Longer Semi-trailers Feasibility Study and Impact Assessment

Technical Report D5: Economic Assessment

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by
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1. INTRODUCTION

In June 2009, the Freight and Logistics Division (FLD) of the Department for Transport (DfT) appointed a consortium led by consultants *WSP* and including freight specialists *MDS Transmodal* to undertake the Longer Semi-Trailer Feasibility Study and Impact Assessment. *Transport Research Laboratory (TRL*) and *Cambridge University* were also part of the consultant team, providing specialist inputs into the vehicle engineering, safety and performance components of the study.

The DfT commissioned the study to examine the feasibility and impact of allowing longer semi-trailers to operate within the British road haulage market. The study follows the outcome of previous work commissioned by the Department in 2006, and undertaken by TRL, which examined the likely effects of permitting longer and/or heavier Goods Vehicles (LHVs) in Great Britain[1]. This study highlighted a number of issues that would inhibit the introduction of LHVs on both a permanent or trial basis. Consequently, the Secretary of State ruled out their implementation.

However, the study did suggest that there might be worthwhile benefits from permitting a modest increase in the maximum length of articulated goods vehicles. An overall increase in the length of a semi-trailer by up to 2.05m is therefore being examined as part of this study. However, such a vehicle would have to comply with all other regulations, including those limiting the gross vehicle weight. This would consequently bring an articulated HGV broadly in-line with a rigid/draw-bar trailer combination (in terms of total vehicle length and the load-platform length). Providing an additional 2.05m to the length of a semi-trailer would allow an additional two rows of standard pallets to be conveyed (i.e. 4 pallets single-stack or 8 pallets double-stack given sufficient height availability). However, a longer semi-trailer is likely to have a heavier tare weight, potentially leading to a reduced carrying capacity for some weight-constrained cargoes.

This document reports on the economic assessment undertaken by MDS Transmodal. In brief, it details the following:

- An explanation of the methodology adopted
- The key assumptions applied and data sources utilised; and
- A summary of the main results and outputs.

[1] A summary of the LHV study findings is at http://www.dft.gov.uk/rmd/project.asp?intProjectID=12704

The overall aim of the economics assessment is to estimate the likely cost benefits or increased costs that would directly accrue to industry following the introduction of longer semi-trailers. This also includes estimating the potential impact on the cost and viability of rail freight services together with quantifying any modal shift to/from rail. In addition, the assessment has estimated the environmental impact (noise, congestion, pollution etc.) in monetary terms of introducing longer semi-trailers, thereby allowing the overall economic cost/benefit to be established. The Deliverable 6: Impact Assessment report provides further detail on the methodology which has been adopted to undertake this environmental assessment task, based on costing each individual external environmental impact. Deliverable 6 also provides estimates of the changes in the volume of Carbon Dioxide (CO_2) equivalent emissions that would result from the introduction of longer semi-trailers.

The Final Report of this study (Deliverable 7) provides a summary of the overall project together with the key findings and conclusions. The economic analysis within it summarises the material in the rest of this report. The Impact assessment of Longer Semi-trailers (Deliverable 6) also draws its economic analysis from the findings below and uses the evidence from the various scenario and sensitivity test results to confirm that the main findings hold true across a range of assumptions about how the future may evolve.

2. KEY AIMS AND OBJECTIVES OF ECONOMIC ANALYSIS

The research project's key aims and objectives divide broadly into three areas, namely:

1. Assessing industry benefits:

- Identifying and assessing potential industry benefits resulting from industry adopting longer semi-trailers, particularly cost savings (e.g. lower per pallet-km costs) and efficiency improvements (e.g. fewer HGV trips); and
- Given benefits being identified, identifying the likely freight sectors and journey types which would adopt longer semi-trailer equipment together with the likely tractor unit/longer semi-trailer combinations which would be most used.

2. The economic impact:

- Examining the impact on the cost of transporting goods by road and rail freight, including an assessment of the capital costs and running costs of longer semi-trailer combinations; and
- Estimating the wider economic impact, taking into account any cost savings to industry and impacts on wider society;

3. Safety, performance and environmental impact:

- The overall environmental impact, including but not restricted to Carbon Dioxide (CO_2) emissions across freight modes as a whole and other environmental impacts such as noise, air quality and congestion;
- The implications for vehicle design and performance;
- The effects on fatalities and serious injuries; and
- A review of experience in other countries.

The economic assessment essentially covers the second of the above outlined aims and objectives, though it will inform (and be informed by) the other two areas. The overall aim of the economics assessment is to estimate the likely cost benefits or increased costs that would directly accrue to industry following the introduction of longer semi-trailers. This also includes estimating the potential impact on the cost and viability of rail freight services together with quantifying any modal shift to/from rail. In addition, the assessment has estimated the environmental impact (noise, congestion, pollution etc.) in monetary terms of introducing longer semi-trailers, thereby allowing the overall economic cost/benefit to be established.

Essentially, twelve tasks have been completed as part of the assessment, namely:

1. Establishing the capital and operating costs for existing tractor unit and semi-trailer combinations and rigid and draw-bar goods vehicles;

2. Establishing rail freight operating costs for those sectors of the market which potentially would switch to longer semi-trailers, for current and future years;
3. Quantifying the total amount of cargo currently lifted and moved by road goods vehicles, together with identifying and quantifying those sectors of the market which potentially might adopt the use of longer semi-trailers (by vehicle type, commodity etc);
4. Quantifying the current total amount of cargo lifted and moved by rail freight, for those sectors of the market which potentially would switch to longer semi-trailers;
5. Estimating the current total cost at a national level of moving goods by road transport for those sectors of the market which potential might adopt the use of longer semi-trailers (i.e. the direct cost to industry). Estimating the current total cost at a national level of moving goods by rail freight, for those sectors of the market which potentially would switch to longer semi-trailers (i.e. the direct cost to industry);
6. Establishing the capital and vehicle operating costs for existing length and longer semi-trailer combinations in future years. Establishing rail freight operating costs in future years;
7. Forecasting future traffic flows for both road transport and rail freight for those sectors of the market which potentially might adopt the use of longer semi-trailers, on the basis that longer semi-trailers are not introduced (the Baseline scenario);
8. Estimating the forecast total cost at a national level of moving goods by road transport and rail freight for those sectors of the market which potentially might adopt the use of longer semi-trailers (i.e. the direct cost to industry), on the basis that longer semi-trailers are not introduced (the Baseline scenario);
9. Forecasting future traffic flows for both road transport and rail freight for those sectors of the market which potentially might adopt the use of longer semi-trailers, for a variety of scenarios and take-up rates of longer semi-trailer equipment. These have then been compared with the Baseline scenario;
10. Forecasting the total cost at a national level of moving goods by road transport and rail freight for those sectors of the market which potentially might adopt the use of longer semi-trailers (i.e. the direct cost to industry), for a variety of scenarios and take-up rates of longer semi-trailer equipment. These have then been compared with the Baseline scenario, with the direct economic benefit or cost to industry subsequently established; and
11. Estimating the wider environmental impact in monetary terms for the Baseline and each longer semi-trailer scenario, by taking into account factors such as noise, congestion and pollution. Comparing the Baseline and longer semi-trailer scenarios, thereby establishing whether longer semi-trailer equipment would generate environmental benefits or additional environmental costs.
12. Estimating the overall economic impact by taking into account the direct economic benefit or cost to industry and the wider environmental impact in monetary terms.

The following sections describe in detail the methodology adopted to complete the afore-mentioned tasks together with summarising the main outputs and findings. The forecast years are 2015, 2020 and 2025.

3. IDENTIFYING KEY MARKET SECTORS

In order to focus the overall project, and the economics analysis in particular, the first task was to identify those sectors of the inland logistics market which potentially might utilise longer semi-trailer equipment (i.e. would derive cost and other benefits). This primarily involved desk-top research, but also involved discussions with the logistics industry during the early stages of the evidence gathering exercise (see Technical Report D4).

The analysis indicates that it will be domestic shippers of lighter weight palletised consumer goods (including goods in roll cages), general cargo and mail/parcels as the market sectors which potentially would take advantage of the additional cargo capacity that longer semi-trailers will provide. This position has been arrived at by considering the analysis below.

1. *Liquid bulk commodities* e.g. petroleum. Liquid bulk cargoes are generally weight-constrained within the current vehicle length restrictions i.e. they reach the maximum gross vehicle weight (gvw) before volume capacity. This can be deduced from the following table.

Table 3.1: Bulk Liquid Tanker

Length (of tank)	13.5 m		
Tank diameter	2.0 m		
Volume (capacity)	42.4 m^3		
Tractor tare weight	8,500 kg		
Semi-trailer tare weight	7,000 kg		
Combination tare weight	15,500 kg		
Product	Density (kg/m^3)	Mass of product at max gvw (kg)	Volume at max gvw (m^3)
Petroleum spirit	737	28,500	38.7
Gas Oil	850	28,500	33.5
Water	1,000	28,500	28.5
Beer	1,010	28,500	28.2

A bulk liquid tanker semi-trailer with a cylindrical tank (diameter of 2.0m and length 13.5m i.e. within existing length and width restrictions) would have a volume capacity of 42.4m^3. Typical products conveyed by bulk liquid tankers are shown together with their densities. Each commodity reaches the maximum gross vehicle weight before the tanker reaches its volume capacity. On the basis that there are no plans to increase the gross vehicle weight limits, operators are unlikely to purchase more expensive longer semi-trailers as they will not be able to convey additional cargo. Consequently, there is unlikely to be demand from this sector of the market for longer semi-trailers. In this case, it would be possible within the existing regulations to increase the diameter of the tank by 0.5m without increasing the semi-trailer length, which would add around 24 m^3 to the semi-trailer capacity.

As a result, we can also conclude that there is unlikely to be any impact on the rail freight industry within this sector of the market, given that the road haulage industry will not be gaining any commercial or competitive advantage.

2. *Dry bulk commodities* e.g. aggregates. Dry bulk cargoes are generally weight-constrained within the current vehicle length restrictions. This can be deduced from the following table.

Table 3.2: Dry Bulk Tipper

Length (internal)	13.5 m		
Width (internal)	2.4 m		
Height (internal)	1.5 m		
Volume (capacity)	48.6 m^3		
Tractor tare weight	8,500 kg		
Semi-trailer tare weight	6,500 kg		
Combination tare weight	15,000 kg		
	Density (kg/m^3)	Mass of product at max gvw (kg)	Volume at max gvw (m^3)
Coal	1,105	29,000	26.2
Granite (crushed)	1,605	29,000	18.1
Gravel	1,522	29,000	19.1
Sand (dry)	1,602	29,000	18.1

A dry bulk tipper with an internal length of 13.5m, width 2.4m and height of 1.5m (i.e. within existing length restrictions) would have a volume capacity of 48.6 m^3. Typical products conveyed by dry bulk tippers are shown together with their densities. Again, each commodity reaches the maximum gross vehicle weight before the tipper reaches its volume capacity. On the basis that there are no plans to increase the gross vehicle weight limits, operators are unlikely to purchase more expensive longer semi-trailers as they will not be able to convey additional cargo. Consequently, there is unlikely to be demand from this sector of the market for longer semi-trailers. In this case, extra cargo could be carried by increasing the height of the semi-trailer (compliant with regulations).

As a result, we can also conclude that there is unlikely to be any impact on the rail freight industry within this sector of the market, given that the road haulage industry will not be gaining any commercial or competitive advantage.

3. *Semi-bulk commodities* e.g. metals. Semi-bulk cargoes are generally weight-constrained within the current vehicle length restrictions. This can be deduced from the following table.

Table 3.3: Flat-bed Semi-trailer

Length	13.6 m		
Width	2.5 m		
Height (notional)	2.9 m		
Volume (capacity)	98.6 m^3		
Tractor tare weight	8,500 kg		
Semi-trailer tare weight	5,000 kg		
Combination tare weight	13,500 kg		
	Density (kg/m^3)	Mass of product at max gvw (kg)	Volume at max gvw (m^3)
Steel	7,850	30,500	3.9
Aluminium alloy	2,800	30,500	10.9
Redwood	510	30,500	59.8
Canadian pine	560	30,500	54.5

A flat-bed semi-trailer with a length of 13.6m, width 2.5m and (notional) height of 2.9m (i.e. within existing length restrictions) would have a volume of 98.6m^3. Typical products conveyed by flat-bed trailers are shown together with their densities. Again, each commodity reaches the maximum gross vehicle weight restriction before the semi-trailer reaches its volume capacity. On the basis that there are no plans to increase the gross vehicle weight limits, operators are unlikely to purchase more expensive longer semi-trailers as they will not be able to convey additional cargo. Consequently, there is unlikely to be demand from this sector of the market for longer semi-trailers.

Again, we can conclude that there is unlikely to be any impact on the rail freight industry within this sector of the market, given that the road haulage industry will not be gaining any commercial or competitive advantage.

However, while most bulk and semi-bulk cargoes are generally weight-constrained, it is recognised that there are likely to be some niche exceptions within the three sectors outlined above. For example, low density industrial supplies of products like plastics, foam, upholstery, packaging materials (which tend to be volume-constrained) may be suitable for movement by longer semi-trailers. The analysis has, where possible, attempted to quantify such flows and account for them in the traffic and cost impact analysis.

4. *International Traffics by Road (via roll-on roll-off ferry or Channel Tunnel).* Longer semi-trailers will be confined to domestic flows only. Consequently, there is likely to be no demand for longer semi-trailers from the sector of the market involved in international operations.

Again, we can conclude that there is unlikely to be any impact on the rail freight industry within this sector of the market, given that the road haulage industry will not be 'gaining' any commercial or competitive advantage.

5. *Maritime containers.* Deep-sea maritime containers (up to length 12.2m/40ft) can already be transported by road within the current length regulations as they are slightly shorter than the existing semi-trailer length limits. In addition, there are currently no known plans to increase the internationally agreed dimensions of such units. Short-sea 13.7m (45ft) pallet wide containers can also be transported by road within the current length regulation, albeit with a slight over-hang at the rear of the semi-trailer. Consequently, there is unlikely to be demand from this sector of the market for longer semi-trailers. Operators are unlikely to purchase more expensive longer semi-trailers when existing length equipment meets their requirements.

A semi-trailer length increase may permit 14.6m (48ft) length maritime containers to be shipped to Britain. However, most containers of this length are generally confined to North American markets. In addition, a 14.6m container could also be transported by rail using existing intermodal wagon equipment were they to be shipped to Britain. The cost impact in this case might also be to the benefit of the rail market, as operators could utilise existing rolling stock whereas road hauliers would have to purchase more expensive longer semi-trailers.

Overall, we can conclude that there is unlikely to be any impact on the rail freight industry within this sector of the market, given that the road haulage industry will not be gaining any commercial or competitive advantage.

6. *Operators of rigid goods vehicles and shorter single-axle semi-trailers*. Existing operations which utilise rigid goods vehicles or short length semi-trailers to transport palletised cargo can already upgrade to larger articulated or draw-bar combinations should the need arise to transport additional cargo in individual shipments. Rigid vehicles and combinations, which are significantly cheaper to operate, are therefore being used because the quantity of cargo being transported in one move does not demand a larger vehicle. In addition, there are sometimes specific operational requirements for using a smaller vehicle e.g. rigid HGVs often deliver into urban areas where there are access restrictions. Also, such vehicles are often utilised on multiple drop/collection rounds, meaning that the vehicle load (and hence capacity) is often constrained by the distance that can be travelled in a driver's shift (allowing for loading and unloading times). Consequently, there is unlikely to be demand from this sector of the market for longer semi-trailers.

