for Proportional Approach

The proposed scheme is at an advanced stage and involves substantial expenditure. A Level 5 Analysis has therefore been undertaken in which all the impacts have been quantified and, where possible, monetised. The analysis has been undertaken in accordance with the full requirements of WebTAG. In particular, all the potential impacts identified in WebTAG have been quantified and all of these have been assessed using the methodologies prescribed therein.

7. Risks and Assumptions

In accordance with WebTAG, a Quantified Risk Assessment has been undertaken in relation to risks affecting the costs of construction and a Risk Allowance is included in the scheme estimate. Optimism Bias has also been included.

In terms of the magnitude of the benefits, these are primarily dependent upon the accuracy of the traffic model and the future year forecasts of traffic demand. The primary issue with the modelling is that commercially available models are designed to deal with links which have static rather then dynamic traffic capacities ie capacities which change in response to traffic demand through opening of the hard shoulder. It has been necessary therefore to represent the operation of the managed motorway in a simplified and somewhat idealised manner.

An implicit assumption is that road based travel will continue to have the same level of importance for the full 60 years of the appraisal period. Whilst this seems likely, there is much less certainty as to whether Managed Motorway will continue in its present form for this length of time. However, since it is likely that any changes will be the result of innovation from experience or developments in technology, these can be expected to reduce the operating/maintenance costs and/or increase the benefits.

8. Direct Costs and Benefits to Business (One-In, One-Out Approach)

The One-in, One-out (OIOO) rule means that no new primary or secondary UK legislation that imposes costs on business can be brought "In" without the identification of existing regulations with an equivalent value that can be removed, or taken "Out". The deployment of VMSL requires secondary legislation, as does the introduction of hard shoulder running. The proposals are therefore in scope for purposes of applying the OIOO rule.

The proposed managed motorway imposes no direct costs on business. Its net impact on business is to increase business productivity by improving transport economic efficiency and journey time reliability. It is therefore an "In" regulation with "Zero net cost" to business.

The computer program TUBA calculates the monetised transport economic efficiency benefits by different trip purposes: business users, commuting users and other users. INCA and COBA do not disaggregate the journey time reliability and accident benefits, but an estimate of the proportion of benefits received by business users is 73%. The total benefits to business users over 60 years are as follows (in 2009 market prices, discounted to 2010 at 3.5% for years 0-30 and 3% for years 31-60).

- Transport Economic Efficiency £612.1m
- Journey Time Reliability £225.8m
- Accidents £-4.6m

The equivalent annual values are as follows;

- Transport Economic Efficiency £22.96m
- Journey Time Reliability 8.47m
- Accidents £-0.2m

9. Wider Impacts

Consideration has been given to the list of potential wider impacts set out on Pages 16-18 of the IA Toolkit. The following paragraphs describe the assessed impact in relation to those items where the impact is considered to be non-neutral. It should be noted that some of the wider impacts are considered under WebTAG and, if non-neutral, the assessed impact is discussed in Section 5 above.

9.1 Justice System

In Managed Motorway schemes, the enforcement of VMSL will use the Highways Agency Digital Enforcement Camera System (HADECS). The digital photographs are transmitted electronically to a Police Fixed Penalty Office (FPO), where the offending drivers are identified and appropriate action taken. However, experience has shown that a relatively small number of offenders will have to be processed through the Magistrates' Courts. The complete process impacts on the Highways Agency, the Police, the Crown Prosecution Service (CPS) and HM Courts Service.

This has been dealt with by an agreement between the four parties (Managed Motorway National Enforcement Strategic Agreement, December 2009). The intention of the agreement is to ensure that enforcement of controlled motorway will have minimal impact on the normal procedures of the Police, CPS and Courts. To maximise efficiency, ensure consistency and minimise financial impact it is proposed to identify key Police Forces, CPS offices and Magistrates Courts in each of the seven Highways Agency Regions and to process enforcement cases centrally on a regional basis.

Offences captured by HADECS are processed with financial support from the Highways Agency by virtue of Section 38 of the Vehicle (Crime) Act 2001. This enables the Secretary of State to fund Police and others to undertake the enforcement of variable speed limits.

10. Recommendation, Implementation and Review

10.1 Proposed Solution

The proposed scheme involves the implementation of Managed Motorway between Junctions 10-13 of the M1 in Bedfordshire. The Managed Motorway (MM) system is essentially the Controlled Motorway (CM) system with a facility to provide additional traffic capacity by opening the hard shoulder to motorway traffic at busy times ie Hard Shoulder Running (HSR).

The purpose of the CM element of MM is to reduce the incidence of flow breakdown by using Variable Mandatory Speed Limits (VMSL) of 60, 50 and 40 mph to reduce the likelihood of faster moving upstream traffic “catching up” with a pocket of slower moving traffic and causing traffic density in this region to reach a level where flow breakdown occurs. By reducing the incidence of flow breakdown, there is less variation in journey times and journey times become more predictable or “reliable”.

The HSR element of MM reduces average journey times as well as improving journey time reliability. This is achieved because the hard shoulder temporarily acts as a running lane, thereby reducing traffic density and increasing traffic speeds above what they would otherwise be. The aim is to open the hard shoulder when traffic volume on the three normal lanes reduces average speeds to around 60mph and to then close it again (and remove the 60mph limit) when the volume has reduced to the extent that speeds on the normal three lanes would be in excess of 60.

In order for Managed Motorway to be successful, it is essential that the variable speed limits which form part of the system are complied with. This requires the speed limits to be mandatory. Secondary legislation is required to allow mandatory variable speed limits to operate. Secondary legislation is also required for the introduction of hard shoulder running.

Enforcement of the VMSL is planned to be carried out using a combination of gantry-mounted speed enforcement cameras and traditional enforcement by the Police. The Highways Agency Detection Enforcement Camera System (HADECS) will be used to automatically monitor VMSL.

A summary of the costs and benefits of the proposed scheme is provided in Table 2 below. The costs and benefits cover the standard DfT 60 year appraisal period from 2013. In accordance with the Treasury Green Book, the discount rate is 3.5% per year for 30 years from the present year and 3% per year thereafter.

Table 2 – Summary of 60 year Costs and Benefits (2010 Market Prices, Discounted to 2011)

Type of Cost (A)	Cost (£m)	Type of Benefit (B)	Benefit (£m)
Installation	160.6	Journey Times (TEE)	1,051.9
Enforcement	2.8	Vehicle Operating Costs (TEE)	-433.8
Operation and Maintenance	73.9	Journey Time Reliability	241.1
Renewal	110.5	Incident Related Delay	88.4
Delays during Installation (TEE)	13.1	Noise	13.3
Delays during Maintenance (TEE)	8.5	Additional Tax Revenue	559.7
Accidents	6.7		
Greenhouse Gases (CO_2)	78.8		
ALL (TOTAL A)	**£454.9**	**ALL (TOTAL B)**	**£1,520.6**

Net Present Value (B-A)	**£1,065.7m**
Benefit Cost Ratio (B/A)	**3.3**

10.2 Implementation Plan

Construction of the Managed Motorway scheme commenced in 2009 and is due to be completed in 2013.

10.3 Post Implementation Review (Evaluation)

The Post Implementation Review Plan is attached as Annex 1.