3.1 The Identified Market

Having eliminated the above operations/markets, this effectively leaves shippers of lighter weight palletised consumer goods (including goods in roll cages), general cargo and mail/parcels as the market sectors which potentially would take advantage of the additional cargo capacity that longer semi-trailers will provide. Within this sector of the market, operators generally utilise existing maximum length goods vehicles, either curtain-sided, box-body (including reefer) and double-deck, as follows:

- 4x2 tractor unit and twin-axle semi-trailer (maximum 34 tonnes gvw);
- 4x2 tractor unit and tri-axle semi-trailer (maximum 40 tonnes gvw);
- 6x2 tractor unit and tri-axle semi-trailer; and
- Rigid and draw-bar trailer equipment (maximum 44 tonnes gvw).

Vehicles conveying these types of commodities are often volume constrained i.e. they reach their cube capacity well before the maximum gross vehicle weight limit. This is demonstrated by the table below.

Table 3.4: Standard Box-body/Curtain-side Semi-trailer (4m height)

Length (internal)	13.5 m		
Width (internal)	2.4 m		
Height (internal)	2.8 m		
Volume (capacity)	90.7 m^3		
Tractor tare weight	8,500 kg		
Semi-trailer tare weight	6,500 kg		
Combination tare weight	15,000 kg		
	Density (kg/m^3)	Mass of product at max gvw (kg)	Volume at max gvw (m^3)
General cargo	200	29,000	145.0
General cargo	250	29,000	116.0
General cargo	300	29,000	96.7
General cargo	350	29,000	82.9

Mean cargo loads are around 600kg per pallet, meaning that if a pallet was stacked to 1.8m it would have a density of around 277kg per cubic metre. Even at 300kg per cubic metre a standard 13.6m semi-trailer (4m external height) would reach the cube capacity before the maximum gross vehicle weight limit. Taking the above into account, this implies the following types of operations:

- Factories to National Distribution Centres (NDCs) and Regional Distribution Centres (RDCs)
- Flows between NDCs and RDCs;
- From NDCs to retail stores;
- From RDCs to retail stores
- Mail/parcels;
- Palletline trunking operations; and
- Low density industrial supplies.

However, the shipment of lighter weight palletised consumer goods is also a key and growing market sector for the rail freight industry *i.e. domestic intermodal rail freight*. This is particularly the case for flows between Midlands NDCs and RDCs in Scotland. As new rail-linked warehousing developments are delivered, shorter distance flows by rail within England and Wales are also likely to become more viable. Forecasts produced by the FTA/RFG and by the rail freight operators suggest that domestic intermodal rail freight is likely to be one of the largest growth sectors over the medium to longer term. If the road haulage sector were to gain significant competitive benefits from the introduction of longer semi-trailers, this may result in some intermodal rail traffics switching to road transport, or traffics which would have transferred to rail remaining on the road. It is therefore vital that the study assesses fully the potential impact on the rail freight sector, including the cost and viability of rail freight services and modal shift.

The economic analysis has therefore focused on the above markets.

4. METHODOLOGY ADOPTED

4.1 Development of Cost Models

The second stage in the assessment was the production of a series of cost models for existing goods vehicles and trailer/semi-trailer combinations, for various longer semi-trailer options and for domestic intermodal rail freight services. A key component of the *MDS Transmodal GB Freight Model (GBFMv5)* is a series of cost models for goods vehicles and rail freight which replicates rates in the market and explains mode choice by route. These models have been further developed and extended specifically for this study, to reflect existing operating conditions and operations in future years with both existing length semi-trailers and potential longer semi-trailer equipment. The cost models have been developed for the following tasks:

- To compare the capital costs and operating costs of existing tractor unit/semi-trailer combinations with longer semi-trailer equipment;
- To compare the operating costs of longer semi-trailer equipment with intermodal rail freight (to assess the cost and viability of rail freight services with longer semi-trailers);
- As an input component to the various traffic forecasts (to assess the modal shift impact); and
- To estimate the total annual operating costs of road freight activity and rail freight in the identified sectors and markets, both for the current year and forecast years with various combinations of longer semi-trailers.

4.1.1 Road Goods Vehicle Cost Models – Existing Maximum Length and Operating Conditions

Based on the markets and sectors identified in Section 3 and informed by the Continuing Survey of Road Goods Traffic (CSRGT, see Section 4.2 below), a series of cost models for the following current vehicle combinations have been developed:

- 4x2 tractor unit and twin-axle semi-trailer standard height (34 tonnes gvw);
- 4x2 tractor unit and tri-axle semi-trailer standard height (40 tonnes gvw);
- 4x2 tractor unit and tri-axle semi-trailer 4.9m height (40 tonnes gvw);
- 6x2 tractor unit and tri-axle semi-trailer standard height (40 tonnes gvw);
- 6x2 tractor unit and tri-axle semi-trailer standard height (44 tonnes gvw);
- 6x2 tractor unit and tri-axle semi-trailer 4.9m height (44 tonnes gvw);
- 2 axle rigid and twin-axle trailer (34 tonnes gvw);
- 2 axle rigid and tri-axle trailer (40 tonnes gvw);
- 3 axle rigid and twin-axle trailer (40 tonnes gvw); and
- 3 axle rigid and tri-axle trailer (44 tonnes gvw).

These are the most popular vehicle combinations in the identified sectors and markets, accounting for around 98% of tonnes lifted.

All vehicle combinations are based on curtain-sided trailers/semi-trailers used for transporting general cargo, palletised goods, roll-cages and mail/parcels. All the individual cost components and assumptions which form the basis of the models have been collected from a number of robust sources, including industry survey results and actual published costs. The sources include:

- Motor Transport Cost Tables – the weekly road transport journal publishes a twice yearly survey of goods vehicle operating costs which are a representative reflection of actual industry operating costs;
- RHA Costs – the Road Haulage Association publishes an annual survey of its member's operating costs;
- Government departments and agencies – Taxes and other costs charged by the Government are published by the Treasury and DVLA; and
- Published costs from other sources e.g. AA online for fuel prices, suppliers of tyres etc..

In addition, capital costs of equipment and fuel consumption rates were sourced from industry during the evidence gathering exercise. These have been used to validate these particular model components. Fuel consumption rates have also been verified by TRL. All the individual cost elements contained in the models, and hence the outputs, are in 2009 prices.

Goods vehicle operating costs can be divided into two broad categories, namely:

- Fixed operating costs; and
- Running costs.

These categories are reflected in the structure of the cost models.

Fixed operating costs are incurred by vehicle operators purely by purchasing a goods vehicle and preparing it to a road-worthy condition so that it is able to operate on the public highway network. As the name implies, they are fixed and they do not vary regardless of how much the vehicle is worked over the course of a year. Consequently, annual fixed costs per unit of output will reduce the more a vehicle is worked. Annual fixed costs can be further sub-divided into capital costs (costs associated with owning the asset) and operating costs (costs related to preparing and operating the vehicle). Individual annual fixed cost components of a goods vehicle, which are included in the models, are shown in the table below.

Cost Component	Cost Type
Interest charges on capital borrowed	Capital cost
Depreciation	Capital cost
Maintenance	Operating cost
Insurance (Motor and Goods-in-Transit)	Operating cost
Vehicle Excise Duty (VED)	Operating cost
Driver wages, including NICs	Operating cost
Driver equipment	Operating cost
Mobile telephones	Operating cost
Vehicle cleaning	Operating cost
Overheads and Office Costs	Operating cost

A financial return on the assets employed (profit element) is also included (at 10% of mid-life book-value). The models assume that tractor and semi-trailer equipment is purchased from a manufacturer or vehicle dealer by means of borrowing a sum of capital from a bank/finance company. The actual purchase cost or list price of equipment (i.e. the capital cost) will vary depending on the type, model/specification, the number being purchased and whether any additional equipment is fitted to the vehicle post-manufacture. In this case, the capital costs used in the models for both tractors and semi-trailers are based on standard specification equipment from European manufacturers and have been validated though industry contacts, as follows:

- 4x2 tractor unit: £63,000;
- 6x2 tractor-unit: £69,200;
- Twin-axle curtain-sided semi-trailer: £17,000;
- Tri-axle curtain-sided semi-trailer at standard height: £19,000;
- Tri-axle curtain-sided semi-trailer double-deck (4.9m): £30,000 (basic design with fixed racking – hydraulic lifting floors can be considerably extra);
- Twin axle rigid: £74,500;
- Tri-axle rigid: £80,000;
- Twin axle draw-bar trailer: £17,000; and
- Tri-axle draw-bar trailer: £19,000.

Annual interest charges (on the capital borrowed) are calculated in the model at a flat percentage of the original capital cost of the equipment. Depreciation is calculated on a straight line basis, and it has been assumed that a tractor unit will be depreciated over 6 years and have a residual value of 25% of the original capital cost. Semi-trailers have been depreciated over 10 years with an assumed zero residual value (scrap value). The combined interest charges and depreciation in the model will therefore reflect the true capital cost on an annual basis to the operator of the owning the vehicle combination (i.e. does not reflect cash flow and it takes into account the fact that assets on disposal can have a residual value). The annual costs calculated on this basis are broadly similar to an operating lease arrangement.

The remaining annual fixed costs can be considered as operating costs, as they represent costs associated with preparing the vehicle combination to a road-worthy condition so that they are able to operate on the road network (though they are fixed on an annual basis). They include motor and goods-in-transit insurance, planned maintenance, Vehicle Excise Duty, driver wages (including employer National Insurance Contributions at current rates) and overheads.

In the models, each individual annual fixed cost component has been added together to produce a total annual fixed cost for the tractor unit, rigid and trailer/semi-trailer separately, and these have subsequently been added together to calculate the total annual fixed cost for the vehicle combination.

Running costs are incurred by driving the vehicle and are directly proportional to distance. Running costs are therefore calculated on a per kilometre basis. In general, the longer the distance covered the cheaper the total cost per kilometre, due to the higher proportion of running costs. The individual running cost components in the models are described below (including how they are calculated), as follows:

- Fuel – calculated from the cost of the fuel (£/litre) and the average fuel consumption for the type of vehicle (i.e. fuel cost per litre divided by fuel consumption per km);
- Oil – based on average oil consumption rates per km for each type of vehicle (i.e. cost of oil per litre divided by consumption rate per litre); and
- Tyres – calculated from the original cost of the tyre divided by the expected life of the tyres.

The price of diesel fuel was taken to be the cost incurred by hauliers to replenish their own bunkers at the start of December 2009 i.e. excluding VAT and forecourt margins. As with the annual fixed costs, in the models each individual running cost component has been valued separately and then added together to produce a total running cost per kilometre.

Output: The principal outputs subsequently produced from the models are as follows (*Baseline Output*):

- The capital costs of tractor unit, rigid, and trailer/semi-trailer equipment;
- Fixed operating costs by vehicle type – total per annum, and equated as 'per operating hour' (based on 2,750 operating hours per annum i.e. 11 hours per day, 5 days per week and 50 weeks per year);

- Running costs by vehicle type – per kilometre (km);
- Total operating cost per km by vehicle type – assuming an annual distance operated of 130,000km; and
- Cost per pallet-km by vehicle type – total operating cost per km divided by the pallet capacity of the vehicle combination type.

4.1.2 Road Goods Vehicle Cost Models – Existing Maximum Length in Future Years

The goods vehicle cost models outlined above were re-produced for the forecast years 2015, 2020 and 2025. These effectively form a *baseline output* against which longer articulated HGVs can be compared. All the individual cost elements contained in the models (as described above) remain in constant (2009) prices through to 2025 (i.e. no change in real terms), with the exception of the following which have been adjusted in real terms:

- Fuel costs;
- Fuel efficiency of HGVs; and
- Driver wages.

Guidance was sought from *WebTAG Unit 3.5.6* (issued by DfT in April 2009) and *HM Revenue & Customs Hydrocarbon Oils Duty Rates note* (April 2009) to estimate the value of these costs in real terms going forward for each forecast year.

Fuel Costs

The cost of diesel fuel for HGVs is essentially determined by a combination of the following:

- Cost of the fuel itself – so called *resource cost*; and
- Level of *excise duty* charged by Government.

Resource Cost

WebTAG provides guidance on the resource cost of diesel fuel, which is essentially set by international markets. WebTAG states the following forecast changes in the real terms resource cost of diesel:

- 2009-2010: 2.75% decrease
- 2010-2015: 0.56% increase per annum;
- 2015-2020: 0.55% increase per annum; and
- 2020-2025: 0.54% increase per annum.

The real terms resource cost of diesel fuel to 2025 has therefore been adjusted in line with the WebTAG forecast.

Excise Duty

The level of excise duty for road diesel in December 2009 was £0.5619 per litre (2009 prices), and the Revenue & Customs Hydrocarbon Oils Duty Rates note (April 2009) states that the level of excise duty will increase each April from 2010 to 2013 (inclusive) by indexation plus a further £0.01 per litre i.e. a real terms increase of £0.01 per litre each April.

On this basis, the December 2009 level of excise duty on road diesel has been increased in real terms by £0.01 per litre each year from 2010 to 2013. It then remains constant in real terms through to 2025. This has then to be added to the resource cost for diesel as described above.

Fuel efficiency improvements

WebTAG states a reduction of 1.23% from 2009 to 2010 in the fuel consumption of HGVs but then no change after 2010. Fuel consumption rates have therefore been reduced by 1.23% from 2009 to 2010, and then held at that level through to 2025 (albeit with some marginal increases, based on TRL findings, for those new combinations hauling longer semi-trailers).

Labour Costs

WebTAG states the following forecast changes in the work value of time to 2025:

- 2004-2011: 2.20% increase per annum;
- 2011-2021: 1.94% increase per annum;
- 2021-2031: 1.55% increase per annum.

Drivers wages have therefore been increase annually through to 2025 in line with these WebTAG forecasts.

Output: The principal outputs produced for the forecast years 2015, 2020 and 2025 are as follows (*Baseline Output*):

- The capital costs of tractor unit, rigid, and trailer/semi-trailer equipment;
- Fixed operating costs by vehicle type – total per annum, and equated as per operating hour;
- Running costs by vehicle type – per kilometre (km);
- Total operating cost per km by vehicle type – assuming an annual distance operated of 130,000km; and
- Cost per pallet-km by vehicle type – total operating cost per km divided by the pallet capacity of the vehicle combination type.

4.1.3 Road Goods Vehicle Cost Models – Longer Semi-trailers in Future Years

A series of cost models for various longer semi-trailer combinations, taking into account the different types of steering axle technology which potentially will need to be fitted together with other factors which will add to their weight and cost, have been developed for the forecast years 2015, 2020 and 2025. The concept being examined in this study is an increase of up to 2.05m in the length of a semi-trailer. In theory, therefore, numerous combinations and length increases could have been considered. However, given the dominance of standard ISO pallets (1.2m x 1.0m) within the British logistics sector (rather than CEN pallets used in other European markets), this suggests that any length increase should be in multiples of ISO pallet width. Consequently, two length increases have been considered, namely:

- An additional 1.0m, thereby allowing an additional one row of standard ISO pallets to be conveyed i.e. two pallets single-stack and four pallets double-stacked; and
- An additional 2.05m, thereby allowing an additional two rows of ISO pallets to be conveyed i.e. four pallets single-stack and eight pallets double-stacked.

A length increase of between 1.0m and 2.0m would only allow an additional one row of standard ISO pallets to be conveyed. Similarly, length increased below 0.95m would not increase the pallet capacity. As a result, other intermediate length increases have not been considered.

In terms of the different types of steering axle technology which potentially will need to be fitted together with other factors which will add to their weight and cost, advice was provided by TRL from their project findings. In their work (reported in more detail in Deliverable D3), TRL have considered two broad scenarios for longer equipment, namely:

- Longer semi-trailers meeting the existing Construction and Use Regulations; and
- Longer semi-trailers equalling the actual performance of existing maximum-length semi-trailers, on the basis that the performance of some semi-trailers currently exceeds the current regulations.

When applied to the longer semi-trailer lengths being considered, this effectively means the following options:

An additional 1.0m:

- Fixed axles on tri-axle semi-trailers, at standard height and double deck (4.9m), but limited to around 40 gvw;
- Single self-steer axle on tri-axle semi-trailers, at standard height and double deck (4.9m); and
- Active-steer technology on tri-axle semi-trailers, at standard height and double deck (4.9m).

An additional 2.05m:

- Two self-steer axles on tri-axle semi-trailers, at standard height and double deck (4.9m);
- Single command-steer axle on tri-axle semi-trailers, at standard height and double deck (4.9m)
- Two command-steer axles on tri-axle semi-trailers, at standard height and double deck (4.9m); and
- Active-steer technology on tri-axle semi-trailers, at standard height and double deck (4.9m).

In each case, the *active-steer technology* option represents the ‘equal actual performance’ scenario, with the fixed axle (but gross-weight limited), self-steer and command-steer systems being applied to meet the existing regulations.

Each semi-trailer type was paired with a 4x2 and 6x2 tractor unit, thereby generating 12 vehicle combinations for the additional 1.0m option and 16 combinations for the additional 2.05m option. Essentially, the relevant cost model for existing maximum length goods vehicles in the forecast years 2015, 2020 and 2025 were amended to reflect the following:

- The higher capital costs of longer semi-trailers, resulting from the additional length and steering axle technology; and
- Higher fuel consumption rates due to the additional tare weight associated with the extra length and axle technology and extra aerodynamic drag.

It is assumed that all other capital and operating costs in the forecast years will be the same as for existing maximum length goods vehicles.

Based on TRL's discussions with trailer manufacturers, capital costs are assumed to increase as follows:

- Length at standard height – an additional £514 per metre length increase;
- Length at 4.9m height – an additional £590 per metre length increase;
- Self-steer axles - £2,300 per axle;
- Single command-steer axle - £4,000 per semi-trailer;
- Two command-steer axles - £6,600 per semi-trailer; and
- Active-steer technology - £6,000 per semi-trailer.

Fuel consumption rates have been verified by TRL and currently reflect an across the board penalty of 2.8% compared with the fuel consumption rates of existing equipment. All other costs remain as per the cost models described at Stage 2. Again, costs for years 2015, 2020 and 2025 are quoted in constant (2009) prices, except for fuel costs, fuel efficiency and wage changes, to which the same real terms adjustments for existing length vehicles were applied (outlined above).

Given the above, we would expect the capital and operating costs of longer semi-trailer equipment to be higher than existing length articulated HGVs. However, the higher cargo capacity could result in longer semi-trailer equipment being more efficient, when measured on a per tonne lifted, per pallet or per pallet-km basis. Additionally, one of the underlining rationales for longer semi-trailer equipment is that they will lead to an overall reduction in the number of HGV trips and HGV kilometres, which we would expect to generate further cost benefits.

Output: The principal outputs subsequently produced from the models for the forecast years 2015, 2020 and 2025 are as follows:

- The capital costs of tractor unit and longer semi-trailer equipment;
- Fixed operating costs for each longer semi-trailer combination – total per annum, and equated as per operating hour;
- Running costs for each longer semi-trailer combination – per kilometre (km);
- Total operating cost per km for each longer semi-trailer combination – assuming an annual distance operated of 130,000km; and
- Cost per pallet-km for each longer semi-trailer combination – total operating cost per km divided by the pallet capacity of the vehicle combination type.

It is therefore possible to compare these outputs with those for existing length semi-trailers (baseline output), thereby enabling the impact on operating costs to be established.

4.1.4 Rail Freight Cost Model – Domestic Intermodal Rail Freight for Existing Operating Conditions

Based on the markets and sectors identified in Section 3, the key comparator sector in terms of rail freight will be domestic intermodal flows. The intermodal rail freight model (component of the GB Freight Model) has been further developed and extended specifically for this study, to reflect existing operating conditions and operations in future years. The model is based on a Class 66 diesel locomotive hauling a rake of Megafret intermodal platform wagons together with the use of open access terminals.

Rail freight operating costs can be divided into four broad categories, namely:

- Locomotive traction costs;
- Wagon costs (including intermodal unit costs);
- Track Access Charges; and
- Terminal costs.

These categories are reflected in the structure of the cost model. The individual cost components have been obtained from a number of sources, including costs in the public domain. They have also been validated during the evidence gathering exercise with the rail freight industry and by cost data held by the DfT which was used to value the Mode Shift Benefits (MSB) used for rail and waterway grants[2].

The *locomotive traction costs* in the model are based on a Class 66 locomotive, the locomotive used by most of the freight traction providers in Britain. On a similar basis to goods vehicle operating costs, locomotive traction costs are divided into annual fixed costs and running costs, as follows:

Annual Fixed Costs

- Interest charges;
- Depreciation;
- Train crew;
- Maintenance;
- Insurance;
- Overheads; and
- Profit

Running Costs

- Fuel.

The capital cost of a Class 66 locomotive is approximately £1.55 million. *Annual interest charges* (on any capital borrowed) are calculated in the model at a flat rate of the original capital cost of the locomotive. The locomotive has been *depreciated* in the model, on a straight line basis, over an estimated working life of 25 years and it has been assumed that a locomotive will have a zero residual value. The combined *interest charges* and *depreciation* in the model will therefore reflect the true capital cost to the operator of the owning the locomotive on an annual basis and they broadly reflect an operating lease arrangement (most railway traction is leased from a ROSCO or other financial institution).

Locomotive traction has to be *maintained* regularly in order that locomotives remain in a safe condition. The cost model assumes a flat annual rate of £50,000 plus a variable element based on usage (see running costs below). The model assumes that the train crew to locomotive ratio is broadly four drivers per locomotive and that each member of crew costs the operator £40,000 per annum plus NICs and pension contributions. The other costs reflect *office overheads* and *profit margin.*

[2] See http://www.dft.gov.uk/pgr/freight/railfreight/modeshiftben/

In the model, each individual annual fixed cost component has been added together to produce a total annual fixed cost for the locomotive. This annual fixed cost has then been equated as an annual fixed cost per operating hour (divided by total annual operating time). We have assumed that the locomotive will operate for *3,000 hours per annum* (i.e.12 hours per day, 5 days per week and 50 weeks per year).

Running costs are incurred by operating the locomotive and are directly proportional to distance. Running costs are therefore calculated on a per kilometre basis. In this case, the running costs essentially reflect fuel consumption, calculated from the cost of fuel per litre and the average fuel consumption for the locomotive. A Class 66 locomotive fuel consumption rate is approximately 0.24km per litre (Source: Freight traction operators).

Access to the national (Network Rail) railway infrastructure is dependent on the payment of *Track Access Charges* to Network Rail. These are levied on a 1,000 gross tonne kilometre (gtkm) basis (i.e. a train, including locomotive, wagons and cargo, of 1,000 tonnes moving one kilometre). The actual value per 1,000gtkm will vary as a function of both wagon type and commodity and locomotive used to haul the train.

For trains currently involved in domestic intermodal rail freight, the current track access charges for wagons and locomotives are as follows (Source: Office of Rail Regulation):

- Locomotive (Class 66): £1.4248 per 1,000gtkm; and
- Wagons (Megafret) £0.6708 per 1,000gtkm.

These charges increase or decrease on a pro-rata basis as the weight of the train increases or decreases.

Wagon costs are essentially fixed annually, as follows:

- Interest charges;
- Depreciation; and
- Fixed maintenance costs.

The model is based on the use of Megafret twin intermodal platform wagons (TOPS Code; IKA). These are the platform wagons employed on most domestic intermodal operations and on international services through the Channel Tunnel[3] (validated by rail freight operators). They are effectively two permanently coupled platform wagons, each offering a loading deck of around 15.65m length. Based on a standard European design, they are freely available to lease and each platform can accommodate one or two intermodal units up to the maximum deck length (they were originally designed to convey 2 x 7.82m length swap bodies per

[3] Rail services to/from the deep-sea container ports generally utilise wagons with a 60ft/18.25m deck length, thereby allowing 1 x 40ft (12.2m) and 1 x 20ft (6.1m) to be conveyed on each platform.

platform, the longest units which can move on a rigid and draw-bar trailer combination). Their deck height of 0.825m also allows them to convey 2.9m/9'6" high cube containers on W9 cleared routes (W10 for other wagon types) and 2.59m/8'6" units through the W7 loading gauge profile (normally requires W8). This enhances their operational flexibility compared with a 60ft/18.25m length wagon (which has a 0.98m deck height, and therefore requires more generous loading gauge profiles to convey the largest units).

In addition, the model accounts for the investment an operator would need to make in a fleet of intermodal units. For a standard 13.6m/45ft pallet-wide intermodal unit, the capital costs are assumed to be £4,000 per unit. Accounting for interest payments and depreciation over a 10 year period, this equates to just over £2 per operating day.

Terminals are assumed to charge for the train accessing the terminal, lifting intermodal units to/from trains and for shunting boxes between trains and any on-site warehousing. The model assumes that a third party operator charges the train operator a fixed fee per train handled and per intermodal unit lifted. Again, these costs have been validated by rail freight operators and represent current market rates for such services.

The standard train operating formation assumed in the model is as follows (validated by train operators):

- Class 66 locomotive, maximum weight of 126 tonnes;
- 14 x IKA Megafret twin wagons (maximum capacity of 28 x 13.6m/45ft intermodal units);
- Use of 13.6m/45ft pallet-wide intermodal units, capable of accommodating 26 pallets single stacked;
- Mean load factor of 24 intermodal units per train; and
- Trailing weight of 896 tonnes (wagon tare weight of 40 tonnes plus 14 tonnes per intermodal unit – tare plus cargo).

This formation is currently the longest train permitted on Anglo-Scottish services via the West Coast Mainline (WCML) when hauled by diesel traction[4]. It is assumed that a train takes 6 hours to discharge and re-load. A further two hours traction fixed costs are also added to each trip to account for shunting and train formation. The model also accounts for the capital costs associated with an operator investing in a fleet of intermodal units (or leasing such units).

[4] Due to the steep gradients at Shap and Beatock summits. Longer trains could be hauled by the same diesel traction, however they would travel at slower speeds and therefore utilise additional path capacity. This might prevent other services from operating and result in express passenger trains having to run at slower speeds.

Output: The principal outputs subsequently produced from the models are as follows (*Baseline Output*):

- Locomotive traction: Fixed cost per operating hour plus running cost per kilometre;
- Wagons: Fixed cost per day or per operating hour;
- Track Access Charges: Fixed cost per train kilometre;
- Terminal Charges: Train access, lifting and shunting;
- Intermodal unit investment: daily cost; and
- Total train costs on a terminal to terminal basis.

Local road haulage costs are also included where relevant (calculated by means of the existing vehicle cost models, and subsequently validated by the rail freight operators and the MSB cost data). The MSB grants have also been included where relevant. These outputs subsequently allow the calculation of door to door costs per intermodal unit.

4.1.5 Rail Freight Cost Model – Domestic Intermodal Rail Freight for Future Years

The cost model outlined above was re-produced for the forecast years 2015, 2020 and 2025. All the individual cost elements contained in the models are in constant (2009) prices through to 2025 (i.e. no change in real terms), with the exception of the following which have been adjusted in real terms:

- Fuel costs; and
- Driver wages.

The same WebTAG assumptions as described above for the road cost models have been adopted. The use of Class 66 locomotives through to 2025 has been maintained. Despite recent announcements concerning the electrification of some key routes (Great Western Mainline and some 'infill' schemes in the North West), diesel locomotives are likely to remain the primary traction solution for freight operators for some years to come, as they offer go-anywhere flexibility. Recent operator investment in traction has been in diesel rather than electric locomotives (e.g. Class 70s), and these would be expected to have a 20 year economic life.

For the main scenarios tested, train productivity is also assumed to be constant through to 2025 i.e. 14 x IKA Megafret wagons per train. In practice, however, train lengths may increase over time, either through a small increase in the deployment of electric locomotives (which are more powerful and therefore able to haul longer trains on the steeper sections of the WCML) or the use of more powerful diesel traction (e.g. Class 70s). This would have the affect of reducing per unit transport costs. The impact of this has been assessed through a sensitivity test (see Section 4.10 below). It has been assumed that locomotive fuel consumption will also remain as per 2009 rates.

The continued use of Megafret wagons has also been assumed (validated by train operators). In fact, as the number of 40ft maritime containers continues to increase, future large scale investment in new wagons for these services can be expected to be in designs similar to the Megafret.[5] Again, local road haulage costs are also included where relevant.

Output: The principal outputs subsequently produced from the models for the forecast years 2015, 2020 and 2025 are as follows (*Baseline Output*):

- Locomotive traction: Fixed cost per operating hour plus running cost per kilometre;
- Wagons: Fixed cost per day or per operating hour;
- Track Access Charges: Fixed cost per train kilometre;
- Terminal Charges: Train access, lifting and shunting;
- Intermodal unit investment: daily cost; and
- Total train costs on a terminal to terminal basis.

The future year models can also be adapted to reflect the use of longer intermodal units – up to 15.6m length (see Section 4.6 below). In such circumstances, the model again accounts for the investment an operator would need to make in a fleet of longer intermodal units. For a 15.6m longer intermodal unit, the capital costs are assumed to be £5,000 per unit. Accounting for interest payments and depreciation over a 10 year period, this equates to just under £3 per operating day.

When establishing local road haul costs for moving longer intermodal units, this has been calculated using the relevant longer semi-trailer cost model. Again, the MSB grants have also been included where relevant. However, the mode-share traffic forecasts (see Sections 4.4 and 4.6) did not include these grants, though they were accounted for when estimating the direct industry costs.

4.2 Quantifying the Current Market

The next stage in the assessment has been the quantification of the identified markets and sectors (i.e. the road sectors and domestic intermodal rail market identified in Section 3). MDS Transmodal were supplied outputs from the CSRGT database, which contains data quantified in terms of grossed tonnes lifted, vehicle kilometres and tonne-kilometres. A total of four years combined data was supplied in Microsoft Access format (2004-2007)[6] in order to minimise potential dataset gaps and lessen the risk of being able to identify individual

[5] The 18.25m deck wagon design was originally introduced when 40ft to 20ft containers were in a broad 1:1 ratio (i.e. each wagon would convey 1x20ft and 1x40ft). Nowadays, this ratio is closer to 2:1, resulting in deep-sea container services operating with many 18.25m wagons at two-thirds capacity. This problem would be overcome by adopting Megafret or similar type wagons.
[6] 2007 was the latest year available when this section of the project commenced.

flows and companies. An average (mean) of the four years data is considered to represent current road freight activity.

The initial outputs produced were a record of all road freight activity by annual grossed tonnes lifted, vehicle-kilometres, tonne-kilometres and vehicle type. Vehicle trips associated with each record were estimated using the vehicle-kilometres divided by the distance derived from the tonnes and tonne-kilometres data. For records with zero tonnes, distances were taken from the zone-to-zone average distance.

This data was then further filtered (using an Access query) to extract only records of freight activity by the vehicle and trailer/semi-trailer combinations modelled above and for the identified markets and sectors. Based on the commodity categories contained within CSRGT, the identified markets and sectors were taken to be the following commodities:

- Empty (No commodity);
- Fresh/fruit & vegetables;
- Textiles;
- Raw animal & vegetables material;
- Beverages exc. tea & coffee;
- Stimulants & spices;
- Perishable foodstuffs;
- Household shopping;
- Other non perishable foodstuffs;
- Oil, seeds & oleaginous fruit & fat;
- Tools/equipment/other materials;
- Packaging only;
- Household waste;
- Paper pulp & waste paper;
- Mail pouches/other mail items;
- Parcels;
- Other chemical products;
- Manufactures of metal;
- Glass, glassware & ceramic products;
- Leather, textiles and clothing;
- Other manufactured articles;
- Misc articles;
- Semi-finished products and manufactures of rubber;
- Paper and paperboard, unworked;
- Paper and paperboard manufactures;
- Paper matter;
- Furniture, new;

- Wood and cork manufactures excluding furniture;
- Other manufactured articles;
- Packaging containers used;
- Construction materials and equipment, used;
- Removal equipment;
- Gold coins, medals;
- Other manufactured goods not classified according to kind;

and the following modes of appearance:

- Other Freight Containers including Stillages;
- Palletised goods;
- Pre Slung goods;
- Roll Cages; and
- Other cargo types.

Outputs were also divided into the following classifications:

- Volume-constrained;
- Weight-constrained; and
- Neither volume nor weight-constrained.

While most bulk and semi-bulk cargoes are generally weight-constrained, it may be the case that there are some niche flows and commodities within these sectors that are volume-constrained. A further query was therefore undertaken to identify and quantify any other commodities not listed above which are volume-constrained and are moved on pallets, roll-cages, pre-slung and other containers/stillages.

Essentially, most bulk and semi-bulk cargoes which are weight-constrained were removed from the analysis. Also, goods moved on rigid and shorter single-axle semi-trailers were removed from the analysis. As explained earlier, operators of such vehicles can already upgrade to larger vehicle equipment.

Output: The principal output produced was a record of current road freight activity in the identified market/sectors as follows (*Baseline Output*):

- Annual tonnes lifted;
- Annual tonne-km;
- Annual vehicle-km;
- Annual vehicle trips;
- Vehicle type;
- Commodity and cargo type; and
- Volume or weight-constrained or neither.

The domestic intermodal rail freight market was identified in Section 3 as the key competitor sector. In addition, therefore, the domestic intermodal rail market for 2008 was also quantified using raw Network Rail billing data (processed by MDS Transmodal).

Output: A record of current domestic intermodal rail freight activity as follows (*Baseline Output*):

- Annual tonnes lifted;
- Annual tonne-km.

Output: From the above results, it was possible to quantify total domestic unit load traffic (i.e. road and domestic intermodal traffic combined) within our identified sectors and markets, as follows (*Baseline Output*):

- Annual tonnes lifted;
- Annual tonne-km.

4.3 Direct Costs to Industry: Current Total Annual Operating Costs

The next stage in the analysis was to estimate the current total annual operating costs of road freight activity in the identified sectors and markets (i.e. for those vehicle combinations and commodities which may upgrade to longer semi-trailer equipment). The total annual cost of moving goods by domestic intermodal rail freight was also calculated. Essentially, these combined figures represent the total direct cost to industry of moving goods by road transport in the identified sectors and by domestic intermodal rail freight, and effectively produces the *Baseline* cost against which future options/scenarios can be compared.

Following the outputs produced in Sections 4.1 and 4.2 above, the following data was known for road transport by vehicle type and commodity:

- Annual vehicle-km;
- Annual vehicle trips;
- Fixed cost per operating hour; and
- Running cost per km.

Dividing annual *vehicle-km* by annual *vehicle trips* allowed an estimation of *mean kilometres per vehicle trip* to be calculated (by vehicle type and commodity). Assuming an average vehicle speed of 65km/h, this subsequently allowed an estimation of mean driving time per vehicle trip (by vehicle type and commodity) to be calculated. Adding a further two hours to each trip to account for loading/discharge etc, a *mean trip time per vehicle trip* has been be calculated (by vehicle type and commodity). From this data, an estimation of the *mean* *operating cost per vehicle trip* (by vehicle type and commodity) was consequently calculated, as follows:

- Mean trip time per vehicle trip x Fixed cost per operating hour; plus
- Mean kilometres per vehicle trip x Running cost per kilometre; equals
- Mean operating cost per vehicle trip.

The *mean operating cost per vehicle trip* (by vehicle type and commodity) was consequently multiplied by the *annual vehicle trips* to produce the *total annual operating costs* for that vehicle type and commodity. The *total annual operating costs* for each vehicle type and commodity were then summed to produce the *total annual operating costs* in the identified sectors and markets.

Output: The principal output produced was an estimation of the current total annual operating costs of road freight activity in the identified sectors and markets. Similarly, the total annual cost of moving goods by domestic intermodal rail freight was produced. The sum of both figures represents current total transport costs (total direct cost to industry) in the identified markets and sectors. It is considered to be a *Baseline* output against which to compare future scenarios, reflecting longer semi-trailers not being introduced or differing take-up rates of longer semi-trailer equipment.

4.4 Traffic Forecasts for 2015, 2020 and 2025 – Longer Semi-trailers Not Introduced

The next stage in the assessment was the production of traffic forecasts for both road freight and domestic intermodal rail freight in the identified markets and sectors, on the basis that longer semi-trailer equipment is not introduced. Two forecasting tools have been utilised, namely:

- The MDS Transmodal GB Freight Model version 5 (GBFMv5); and
- The GB intermodal forecasting module.

The *GBFMv5* is an established analysis and forecasting tool for freight traffic. It has been audited by the ITEA division of DfT and it has been adopted by the Department as part of the National Transport Model. GBFM Version 5.0 Report, submitted to DfT in March 2008, fully documents latest version of GBFM (available to download from dft.gov.uk). The *GB intermodal forecasting module* is an add-on tool to the GBFMv5. This forecasting tool was utilised to produce national rail freight forecasts for the DfT in Autumn 2009.

The GBFMv5 was subsequently utilised to establish the growth rates (scaling factors) for total domestic unit load traffic to 2019 for the identified markets (i.e. road and domestic intermodal rail combined), for both tonnes-lifted and tonne-kilometres. These scaling factors were then applied to the current total domestic unit load traffic figures as calculated in Section 4.2 above. The scaling factor for both tonnes-lifted and tonne-kilometres is 1.0468. The tonnes-lifted and tonne-kilometres for current total domestic unit load traffic were subsequently both multiplied by a factor of 1.0468 to produce tonnes-lifted and tonne-kilometres figures for total unit load traffic in 2019. Forecast years 2015, 2020 and 2025 were then interpolated/extrapolated from the 2019 forecasts.

Ideally, the rail forecasting methodology and assumptions for this project should be consistent with the revised national rail freight forecasts recently produced for the DfT by MDS Transmodal. As a result, the domestic intermodal element of these forecasts were essentially re-produced for this project[7] (in tonnes-lifted and tonne-kilometres). These forecasts were originally produced for the forecast year 2019. Domestic intermodal traffic for this project's forecast years i.e. 2015, 2020 and 2025 were interpolated/extrapolated from the 2019 forecasts. These forecasts do not include rail freight grants (MSB grants). The forecasts assumed that significantly more intermodal rail traffic by 2019 will be to/from terminals with warehousing on-site (i.e. no need for expensive local road hauls), thereby eliminating any need for grant funding.

The national rail freight forecasts were not specifically produced using WebTAG assumptions, but they were broadly consistent with the main WebTAG principles. However, as a sensitivity test, the forecasts were re-run based directly on WebTAG figures, in particular the real terms changes in fuel costs and driver wage rates described above in Section 4.1. The results were essentially the same, albeit the WebTAG compliant forecasts produced a marginally higher tonnes-lifted output. Given this position, it was agreed to use the revised DfT national rail freight forecasts as the *Baseline* output.

At this stage of the analysis, both total domestic unit load traffic and domestic intermodal rail traffic for the forecast years 2015, 2020 and 2025 have been established. By subtracting rail tonnes-lifted from total tonnes-lifted, the amount of cargo moved by road transport can consequently be calculated (and similarly for tonne-kilometres). It is assumed that the proportion of cargo conveyed in the different HGV types (including 4.9m tall semi-trailers) will remain constant at current rates.

The process is undertaken on the basis that transport costs form a small proportion of the overall total cost of goods. As a result, total cargo demand is constant with changes in modal transport costs effectively determining which mode particular freight flows utilise (zero elasticity) e.g. as road transport becomes more expensive relative to rail, there is mode

[7] The national rail freight forecasts produced for the DfT were revised following industry consultation. They are marginally lower than the forecasts initially produced, reflecting the impact of the recession (lower base) and the slightly more conservative view of the freight train operators with regards to future traffic volumes. The domestic intermodal elements of the revised forecasts are 25% less than the initial forecasts.

switch away from road freight to the intermodal sector, though the total amount of cargo lifted will remain constant.

It could be argued that as transport costs per unit reduce (e.g. following the introduction of longer semi-trailers), this may induce a slightly higher total demand for cargo (as lower transport costs manifest themselves in lower product costs, thereby stimulating extra demand). This is unlikely given that that transport costs form a small proportion of the overall total cost of goods. However, a *sensitivity test* has been undertaken (see Section 4.10 below) based on an elasticity of -0.1 in terms of total tonne-kilometres.

Output: Assuming longer semi-trailer equipment is not introduced, the principal output produced was a forecast of domestic unit load freight activity in 2015, 2020 and 2025 in the identified market/sectors as follows (*Baseline Output*):

Road freight traffic:

- Annual tonnes lifted;
- Annual tonne-km;
- Annual vehicle-km;
- Annual vehicle trips;
- Vehicle type;
- Commodity and cargo type; and
- Volume or weight-constrained or neither.

Domestic intermodal rail freight:

- Annual tonnes lifted;
- Annual tonne-km.

Total domestic unit load freight:

- Annual tonnes lifted;
- Annual tonne-km.

4.5 Direct Costs to Industry: Forecast Total Annual Operating Costs 2015, 2020 and 2025 – Longer Semi-trailers not Introduced

The next stage in the analysis was to estimate the total annual operating costs of road freight activity for the forecast years in the identified sectors and markets, on the basis that longer semi-trailer equipment is not introduced. The total annual cost of moving goods by domestic intermodal rail freight in the forecast years was also calculated. Essentially the combined figures will represent the forecast total direct cost to industry of moving goods in the identified sectors. They can then be compared with the current year Baseline output and will allow the likely change in transport costs (to industry) over the medium/long term to be established on the basis that longer semi-trailers are not introduced i.e. effectively a *Baseline* or *do-nothing* scenario.

Following the analysis outlined in Sections 4.1 and 4.4 above, the following data was known by vehicle type and commodity:

- Annual vehicle-km for forecast years 2015, 2020 and 2025;
- Annual vehicle trips for forecast years 2015, 2020 and 2025;
- Fixed cost per operating hour for forecast years 2015, 2020 and 2025; and
- Running cost per km for forecast years 2015, 2020 and 2025.

Calculating the total annual operating costs of road freight activity in the forecast years essentially followed the same methodology as outlined in Section 4.3 above. However, in this case the 2015, 2020 and 2025 traffic forecast outputs described above were utilised along with the vehicle cost models for the forecast years as outlined in Section 4.1.

Output: Assuming longer semi-trailer equipment is not introduced, the main output produced was an estimate of total annual operating costs of road freight activity for the forecast years 2015, 2020 and 2025 in the identified sectors and markets. Similarly, the total annual cost of moving goods by domestic intermodal rail freight in the forecast years was also estimated. The sum of both figures represents forecast total transport costs (total direct cost to industry) in the identified markets and sectors. It is considered to be a *Baseline* output against which future scenarios, reflecting differing options and take-up rates of longer semi-trailer equipment, can be compared.

4.6 Traffic Forecasts for Years 2015, 2020 and 2020 with Longer Semi-trailers

The next stage in the assessment was the production of traffic forecasts in the identified markets and sectors on the basis that longer semi-trailer equipment is introduced. This has taken into account the following:

- The differing types of longer semi-trailer equipment which may be introduced i.e. 14.6m or 15.65m, self-steer, active-steer etc;
- The use of existing length intermodal units on domestic intermodal flows i.e. 13.6m/45ft; and
- The potential introduction of longer intermodal units on domestic intermodal flows i.e. 14.6m or 15.6m.

The ability to operate longer semi-trailers potentially allows the introduction of longer intermodal units on domestic rail freight flows. As noted earlier, the *Megafret* intermodal platform wagon used for most domestic intermodal flows has a 15.65m loading deck and is capable of accommodating units of such a length, so new rolling-stock equipment would not have to be developed i.e. zero R&D investment required by the rail industry. A train hauling a rake of Megafret wagons essentially costs the same, regardless of the length of the intermodal units being conveyed on those wagons. Longer intermodal units could therefore be conveyed for the same cost as a train conveying existing length (13.6m) intermodal units, thereby generating efficiencies. A 15.6m unit would allow an additional 4 pallets to be conveyed compared with an existing maximum length box, generating cost savings in the form of lower per pallet costs.

However, a number of issues have been identified during the evidence gathering exercise which may restrict their introduction, in the short/medium term at least. These include:

- Compatibility with skeletal trailers. Longer skeletal semi-trailers (to convey longer intermodal units by road) will need to be flexible and compatible with existing standard 40/45ft maritime shipping containers. Otherwise, industry will be required to operate two types of skeletal trailers (which will add to industry costs);
- The need to dispose of existing length units. Operators would be forced to dispose of existing length intermodal units before the end of their economic/operational life, thereby incurring write-off costs i.e. before they had been fully depreciated;
- Investment in new equipment. Linked to the above issue, the rail industry would need to invest in a new fleet of longer intermodal units in order to achieve the forecast benefits;
- Cranes. Cranage equipment at some intermodal terminals might not be suitable for longer intermodal units. While the lifting points on the roof of a longer intermodal unit can be located at the same positions, thereby enabling them to be lifted by existing lifting equipment (cranes or reachstackers), they might not longitudinally fit through the gap between the legs on a rail-mounted gantry.

The traffic forecasts have therefore been undertaken, initially, on the basis that the rail freight sector continues to utilise existing length units up to 2025 (i.e. 13.6m or 45ft). In this case, the road haulage market would benefit from the greater payload capacity (and therefore efficiency savings) offered by the introduction of longer semi-trailers, but the rail freight sector would not. This exercise will therefore help identify any modal switch impact as a result of introducing longer semi-trailer equipment, but with rail not taking advantage of the additional length opportunities.

However, the model run was then repeated but with longer intermodal units being operated by the rail freight sector (in this case all operators utilising longer units i.e. 100% take-up). In brief, both modes would benefit from the greater payload capacity offered by the introduction of longer semi-trailers. This model run has assumed the following:

- A universal longer skeletal semi-trailer can be developed which can accommodate standard 40/45ft maritime shipping containers and a 15.6m longer unit (contacts with industry during the evidence gathering exercise suggest this is the case);
- Cranage at terminals is compatible with longer units – any problem with gantry cranes could be over-come by using reach-stacker lifting equipment; and
- Investment required in longer intermodal units, reflected in the cost model through a higher daily cost compared with existing length units, and the ability to dispose of existing equipment without significant cost penalties (the forecast growth in domestic rail freight would, in any case, necessitate investment in additional intermodal unit capacity).

The road haulage industry and the rail freight sector will effectively be in the same position, with both types of operators needing to invest in new longer equipment (and therefore needing to dispose of existing length equipment) to benefit from any efficiency savings they generate. In practice, it may be that the road haulage sector is better able to dispose of existing length equipment compared with the rail freight sector. There is still likely to be a reasonable second-hand market for 13.6m semi-trailers (from general hauliers moving weight-constrained cargo) whereas existing length intermodal units may have to be scrapped given restricted cascade opportunities. However, the model run assumes that both sectors are able to invest and have the ability to dispose of existing equipment without significant cost penalties on a broadly mode-neutral basis.

The traffic forecasts (as calculated in Section 4.4) have been undertaken on the basis that total cargo demand is constant. As a result, the total domestic unit load traffic figures for the forecast years 2015, 2020 and 2025 have been carried forward to this task (they are effectively control totals).

Subsequently, a series of domestic intermodal rail forecasts have been undertaken for the forecast years 2015, 2020 and 2025. Again, these have been produced using the *GB intermodal forecasting module*, adopting the same broad methodology as outlined in Section 4.4. However, as rail freight's cost base changes relative to road transport, the domestic intermodal sector will gain or loose traffic accordingly. As a result, the introduction of longer semi-trailer equipment could impact on the tonnes-lifted and tonne-kilometres accounted for by each mode (modal shift to/from road haulage). The revised domestic intermodal rail forecasts were therefore re-calculated but using input costs reflecting differing length semi-trailers and steering axle systems, both with and without the rail industry adopting longer intermodal units (i.e. the costs derived in Sections 4.1.3 and 4.1.5).

Taking into account the potential steering-axle options required to meet the existing regulations/performance (see section 4.1), the following sets of domestic intermodal rail forecasts have been undertaken.

Table 4.1: Vehicle Options

Option	Semi-trailer length	Semi-trailer and axle type	Intermodal unit
1	14.6m	Fixed axles on tri-axle semi-trailers, at standard height and double deck (4.9m), but limited to around 40t gvw	13.6m/45ft
2	14.6m	Single self-steer axle on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	13.6m/45ft
3	14.6m	Active-steer technology on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	13.6m/45ft
4	15.65m	Two self-steer axles on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	13.6m/45ft
5	15.65m	Single command-steer axle on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	13.6m/45ft
6	15.65m	Two command-steer axles on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	13.6m/45ft
7	15.65m	Active-steer technology on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	13.6m/45ft
8	14.6m	Fixed axles on tri-axle semi-trailers, at standard height and double deck (4.9m), but limited to around 40 gvw	14.6m
9	14.6m	Single self-steer axle on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	14.6m
10	14.6m	Active-steer technology on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	14.6m
11	15.65m	Two self-steer axles on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	15.6m
12	15.65m	Single command-steer axle on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	15.6m
13	15.65m	Two command-steer axles on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	15.6m
14	15.65m	Active-steer technology on tri-axle semi-trailers, at standard height and double deck (4.9m), 44t gvw	15.6m

Effectively, 14 different options reflecting various length increases, steering-axle options and intermodal units have been undertaken. In each case, the derived domestic intermodal rail freight forecast tonnes-lifted and tonne-kilometres were subtracted from the total domestic unit load traffic forecast (control totals) to calculate the forecast road freight activity for each option.

The road freight input costs in each of these options has initially assumed 100% take-up of longer semi-trailers i.e. the costs produced in Sections 4.1.3 for longer semi-trailer HGVs. Given that longer semi-trailer take-up will not be 100% (see below) and that longer equipment is more efficient than existing length semi-trailers, this effectively skews the forecasts slightly in favour of road transport. Also, as there are only marginal differences between the vehicle operating costs for the different steering axle systems, the input costs have been based on an average of the longer semi-trailer costs derived from the models i.e. an average of the three semi-trailer types for 14.6m and of the four semi-trailer types of 15.65m.[8] Again, these mode-share forecasts assume no rail freight grants.

As a result, only four different road-intermodal tonnage splits have been produced for each forecast year i.e. at 14.6m and 15.65m, and with existing and longer intermodal units. However, the process for calculating total transport costs has used the individual vehicle model costs (existing and longer semi-trailers).

Output: A forecast of domestic unit load freight activity in 2015, 2020 and 2025 in the identified market/sectors for each of the 14 options, as follows:

Road freight traffic:

- Annual tonnes lifted; and
- Annual tonne-km;

Domestic intermodal rail freight:

- Annual tonnes lifted; and
- Annual tonne-km;

Total domestic unit load freight:

- Annual tonnes lifted;
- Annual tonne-km.

4.6.1 Take-up Rates for Longer Semi-trailers – The Central Case Scenario

The next stage of the analysis was to estimate take-up rates for longer semi-trailer equipment i.e. to differentiate the forecast road freight traffic by existing length semi-trailers and longer semi-trailers. For various reasons, a 100% take-up of longer semi-trailer equipment in the identified road freight markets is unrealistic. A *best estimate* (from here onwards it is referred to as the C*entral Case* scenario) has therefore been undertaken, using an approach supported by robust underlying assumptions and data.

[8] As there are only marginal differences between the vehicle operating costs for the different steering axle systems, undertaking 14 different model runs would have produced results with marginal differences between the road and intermodal tonnages. Therefore, to quicken the modelling process, only four different options have been produced based on an average of the operating costs

It is important to appreciate that in the sectors and markets identified, goods are generally lifted 2-3 times along the supply chain before being purchased by end users (consumers), as follows:

- NDC to RDC, then RDC to retail outlet;
- Producer to NDC, then NDC to RDC, then RDC to retail outlet; and
- Producer to RDC, then RDC to retail outlet.

Inter-depot trunking movements (i.e. not deliveries to retail outlets) are generally over medium to long distances, being from production sites nationwide or from Midlands based NDCs to depots in other regions. Also, such flows tend to be multiple full-load movements undertaken on existing maximum length goods vehicles, principally 13.6m semi-trailers, both standard height and, increasingly, double-deck equipment (between facilities which can accommodate such vehicles) e.g. some food producers can often despatch 10-15 full-length semi-trailers per day into a single supermarket RDC.

Conversely, flows from RDCs to retail outlets are over much shorter distances. RDCs are located close to the main conurbations of Britain in order to minimise re-distribution transport costs and provide timely stock replenishment. In addition, store deliveries can be undertaken in a range of goods vehicle sizes, depending on volumes delivered and access restrictions.

A broad conclusion which can be drawn from the above, therefore, is that goods being moved on inter-depot trunking operations are prime candidates for transfer to longer semi-trailers, while utilisation on retail store deliveries is likely to be more varied. This conclusion is supported through views presented and data gathered during the evidence gathering exercise. Traffic data supplied by shippers[9] suggests that most inter-depot trunking operations are multiple full-load movements and will therefore benefit greatly from the introduction of longer semi-trailers, principally through a reduction in total HGV trips. A switch to longer equipment, perhaps over a 18-24 month period, is likely to be wide-spread. In addition, some retail outlets have a high throughput of trade and could physically accommodate a larger vehicle e.g. a *hypermarket* type store on an out-of-town retail park. Again, views and evidence supplied suggests that such flows will benefit greatly from the introduction of longer semi-trailers and that a switch to longer equipment will occur.

However, many town centre retail outlets and smaller *metro* or *express* store formats cannot accommodate existing maximum length HGVs or their trade volumes do not warrant the use of a large vehicle. Such stores are therefore served by shorter single-axle articulated or rigid vehicles. In such cases, the use of longer equipment is less likely. As a result, the introduction of longer semi-trailers on retail store deliveries is likely to be more varied.

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[9] Data showing the actual number of full-load HGV trips between particular origins and destinations on a weekly or monthly basis. Estimates were also made of the likely reduction in trip numbers assuming an additional 2.05m length available

This broad conclusion was therefore adopted, supported by robust data, including the *CSRGT* and from the evidence gathering exercise, as a means of informing the *central case* of the likely take-up rate. The broad approach is outlined below.

The *CSRGT* only records goods each time they are lifted by road transport. It is therefore not possible to identify directly at which stage in the supply chain these goods are being lifted. However, the CSRGT does allow the following to be identified:

- Distance of flows;
- Loads which are volume-constrained i.e. reach cube capacity before gvw;
- Loads which are weight-constrained i.e. reach gvw before cube capacity; and
- Loads which are neither weight nor volume-constrained.

The supplied CSRGT dataset was therefore interrogated (i.e. current flows by road transport) and all goods vehicle flows in the identified markets and sectors were further divided into the following 6 categories; as follows:

- Category 1: Volume-constrained but not weight-constrained travelling distances greater than 120km;
- Category 2: Volume-constrained but not weight-constrained travelling distances less than 120km;
- Category 3: Neither volume nor weight-constrained travelling distances greater than 120km;
- Category 4: Neither volume nor weight-constrained travelling distances less than 120km;
- Category 5: Weight-constrained travelling distances greater than 120km; and
- Category 6: Weight-constrained travelling distances less than 120km.

The proportion in each Category was then applied to the forecast road traffic. As before, outputs were in tonnes-lifted, tonne-km, vehicle-km and vehicle trips etc. The 120km figure was based on the average distance between Midlands NDCs and the nearest RDCs in the adjacent South East region (the nearest region to the Midlands).

However, it was deemed sensible to undertake some *sensitivity tests* around this distance. As a result the exercise was re-run using 100km and 150km as the distance threshold for short/long haul flows (*Sensitivity Tests 1 and 2*).

Essentially, Categories 1, 3 and 5 can be considered as generally representing inter-depot trunking operations, where as Categories 2, 4 and 6 are shorter final delivery to store type flows. The estimated percentage switch to longer semi-trailers in each category was then estimated using robust assumptions, principally based on data obtained during the evidence gathering exercise.

Taking the above into account, traffic data supplied by shippers suggests that the vast majority of loads in Categories 1 and 3 would switch to longer semi-trailer equipment, as significant benefits can be achieved, Consequently, *90% of all loads* in Categories 1 and 3 are assumed to switch to longer semi-trailer equipment. This would reflect the anticipated wide-spread switch but acknowledge that some shippers would continue to use existing equipment and that sub-contracted hauliers may continue to use 13.6m semi-trailers due to their lower tare-weight (see below) – such equipment would be used at some stage for loads which normally move on a longer semi-trailer (covering during maintenance downtime etc).

Longer semi-trailers will have a heavier tare-weight. Given that there is going to be no associated increase in the gvw restrictions, loads which are weight-constrained are likely to continue being moved in existing length equipment given their greater weight payload, particularly where shippers utilise dedicated semi-trailer equipment. However, some of these loads may transfer to longer semi-trailers given that sub-contracted hauliers may have switched to operating fleets of longer equipment. As a result, *20% of all loads* in Category 5 were assumed to switch to longer semi-trailer equipment i.e. 80% continue to move on existing type semi-trailers.

Rates of switch in Categories 2 and 4 were informed by data supplied by major retailers on store deliveries. From this data, around 40-50% of all loads in these Categories could potentially switch to longer equipment. As a result, *45% of all loads* in Categories 2 and 4 were assumed to switch to longer semi-trailer equipment.

Again, it was deemed sensible to undertake some *sensitivity tests* of these take-up rates. As a result the exercise was re-run using 35% and 55% (*Sensitivity Tests 3 and 4*).

The reason for having these different Categories is to acknowledge that some in-scope operations are more prone to switching than others. The same argument could be made within each category i.e. that it would not be a blanket percentage switch for all loads. However there was a need to limit the complexity of the modelling at some point and this seemed a reasonable level. Effectively, a random 90% selection of vehicles within Category 1 would switch to longer semi-trailers and therefore the remaining vehicles would retain the same characteristics they had before - e.g. average payload, distance band proportions, commodity proportions etc. The table below summarises the C*entral Case* and *sensitivity tests 1-4* assumptions.

	Central Case				
	Core Assumptions	Sensitivity Test 1	Sensitivity Test 2	Sensitivity Test 3	Sensitivity Test 4
Distance Threshold	120km	150km	100km	120km	120km
Switch % Cat 1	90%	90%	90%	90%	90%
Switch % Cat 2	45%	45%	45%	35%	55%
Switch % Cat 3	90%	90%	90%	90%	90%
Switch % Cat 4	45%	45%	45%	35%	55%
Switch % Cat 5	20%	20%	20%	20%	20%
Switch % Cat 6	5%	5%	5%	5%	5%

The overall differentiation into these categories was subsequently applied for the traffic forecasts in 2015, 2020 and 2025, and the above quoted switch percentages were also applied to the forecast traffic levels. These switch rates were also applied uniformly across the different trailer length and steering axle options being considered.

When differentiating the forecast road traffic by vehicle type, in order to avoid over complicating the modelling, loads conveyed on each existing tractor unit-semi-trailer combination type were assumed to simply switch to one particular longer semi-trailer combination. The table below shows each existing combination and the particular type of longer semi-trailer those loads moved to (these are also applied to the other scenarios – see below).

Existing Combinations	Switching to following 14.6m semi-trailers	Switching to following 15.6m semi-trailers
	With Fixed Axles	
4x2 and twin-axle semi-trailer standard height, 34t gvw	Tri-axle, standard height, 40t gvw	NA
4x2 and tri-axle semi-trailer standard height, 40t gvw	Tri-axle, standard height, 40t gvw	NA
4x2 and tri-axle semi-trailer 4.9m height, 40t gvw	Tri-axle, 4.9m height, 40t gvw	NA
6x2 and tri-axle semi-trailer standard height, 40t gvw	Tri-axle, standard height, 40t gvw	NA
6x2 and tri-axle semi-trailer standard height, 44t gvw	NA	NA
6x2 and tri-axle semi-trailer 4.9m height, 44t, gvw	NA	NA
	With Single Self-steer axle	
4x2 and twin-axle semi-trailer standard height, 34t gvw	Tri-axle, standard height, 40t gvw	NA
4x2 and tri-axle semi-trailer standard height, 40t gvw	Tri-axle, standard height, 40t gvw	NA
4x2 and tri-axle semi-trailer	Tri-axle, 4.9m height, 40t gvw	NA

4.9m height, 40t gvw		
6x2 and tri-axle semi-trailer standard height, 40t gvw	Tri-axle, standard height, 40t gvw	NA
6x2 and tri-axle semi-trailer standard height, 44t gvw	Tri-axle, standard height, 44t gvw	NA
6x2 and tri-axle semi-trailer 4.9m height, 44t, gvw	Tri-axle, 4.9m height, 44t gvw	NA
	With 2 x Self-steer axles	
4x2 and twin-axle semi-trailer standard height, 34t gvw	NA	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer standard height, 40t gvw	NA	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer 4.9m height, 40t gvw	NA	Tri-axle, 4.9m height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 40t gvw	NA	Tri-axle, standard height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 44t gvw	NA	Tri-axle, standard height, 44t gvw
6x2 and tri-axle semi-trailer 4.9m height, 44t, gvw	NA	Tri-axle, 4.9m height, 44t gvw
	With 1 x Command-steer axle	
4x2 and twin-axle semi-trailer standard height, 34t gvw	NA	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer standard height, 40t gvw	NA	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer 4.9m height, 40t gvw	NA	Tri-axle, 4.9m height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 40t gvw	NA	Tri-axle, standard height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 44t gvw	NA	Tri-axle, standard height, 44t gvw
6x2 and tri-axle semi-trailer 4.9m height, 44t, gvw	NA	Tri-axle, 4.9m height, 44t gvw
	With 2 x Command-steer axles	
4x2 and twin-axle semi-trailer standard height, 34t gvw	NA	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer standard height, 40t gvw	NA	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer 4.9m height, 40t gvw	NA	Tri-axle, 4.9m height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 40t gvw	NA	Tri-axle, standard height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 44t gvw	NA	Tri-axle, standard height, 44t gvw
6x2 and tri-axle semi-trailer 4.9m height, 44t, gvw	NA	Tri-axle, 4.9m height, 44t gvw

		With Active Steering axles
4x2 and twin-axle semi-trailer standard height, 34t gvw	Tri-axle, standard height, 40t gvw	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer standard height, 40t gvw	Tri-axle, standard height, 40t gvw	Tri-axle, standard height, 40t gvw
4x2 and tri-axle semi-trailer 4.9m height, 40t gvw	Tri-axle, 4.9m height, 40t gvw	Tri-axle, 4.9m height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 40t gvw	Tri-axle, standard height, 40t gvw	Tri-axle, standard height, 40t gvw
6x2 and tri-axle semi-trailer standard height, 44t gvw	Tri-axle, standard height, 44t gvw	Tri-axle, standard height, 44t gvw
6x2 and tri-axle semi-trailer 4.9m height, 44t, gvw	Tri-axle, 4.9m height, 44t gvw	Tri-axle, 4.9m height, 44t gvw

When converting loads to longer semi-trailers, the existing tonnes per vehicle ratios have been scaled up (or down) accordingly. For cargo that is volume-constrained and not weight-constrained, the tonnes per vehicle ratios could have been scaled up in line with the extra volume availability i.e. 15.4% or a scaling factor of 1.15 (i.e. 30 pallets/26 pallets) for the +2.05m options. However, it was felt that this would overstate the benefits available as some loads will currently be on the verge of being mass-constrained and so will not be able to be expanded that much. Based on data collected from the evidence gathering exercise[10], we have assumed 90% of the potential payload capacity increase for the +2.05m options (13.8% or a scaling factor of 1.14 i.e. 90% of 15.4%).

Some operations may currently despatch partially loaded vehicles i.e. neither weight nor volume-constrained. For example, some supermarkets will receive 5-6 full vehicle loads per day, with a further part-load to complete that day's stock replenishment requirements. At present, due to current length restrictions, it may not be possible to combine two part-loads onto one delivery vehicle. The ability to use longer semi-trailers will provide some opportunities to combine two part-loads onto one delivery vehicle, however, this will not be possible on all occasions. As a result, some trips undertaken with a longer semi-trailer are likely to be less efficient than today. Given this position, for neither weight nor volume-constrained goods, we have utilised a lower increase in tonnes per vehicle, compared with volume-constrained and not weight-constrained operations. This is 50% of the potential payload capacity increase for the +2.05m options (7.7% or a scaling factor of 1.08 i.e. 50% of 15.4%).

For weight-constrained traffic, the tonnes per vehicle ratios have been reduced to account for the heavier tare weight of the longer semi-trailers. We have therefore assumed a worsening of cargo per HGV, equal to the percentage loss of payload.

In terms of modelling empty running, the following approach was adopted:

[10] Data from shippers showing that volume-constrained cargo is generally at full-load

- Uses the CSRGT data to calculate the percentage of vehicle-km empty running, disaggregated by vehicle type etc;
- Temporarily discard all empty vehicle-km;
- Modelled the switch to longer semi-trailers as described above; then
- Add in the empty-vehicles again at the end using the percentage empty running figures derived from CSRGT for the appropriate longer-semi-trailer combination.

Output: For each option, a C*entral Case* forecast (and sensitivity tests) of road freight activity in 2015, 2020 and 2025 in the six categories by:

- Annual tonnes lifted;
- Annual tonne-km;
- Annual vehicle-km;
- Annual vehicle trips; and
- Vehicle type – both existing length and longer semi-trailers.

4.6.2 Take-up Rates for Longer Semi-trailers – The Plausible High and Low Scenarios

In addition to the Central Case (and sensitivity tests), it was deemed appropriate to produce a High and Low Estimate. This has been undertaken using the same approach described above, but with differing distance threshold and take-up percentages within each category. These are shown in the table below.

	Plausible Low	Plausible High
Distance Threshold	150km	100km
Switch % Cat 1	50%	100%
Switch % Cat 2	0%	75%
Switch % Cat 3	50%	100%
Switch % Cat 4	0%	75%
Switch % Cat 5	0%	25%
Switch % Cat 6	0%	10%

For the Plausible Low scenario, evidence (and background knowledge) indicates that retailers deliver to a range of outlets with varying access restrictions. However, for operational flexibility reasons operators like to maintain (as near as possible) uniform fleets of semi-trailers (in terms of length). Adding another (longer) semi-trailer size into the fleet mix, for what would potentially be a minority of deliveries, may diminish operational flexibility and minimise/eliminate any efficiency improvements which could be achieved from their introduction. On this basis, operators may decide not to introduce longer semi-trailers for retail deliveries. This has a consequent knock-on effect on take-up rates for trunking operations, which often utilise empty delivery vehicles for backloads into NDCs/RDCs.

Output: For each option, a *High* and *Low* forecast of road freight activity in 2015, 2020 and 2025 in the six categories by:

- Annual tonnes lifted;
- Annual tonne-km;
- Annual vehicle-km;
- Annual vehicle trips; and
- Vehicle type – both existing length and longer semi-trailers.

4.6.3 Take-up Rates for Longer Semi-trailers – Single Deck Only Scenario

It may be the case that a longer semi-trailer will need to be height restricted (i.e. limited to single deck) in order to comply with other regulations or the actual performance of existing maximum-length semi-trailers e.g. a longer double-deck semi-trailer may be less stable in high cross-winds. On that basis, it was deemed appropriate that a further scenario should be undertaken, where longer semi-trailers were restricted to single-deck equipment only (4.0m overall height, in-line with EU free-circulation rules).

As detailed above, the take-up rate analysis has assumed that goods currently moved on a single-deck semi-trailer will switch to a single-deck longer semi-trailer, and similarly traffic on existing double-deck equipment switches to longer semi-trailers. Effectively, it assumes that single-deck and double-deck operations are independent markets. Anecdotal and statistical evidence broadly supports this assumption, as double-deck semi-trailers are largely confined to moving consumer cargo (which is volume-constrained) on longer distance inter-depot trunking operations. On this basis, in the event that a height limit were imposed for longer semi-trailers, it is therefore unlikely that cargo currently moved on a double-deck semi-trailer would switch to a longer single-deck vehicle, as the longer semi-trailer would offer less capacity compared with 13.6m length double-deck equipment.

Given this position, double-deck semi-trailer equipment is largely in competition with domestic intermodal rail freight, particularly on Anglo-Scottish routes. Analysis of the CSRGT data (Section 4.2) indicates that 4% of our in-scope tonnage is currently moved on double-deck semi-trailers. However, taking the above into account and only considering in-scope traffic moving over 200km, the double-deck market share increases to 6%. By only considering ‘Miscellaneous Manufactures’ and ‘Miscellaneous Articles’ traffic moving on Anglo-Scottish routes, the share of traffic on double-deck equipment increases to around 26%. Applying this to the domestic intermodal rail market, therefore, we have assumed that around 30% of the forecast domestic rail traffic would be in competition with double-deck HGVs and 70% will be in competition with single-deck HGVs. This forms the basis of the mode-share modelling of this scenario.

For the existing length intermodal unit options, the following has been applied:

- 30% of forecast domestic rail traffic is unaffected, as introducing longer semi-trailers does not impact on the competitive position of road and rail (30% of baseline forecasts); and
- 70% of forecast domestic rail traffic is liable to mode shift to road – and this has been modelled as described above in line with the already-run scenarios.

For the longer length intermodal unit options, the following has been applied:

- For the 30% of forecast domestic rail traffic that is in competition with double-deck HGVs, rail costs would reduce (due to longer intermodal units) but road costs would remain unchanged. This would see a mode switch to rail. This section of the market has therefore been re-modelled, using cost inputs for longer intermodal units; and
- For the remaining 70% of forecast domestic rail traffic that is in competition with single-deck HGVs, both road and rail costs would reduce - and this has been modelled as described above in line with the already-run scenarios.

Output: a forecast of road freight activity in 2015, 2020 and 2025 in the six categories by:

- Annual tonnes lifted;
- Annual tonne-km;
- Annual vehicle-km;
- Annual vehicle trips; and
- Vehicle type – both existing length and longer semi-trailers.

Output: forecast of Domestic intermodal rail freight activity in 2015, 2020 and 2025 by*:*

- Annual tonnes lifted; and
- Annual tonne-km.

4.7 Direct Cost to Industry: Forecast Total Annual Operating Costs 2015, 2020 and 2025 with Longer Semi-trailers

The next stage in the analysis was to estimate the total annual operating costs of road freight activity for the forecast years in the identified sectors and markets, on the basis that longer semi-trailer equipment is introduced as described above (Central Case, Low, High and Single Deck scenarios). The total annual cost of moving goods by domestic intermodal rail freight in the forecast years was also calculated. Essentially the combined figures will represent the forecast total direct cost to industry of moving goods in the identified sectors. They can then be compared with the future do-nothing (baseline) scenario, enabling the change in transport costs over the medium/long term to be established given longer semi-trailers being introduced. Lower transport costs for the longer semi-trailer scenarios would therefore represent a direct cost benefit to industry, while higher costs would generate a cost penalty to industry.

One of the underlining rationales for longer semi-trailer equipment is that their additional cargo capacity will result in an overall reduction in the number of HGV trips and HGV kilometres nationally. Given this outcome, we should expect the introduction of longer semi-trailer equipment to generate direct cost benefits to industry, when compared with a 'do-nothing' scenario.

Calculating the total annual operating costs of road freight activity in the forecast years essentially followed the same methodology as outlined in Sections 4.3 and 4.5 above. However, in this case the 2015, 2020 and 2025 traffic forecast outputs described above were utilised along with the appropriate longer semi-trailer vehicle cost models as outlined in Section 4.1 (and appropriate existing length operating costs for traffic which does not switch).

Output: An estimate of total annual operating costs of road freight activity for the forecast years 2015, 2020 and 2025 in the identified sectors and markets for each scenario. Similarly, the total annual cost of moving goods by domestic intermodal rail freight in the forecast years was also estimated. The sum of both figures represents forecast total transport costs (total direct cost to industry) in the identified markets and sectors for each scenario. These can then be compared with the Baseline position.

4.8 Direct Cost to Industry: Calculation of Cost Benefits or Cost Penalty and Net Present Value

The next stage in the analysis was to calculate the total cost benefits or cost penalty that would directly accrue to industry following the introduction of longer semi-trailers, for each of the 14 options covered by the Central case, High, Low and Single Deck scenarios. This has been simply calculated as follows for each of the forecast years 2015, 2020 and 2025:

- Baseline total annual transport cost – Total annual transport cost for scenario = Annual direct cost benefit or penalty to industry

A positive result would consequently represent a cost benefit to industry for that particular option or scenario. On the basis that longer semi-trailers are introduced from 2011, the annual cost benefit or penalty in each year up to 2025 has subsequently been calculated by interpolating between the calculated values for the forecast years 2015, 2020 and 2025. The sum of the annual cost benefit in each year up to 2025, for each option and scenario, has then been expressed as a Net Present Value (NPV) using a discount rate of 3.5%.

4.9 Calculation of Environmental Costs for Baseline and Longer Semi-trailer Scenarios

The operation of freight transport equipment (both road and rail) generates wider environmental impacts, such as noise, pollution, accidents and Carbon Dioxide emissions. It is possible to value these impacts in monetary terms (environmental cost).

One of the underlining rationales for longer semi-trailer equipment is that their additional cargo capacity will result in a reduction of HGV traffic on the national road network. On inter-depot trunking, the evidence gathering exercise showed that, overall, a reduction of around *10-15% of HGV trips and HGV kilometres* can be expected on such operations given the introduction of longer semi-trailer equipment (see Section 4.6 of Deliverable 4 – Evidence Gathering Exercise Report). For industry, this reduction is likely to manifest itself in direct cost benefits as described above.

This reduction in HGV-kilometres nationally could therefore lead to lower environmental costs (or environmental benefits, similar to when cargo switches from road to rail), assuming that the environmental impact of a longer semi-trailer goods vehicle is broadly similar to an existing length HGV. Alternatively, further environmental impacts could be incurred if a longer semi-trailer goods vehicle had a significantly greater environmental impact compared with an existing length vehicle. Clearly, the value (in monetary terms) of these wider environmental impacts needs to be established, as this will then allow the overall economic impact to be established.

The next stage in the analysis, therefore, has been to estimate the total environmental costs of each scenario i.e. Baseline, Central Case, High, Low and Single Deck (and sensitivity tests 1 to 4). The Deliverable 6: Impact Assessment report describes in detail the methodology which has been adopted to undertake this environmental assessment task based on costing each individual external environmental impact. In brief, this has been undertaken using the following approach:

- Estimation of total HGV kilometres by road type for the Baseline position i.e. longer semi-trailers not introduced, in each of the forecast years. This has been undertaken using the GBFMv5's route assignment programme;
- Estimation of total HGV kilometres by road and vehicle type (existing and longer) for the Central Case, High, Low and Single Deck scenarios (and sensitivity tests 1 to 4) in each of the forecast years;
- Applying environmental cost values (on a per kilometre basis) to the total HGV kilometres by road and vehicle type, in order to value the overall environmental costs for the Baseline, longer semi-trailer scenarios and the sensitivity tests;
- Comparing the Baseline and longer semi-trailer scenarios results in order to establish whether the introduction of longer semi-trailers will generate environmental benefits

(i.e. lower environmental costs compared with the Baseline) or additional environmental costs (i.e. higher environmental costs compared with the Baseline).

Assuming a start year of 2011, the total annual environmental cost in each year up to 2025 has subsequently been calculated by interpolating between the calculated values for the forecast years 2015, 2020 and 2025. The consequent environmental benefits or additional environmental costs can therefore be calculated as follows:

- Environmental Cost for Baseline – Environmental Cost for Longer Semi-trailers = Environmental Benefits (if positive) or Additional Environmental Costs (if negative)

The sum of the benefits/costs in each year up to 2025, for each option, has then been expressed as a Net Present Value (NPV) using a discount rate of 3.5%.

Quantifying the overall environmental cost of operating a standard articulated HGV is undertaken by reference to six components of environmental impact, namely:

- Congestion;
- Accidents;
- Noise;
- Pollution;
- Climate Change; and
- Infrastructure.

Each environmental impact component has a calculated value by road type on a per distance basis. Multiplying the distance travelled on a particular type of road by the value of each category, and summing the resultant costs for each category produces the overall environmental impact in monetary terms of operating a standard articulated HGV on that type of road.

The DfT supplied the latest environmental cost values for each category, as currently used by the Department for their internal analysis. The cost values were originally supplied on a 'per HGV mile' basis and in 2010 costs. These values were subsequently re-calculated on a 'per HGV-km' basis (divide by 1.61) and into 2009 costs (based on GDP deflator series, which states a 2.75% inflation increase from 2009 to 2010 – Source: HM Treasury). The *Congestion* component of the latest environmental cost values are slightly lower than previous rates used, in order to reflect the general impact of the recession on trade and traffic flows (83% reduction for 2010, 80% reduction for 2015 and 83% reduction for 2025 compared with previous values).

The environmental cost values utilised did not include indirect taxation. Table A1 in the Annex shows the values for the years 2010, 2015, 2020 and 2025 of each component by road type.

For longer semi-trailer equipment, the following environmental impact components were adjusted:

- Pollution – proportionally increased in-line with their additional fuel consumption;
- Climate Change – proportionally increased in-line with their additional fuel consumption; and
- Congestion – increase of 4.14% for the +2.05m semi-trailers and 2.02% for the +1.0m semi-trailers.

The higher value for the congestion component reflects a longer semi-trailer occupying marginally more road capacity. The increase is based on 1/3 of the extra length as a proportional increase e.g. for a +2.05m semi-trailer, the overall length increase of the HGV is from 16.5m to 18.55m, an increase of 12.42%, with 1/3 of the length increase therefore being 4.14%.

A similar process was undertaken for rail freight. For freight trains, however, only the following environmental impact components are considered:

- Noise;
- Local air pollution; and
- Climate Change.

Output: Estimate of the total environmental costs of each scenario i.e. Baseline, Central Case, High, Low and Single Deck (and sensitivity tests 1 to 4).

There is no available body of empirical evidence on the impacts on congestion of the length increase of longer semi-trailers, so that it needs to be considered by assembling indirect evidence on how its impacts would differ from a standard articulated HGV.

- Experience from the longer semi-trailer tests in Germany and Italy suggested that many of the public did not notice the increase in length of the test vehicles so that longer semi-trailers are unlikely to have a disproportionately large impact on congestion;
- As is the case for standard large articulated HGVs[11], the longer semi-trailers are likely to be relatively uncommon in dense urban areas. It is particularly these types of

[11] Transport Statistics Great Britain 2009, table 7.4, shows that articulated HGVs comprise only 0.4% of the vehicle traffic on urban roads, whereas they comprise 2.8% of traffic across Great Britain as a whole.

areas in which the length of tailbacks at junctions would be directly influenced by the length of the vehicle;

- In mixed traffic that is starting and stopping, as experienced in highly congested conditions, it will be the rate of acceleration and deceleration of the goods vehicle relative to a light vehicle that matters – this rate is likely to be similar for longer semi-trailers and standard articulated HGVs so little difference in impacts would be expected; and
- In mixed fairly heavy traffic that is still running smoothly there should be a substantial gap between each moving vehicle for reasons of safety. The proportionate increase in total lane length required per longer semi-trailer, relative to that per standard articulated HGV, is likely to be quite small in comparison to the proportionate difference in their lengths; accordingly the difference in their congestion impacts will be relatively small.

Drawing these strands together, suggests that most of their driving time under reasonably congested conditions would be in circumstances in which the difference in impacts would be relatively small. Accordingly, a rough estimate of an increased impact of one-third the percentage increase in total vehicle length seems appropriate. It should also be noted that both the DfT and TRL have researched this area too and found little useful evidence.

Given this position, it was deemed sensible to undertake some *sensitivity tests* on the congestion component value for longer semi-trailers. The following sensitivity tests have therefore been undertaken (on the Central Case scenario environmental cost results only):

- Sensitivity test 5: Zero change to longer semi-trailer congestion cost component;
- Sensitivity test 6: congestion cost component adjusted to reflect 1/6 of the extra length as a proportional increase;
- Sensitivity test 7: congestion cost component adjusted to reflect 3/6 of the extra length as a proportional increase; and
- Sensitivity test 8: congestion cost component adjusted to reflect 4/6 of the extra length as a proportional increase.

Output: Estimate of the total environmental costs for sensitivity tests 5 to 8.

4.10 Sensitivity Tests 9 and 10

Sensitivity Test 9 – Generated Demand

The above analysis has been undertaken on the basis that transport costs form a small proportion of the overall total cost of goods. As a result, total cargo demand is assumed to remain constant, with changes in modal transport costs effectively determining which mode particular freight flows utilise (i.e. zero elasticity) e.g. as road transport becomes more expensive relative to rail, there is mode switch away from road freight to the intermodal sector, though the total amount of cargo lifted will remain constant.

However, lower overall transport costs may subsequently manifest themselves in the form of reduced prices for consumer goods. The retail market in Britain is highly competitive, with many retailers seeking to reduce costs and offer products at a lower price than their competitors. Lower transport costs could, therefore, be passed on to consumers as part of these price reduction strategies. Lower product costs resulting from falling transport prices could therefore stimulate extra demand for consumer goods.

A sensitivity test has therefore been undertaken in order to measure the impact of generated demand due to lower transport costs (which are the result of introducing longer semi-trailer equipment). An elasticity of -0.1 has therefore been applied to the overall tonne-kilometres with respect to transport costs. The above cost calculations were then effectively repeated but using the new generated demand figures.

Sensitivity Test 10 – Improved Train Productivity

For the main scenarios tested, train productivity is assumed to be constant through to 2025 i.e. 14 x IKA Megafret wagons per train. This formation is currently the longest train permitted on Anglo-Scottish services via the West Coast Mainline (WCML) when hauled by diesel traction (as explained earlier, due to the steep gradients at Shap and Beatock summits). In practice, however, train lengths may increase over time, either through a small increase in the deployment of electric locomotives (which are more powerful and therefore able to haul longer trains on the steeper sections of the WCML) or the use of more powerful diesel traction (e.g. the new Class 70s diesel locomotives). Operating a longer train would have the affect of reducing per unit transport costs.

The impact of this has therefore been assessed through a sensitivity test. Effectively, a further rail freight forecast was undertaken for 2019 and the relevant forecast years (as above). The above cost calculations were also then repeated (for Central Case only) but using the new rail freight demand figures.

Despite recent announcements concerning the electrification of some key routes (Great Western Mainline and some ‘infill’ schemes in the North West), diesel locomotives are likely to remain the primary traction solution for freight operators for some years to come. Recent investment in traction has been in diesel rather than electric locomotives (e.g. Class 70s). The sensitivity test has therefore not considered a more widespread use of electric traction to improve train productivity.

However, the new Class 70 locomotives are more powerful than the Class 66 (2,750kW for a Class 70 compared with 2,500kW for a Class 66). Freightliner have recently commenced trials with the new Class 70s hauling longer intermodal trains, testing a 30 x 18.25m wagon train from the Port of Felixstowe (standard current formation being 24 x 18.25m wagons) i.e. a 25% increase in trailing length. On that basis, the train formation assumed in the model through to 2025 has been increased by a similar amount to 17 x IKA Megafret wagons per train. It has been assumed that all other costs, including locomotive fuel consumption, will also remain as per 2009 rates.

4.11 Calculation of Total Economic Impact

Once the environmental impact of introducing longer semi-trailer equipment has been established and valued (for each scenario and relevant sensitivity test), the total economic impact can be estimated. This calculation is undertaken as follows:

- Total Economic Impact = Direct Industry Benefits or Cost Penalty + Value of Environmental Benefits or Additional Environmental Costs

One of three broad outcomes can be expected, namely:

- Direct cost benefits for industry and environmental benefits, resulting in an overall economic benefit;
- Direct cost benefits for industry and additional environmental costs. However, the additional environmental costs are less than the direct industry benefits, meaning that there will be an overall economic benefit; or
- Direct cost benefits for industry and additional environmental costs. However, the additional environmental costs are more than the direct industry benefits, meaning that overall there is a negative economic impact.

The first outcome could be described as the ‘win-win’ result, as it generates both industry cost benefits and environmental benefits (and should signal the introduction of longer semi-trailer equipment). The third outcome, while generating industry benefits, would produce an overall negative economic impact on wider society when all factors are considered (and would probably result in a decision against their introduction). The second outcome may need to consider other factors before a judgement is reached.

The estimation of direct industry costs/benefits has included indirect taxation and rail freight grants, specifically Vehicle Excise Duty (for road transport), Fuel Duty (for both road and rail, albeit at a lower rate for rail freight) and MSB grants for rail freight. The direct industry cost/benefit assessment has also included National Insurance Contributions (NICs), which is a form of direct taxation. In this respect, excise duties and NICs are unavoidable costs which have to be incurred by industry (they are included in the vehicle cost models as described in Section 4.1). They therefore need to be accounted for when the direct cost impact to industry is established (i.e. cost to industry alone and without considering the wider impacts). Rail freight grants should also be considered in a similar manner.

However, it is standard practice when undertaking impact assessments (i.e. cost to industry and wider impacts combined) to consider changes to business costs net of taxation (i.e. direct and indirect taxation removed). The environmental cost calculations are undertaken without indirect taxation. On this basis, the taxation elements of the established direct industry benefits need to be removed before the above calculation can be undertaken.

The Green Book and Impact Assessment guidance states that only where taxes are materially different between options they need to be considered. For this assessment, this effectively means excise duties and rail grants. This is due to the differing rates of fuel duty between road and rail, that rail does not have to pay vehicle excise duty for railway rolling stock but that it can claim grant funding for some flows. NICs are likely to be broadly common across the range of options/scenarios being considered. National Insurance has therefore not been removed.

Given this position, the tasks undertaken in Sections 4.3, 4.5 and 4.7 above were re-run but using versions of the cost model net of excise duties and rail freight grants. This has enabled the direct cost benefits to industry net of indirect taxation to be established. The total economic impact has then been calculated for each scenario and sensitivity test as described above.

On the basis that longer semi-trailers are introduced from 2011, the total economic impact result for each year up to 2025 has subsequently been calculated by interpolating between the calculated values for the forecast years 2015, 2020 and 2025. The sum of the impact in each year up to 2025, for each option and scenario, has then been expressed as a Net Present Value (NPV) using a discount rate of 3.5%.

4.12 Summary of Scenarios and Sensitivity Tests

The table below presents a summary of the Scenarios and Sensitivity Tests Undertaken.

MAIN SCENARIOS							
Base Case	Do-nothing, longer semi-trailers not introduced. Modelled costs of existing length HGVs and intermodal units to 2025 – Base Line position against which to compare longer semi-trailer Scenarios and Sensitivity Tests.						
	Long/Short Distance Threshold (km)	Switch % Cat 1	Switch % Cat 2	Switch % Cat 3	Switch % Cat 4	Switch % Cat 5	Switch % Cat 6
Central Case	120	90	45	90	45	20	5
	'Best Estimate' – the main forecast and scenario against which other scenarios and tests can be compared						
Plausible High	100	100	75	100	75	25	10
	Higher take-up rates in each category and lower long/short distance threshold						
Plausible Low	150	50	0	50	0	0	0
	Lower take-up rate in each category and higher long/short distance threshold						
Single Deck only	120	90	45	90	45	20	5
	Restricted longer semi-trailers to single deck only						

SENSITIVITY TESTS
(on Central Case only)

	Long/Short Distance Threshold (km)	Switch % Cat 1	Switch % Cat 2	Switch % Cat 3	Switch % Cat 4	Switch % Cat 5	Switch % Cat 6
Test 1	150	90	45	90	45	20	5
	Higher long/short distance threshold, take-up rates remain as per Central Case						
Test 2	100	90	45	90	45	20	5
	Lower long/short distance threshold, take-up rates remain as per Central Case						
Test 3	120	90	35	90	35	20	5
	Lower take-up rates in Categories 2 and 4						
Test 4	120	90	55	90	55	20	5
	Higher take-up rates in Categories 2 and 4						
Test 5	120	90	45	90	45	20	5
	Environmental costs: Zero change to longer semi-trailer congestion cost component						
Test 6	120	90	45	90	45	20	5
	Environmental costs: Longer semi-trailer congestion cost component adjusted to reflect 1/6 of additional length						
Test 7	120	90	45	90	45	20	5
	Environmental costs: Longer semi-trailer congestion cost component adjusted to reflect 3/6 of additional length						
Test 8	120	90	45	90	45	20	5
	Environmental costs: Longer semi-trailer congestion cost component adjusted to reflect 4/6 of additional length						
Test 9	120	90	45	90	45	20	5
	Generated demand due to lower transport costs. Elasticity of -0.1 for overall tonne-km						
Test 10	120	90	45	90	45	20	5
	Intermodal train productivity increased i.e. longer trains						

5. SUMMARY OF RESULTS

This section summarises the results of the above tasks and modelling exercises. A number of summary tables are presented below, while a *Technical Annex* contains more detailed data tables. Tables in the Annex are referenced in the format *Table Ax.*

5.1 Road Cost Model Outputs

Capital Costs

Table A2 compares the capital costs of existing tractor unit/semi-trailer combinations with longer semi-trailer equipment. Existing equipment capital costs have been verified through the evidence gathering exercise. Longer equipment costs are based on discussions with trailer manufacturers. The main points to note are:

- A 14.6m tri-axle semi-trailer (standard height) with fixed axles would cost around £500 more compared with an existing 13.6m tri-axle semi-trailer, or £2,500 more compared with existing twin-axle equipment;
- For a 15.65m semi-trailer and taking into account the various axle steering systems, the capital costs are around £6,000-£7,000 higher compared with an existing tri-axle semi-trailer.
- The lowest capital cost solution for 15.65m length equipment is a single command-steer axle.

Operating Costs

Table A3 presents the estimated operating costs of existing tractor unit/semi-trailer combinations in the current year and estimated costs in the forecast years based on the assumptions outlined in Section 4.1.2. Fixed operating costs per hour are forecast to increase by around £4-£5 in real terms (13%-14%). Running costs are forecast to increase by around £0.01-£0.02 per km in real terms (5%). Based on the do-nothing option, therefore, we should expect vehicle operating costs to increase by around 10%-11% in real terms by 2025 on a per kilometre and per pallet-km basis.

Tables A4 and A5 present the estimated operating costs of tractor unit/longer semi-trailer combinations in the forecast years based on the assumptions outlined in Section 4.1.2, and on the capital costs estimates outlined in Section 4.1.3. Overall, the higher capital costs and additional length (drag) and tare weight of the longer semi-trailers do marginally increase vehicle operating costs. For the forecast year 2015, compared with the existing equivalent outfit, for a standard 6x2 tractor unit and 15.65m semi-trailer plated at 44 tonnes gross, the fixed operating costs (on a per operating hour basis) are estimated to be around £0.40-£0.60

higher per hour (depending on steering axle system), while running costs are estimated to be approximately 2.5% higher.

However, the most important figure to consider is the consequent cost per pallet-kilometre, which is the measure of the vehicle's overall efficiency when fully laden. Due to the longer load-platform capacity, in terms of pallet-kilometre costs a 15.65m semi-trailer combined with a 6x2 tractor unit is forecast to be around 12% more efficient when fully laden. Similarly, a 14.6m semi-trailer is forecast to be around 7% more efficient.

5.2 Existing Freight Flows and Traffic Forecasts for 2015, 2020 and 2025

Tables A6 to A9 present the forecast traffic flows by mode (road and domestic intermodal) in the selected years for the Central Case, Low and High take-up Scenarios (in both tonnes-lifted and tonne-kilometres, and for the existing length and longer length intermodal unit options). The Base Case is the do-nothing option i.e. longer semi-trailers are not introduced. Similarly, Tables A10 and A11 present the forecast traffic flows in the selected years for the Single Deck scenario.

For the existing length intermodal unit options, the main points to note are:

- Under the *Base Case* option, domestic intermodal rail freight is estimated to grow to around 14.3 million tonnes-lifted by 2025 (from 2.0 million tonnes in 2009), with road freight increasing from 430.8 million tonnes-lifted (in 2009) to 450.9 million tonnes lifted by 2025;
- The introduction of longer semi-trailers in the road haulage sector, but with domestic intermodal continuing to use existing length units, results in a switch to road freight transport. For 15.65m semi-trailers, domestic intermodal rail freight would be around 5.1 million tonnes in 2025 (i.e. 9.2 million tonnes-lifted lower compared with the Base Case option);
- Road freight activity is forecast to be around 3.7 billion tonne-km higher by 2025 compared with the Base Case scenario, on the basis that domestic intermodal rail continues to use existing length units.
- Introducing a height limit which restricts longer semi-trailers to single-deck loading also results in a switch to road freight transport (compared with the Base Case) but at a lower rate. For 15.65m semi-trailers at single-deck only, domestic intermodal rail freight would be around 9.1 million tonnes in 2025 (i.e. 5.2 million tonnes-lifted lower compared with the Base Case option).

When interpreting these results, it is important to remember that the traffic forecasts for the longer semi-trailer scenarios assumed that:

- In-scope goods currently moved on an existing length single-deck semi-trailer will switch to a single-deck longer semi-trailer (at the various rates detailed in Section 4); and
- In-scope goods currently moved on an existing length double-deck semi-trailer will switch to a double-deck longer semi-trailer (again, at the various rates detailed in Section 4).

The modelling is therefore based on the assumption that single-deck and double-deck semi-trailer operations are essentially independent markets. Anecdotal and statistical evidence supports this, as double-deck semi-trailers are largely confined to moving consumer cargo on longer distance inter-depot trunking operations. Given a height limit being imposed for longer semi-trailers, it is therefore unlikely that goods currently moved on an existing length double-deck semi-trailer would switch to a single-deck longer semi-trailer, as the longer vehicle would offer less capacity (and therefore higher per unit costs) compared with the 13.6m length double-deck semi-trailer.

However, intermodal rail freight is also in competition with both independent markets, as follows:

- Single deck HGV v intermodal rail; and
- Double deck HGV v intermodal rail.

On that basis, goods moved on an existing length double-deck semi-trailer would either remain on that equipment or switch to intermodal rail if that offered a more competitive option over time (but not to single-deck).

For the *Base Case* scenario, which assumes that longer semi-trailers are not introduced, intermodal rail freight becomes more competitive over time compared with road haulage, primarily due to a growth of warehousing on rail-served sites. As a result, intermodal rail would win traffic from both the single and the double deck road markets (the development of rail-served sites, and the consequent network effect from joining up these developments, lowers the distance at which rail freight becomes competitive, meaning that it is able to win traffic over much shorter distances than previously was the case). As noted above, these intermodal forecasts are consistent with those recently undertaken for DfT-Rail.

For the *Existing Length Intermodal Unit* options (i.e. 1-7) but assuming *no height restriction*, intermodal rail freight's efficiency is static over time compared with the *Base Case* scenario. However, both single and double-deck HGVs improve their efficiency over time (compared with the *Base Case*) due to the length increase, and therefore become more competitive versus intermodal rail. As a result, both of the independent road markets would win traffic from intermodal rail (i.e. the distance at which rail freight becomes competitive increases, meaning that road haulage is able to win traffic over much longer distances than previously was the case).

For the *Existing Length Intermodal Unit* options but assuming *a height restriction* (i.e. single deck longer semi-trailers only), intermodal rail freight's efficiency is again static compared with the *Base Case* scenario. Double-deck HGV efficiency is also static compared with the *Base Case* scenario (as they do not become longer). Consequently, the intermodal rail/double-deck HGV competitive position effectively remains as per the *Base Case*. As a result, compared with the *Base Case* no traffic would switch from intermodal rail to double-deck HGVs (or visa versa). However, single-deck HGVs would improve their efficiency due to the length increase, and therefore would become more competitive versus intermodal rail. Consequently, only this independent market would win traffic from intermodal rail.

This position is reflected in the tonnes-lifted outputs for Options 4-7, the 15.65m length longer semi-trailers (in 2025), as follows:

Options 4-7 in 2025	**Tonnes lifted (million tonnes)**	
	Intermodal Rail	**Road**
Base Case	14.3	450.9
Single-deck HGVs only	7.9	457.3
Single and double-deck HGV	5.1	460.1

Source: Summary of Tables A6 and A10 from Annex

For the single-deck only scenario, the rail traffic (from the *Base Case*) which would otherwise have switched to longer double-deck HGVs remains on rail. However, if longer double-deck equipment is an option, the rail traffic switches to road (along with the traffic which the single-deck market wins from intermodal).

Given the introduction of longer semi-trailers in the road haulage sector and with domestic intermodal *adopting the use of longer intermodal units*, the traffic forecasts suggest a further (marginal) switch to domestic intermodal rail freight (compared with the Base Case). Table A8 shows that for the 15.65m option, rail is forecast to gain an additional 1.0 million tonnes-lifted by 2025 compared with the Base Case option. Similarly, road freight activity is forecast to be around 3.4 million tonne-km lower by 2025.

For the *Longer Length Intermodal Unit* options (i.e. 8-14) but assuming *no height restriction*, intermodal rail freight's efficiency improves over time compared with the *Base Case* scenario due to the length increase. Both single and double-deck HGVs also improve their efficiency over time (compared with the *Base Case*) due to the length increase. However, the efficiency increase for intermodal rail is marginally greater than that for road haulage (both single and double-deck). As a result, intermodal rail would win slightly more traffic from both road haulage markets compared with the *Base Case* (i.e. the distance at which rail freight becomes competitive would fall further, meaning that compared with the Base Case it is able to win more traffic over shorter distances).

This position is further enhanced should longer semi-trailer equipment be restricted in height to single deck vehicles only. For the 15.65m option, Table A11 shows rail is forecast to gain an additional 7.5 million tonnes-lifted by 2025 compared with the Base Case option (21.8 million tonnes-lifted by 2025). Similarly, road freight activity is forecast to be around 2.0 billion tonne-km lower by 2025.

For the *Longer Length Intermodal Unit* options but assuming *a height restriction* (i.e. single deck longer semi-trailers only), intermodal rail freight's efficiency again would improve over time compared with the *Base Case* (as per above). Single-deck HGVs also would improve their efficiency over time (as per above) due to the length increase. Consequently, the intermodal rail/single-deck HGV competitive position would effectively remain as per above. As a result, there is no further traffic switch from single-deck HGVs to intermodal rail.

However, double-deck HGV efficiency would be static compared with the *Base Case* scenario (as they do not become longer). In addition, double-deck HGVs would become less competitive versus intermodal rail (due to its length increase). Consequently, there is further modal shift away from double-deck HGVs to intermodal rail. Effectively, some goods moved on an existing length double-deck semi-trailer would switch to rail as it would offer a more competitive option over time.

This position is again reflected in the tonnes lifted outputs for 15.65m length longer semi-trailers (in 2025):

Options 11-14 in 2025	**Tonnes lifted (million tonnes)**	
	Intermodal Rail	**Road**
Base Case	14.3	450.9
Single-deck HGVs only	21.8	443.4
Single and double-deck HGV	15.3	450.0

Source: Summary of Tables A8 and A11 from Annex

Limiting the height of longer semi-trailers effectively allows rail freight to gain additional efficiency benefits (associated with the greater payload capacity) compared with the road transport market. This results in further modal shift to rail. Assuming the widespread adoption of longer intermodal units, it would appear that, at worst, the impact of longer semi-trailers would be neutral on the domestic intermodal sector, while there may actually be some marginal benefits.

5.3 Direct Costs to Industry

This sub-section summarises the forecast direct total annual operating costs for the Central Case, High, Low take-up and Single Deck scenarios, together with the estimated cost benefits or cost penalty that would directly accrue to industry following the introduction of longer semi-trailers. These costs include indirect taxation, as they are unavoidable costs which have to be incurred by industry.

The Central Case

Tables A12 and A13 present the estimated direct total annual operating costs for the Central Case (differentiated by road and rail) in the forecast years 2015, 2020 and 2025 by vehicle option. These combined figures represent the total direct cost to industry of moving goods in the identified markets and sectors by road transport and domestic intermodal rail freight. Also shown in the tables is the annual cost benefit or cost penalty (in money and percentage terms) for each forecast year compared with the Base Case.

For the existing length intermodal units options (Options 1-7), the estimated annual direct industry benefits in 2025 range from:

- -£34.2 million (i.e. a cost penalty compared with a do-nothing scenario) for 14.6m semi-trailers with fixed axles; through to
- £293 million for 15.65m semi-trailers with one Command-steer axle. This figure represents an annual saving of 2.6% compared to the Base Case option.

For the longer intermodal units options (options 8-14), the estimated annual direct industry benefits in 2025 range from:

- £136 million for 14.6m semi-trailers with Active Steering; through to
- £574.7 million for 15.65m semi-trailers with one Command-steer axle. This figure represents an annual saving of 5.1% compared to the Base Case option.

Table A14 shows the direct financial benefits to industry for each year together with the NPV of the annual benefits from 2011 to 2025. The 14.6m semi-trailer with fixed axles option produces the lowest NPV value at £117.5 million. The 15.65m semi-trailer with one Command-steer axle option generates the highest NPV value at £5,111.5 million.

Central Case: Sensitivity Tests 1 to 4

Tables A15 to A22 present the estimated direct total annual operating costs for Sensitivity Tests 1 to 4 in the forecast years 2015, 2020 and 2025 by vehicle option. Also shown in the tables is the annual change (in money and percentage terms) for each forecast year compared with the Central Case.

Overall, varying the short/long distance cut-off and the take-up rates in Categories 2 and 4 has a marginal impact compared with the Central Case scenario. Accordingly, understanding the broad balance of costs versus benefits from introducing longer semi-trailers is not highly conditional on being able to measure with precision their likely market for take-up.

Low, High and Single Deck Scenarios

Tables A23 to A28 present the estimated direct total annual operating costs for the High, Low take-up and the Single Deck scenarios. Also shown in the tables is the annual change (in money and percentage terms) for each forecast year compared with the Central Case and Base Case scenarios. For the High take-up scenario, the total direct costs are just over 1% lower compared with the Central Case, or around 5.5% lower compared with a do-nothing option.

Tables A29 to A31 show the direct financial benefits to industry for each year for each scenario together with the NPV of the annual benefits from 2011 to 2025.

Summary of Central Case, High, Low and Single Deck Scenarios

The table below shows the estimated direct cost benefits likely to accrue to industry in the year 2025 for each scenario.

Table 5.1: Direct Industry Benefits 2025 for Central, High, Low and Single Deck Scenarios

		£ Millions Annual Direct Benefits 2025 v Base Case			
	Option	**Central**	**High**	**Low**	**Single**
1	14.6m Fixed Axles	-£34.2	-£6.2	-£98.3	-£5.8
2	14.6m Single Self-steer Axle	£94.1	£150.7	-£46.0	£117.6
3	14.6m Active Steering	£49.4	£93.2	-£59.2	£74.9
4	15.65m 2 x Self-steer Axles	£288.6	£421.4	-£44.8	£328.6
5	15.65m 1 x Command-steer Axle	£293.0	£426.9	-£42.7	£332.9
6	15.65m 2 x Command-steer Axles	£263.8	£389.4	-£51.7	£304.9
7	15.65m Active Steering	£230.9	£350.3	-£65.6	£271.0
8	14.6m Fixed Axles	£136.0	£163.4	£73.5	£175.6
9	14.6m Single Self-steer Axle	£260.5	£315.7	£124.0	£295.4
10	14.6m Active Steering	£216.6	£259.4	£110.9	£253.4
11	15.65m 2 x Self-steer Axles	£570.6	£697.5	£253.1	£670.3
12	15.65m 1 x Command-steer Axle	£574.7	£702.7	£255.0	£674.2
13	15.65m 2 x Command-steer Axles	£546.7	£666.7	£246.3	£647.4
14	15.65m Active Steering	£516.1	£630.4	£233.4	£615.8

The 15.65m semi-trailer with single command-steer axle (Option 12) produces the greatest direct benefits to industry in each case. This is essentially due to a combination of the following factors:

- The additional 2.05m generates larger efficiency savings compared with the +1.0m options; and
- The lower capital costs of the single command-steer technology compared with the other steering axle solutions.

The table below shows the NPV of the annual benefits from 2011 to 2025 for each scenario

Table 5.2: NPV of Direct Industry Benefits 2011 to 2025 for Central, High, Low and Single Deck Scenarios

		£ Millions NPV of Direct Benefits 2011-2025			
	Option	**Central**	**High**	**Low**	**Single**
1	14.6m Fixed Axles	£117.53	£367.44	-£455.34	£257.08
2	14.6m Single Self-steer Axle	£1,284.02	£1,792.20	£22.34	£1,379.37
3	14.6m Active Steering	£859.49	£1,246.16	-£103.58	£973.43
4	15.65m 2 x Self-steer Axles	£3,439.52	£4,636.16	£428.21	£3,578.35
5	15.65m 1 x Command-steer Axle	£3,482.30	£4,689.30	£447.89	£3,619.10
6	15.65m 2 x Command-steer Axles	£3,206.28	£4,335.24	£362.60	£3,355.24
7	15.65m Active Steering	£2,892.66	£3,962.86	£230.71	£3,032.32
8	14.6m Fixed Axles	£1,100.44	£1,346.70	£536.63	£1,304.25
9	14.6m Single Self-steer Axle	£2,244.83	£2,745.23	£1,004.18	£2,405.20
10	14.6m Active Steering	£1,825.31	£2,206.05	£878.30	£2,003.65
11	15.65m 2 x Self-steer Axles	£5,070.51	£6,233.69	£2,150.20	£5,550.36
12	15.65m 1 x Command-steer Axle	£5,111.48	£6,284.81	£2,168.59	£5,589.14
13	15.65m 2 x Command-steer Axles	£4,842.47	£5,939.76	£2,084.97	£5,331.56
14	15.65m Active Steering	£4,542.55	£5,583.79	£1,958.60	£5,022.61

As above, the 15.65m semi-trailer with single command-steer axle produces the greatest direct benefits to industry in each case.

From the above analysis, therefore, we can conclude that industry is likely to achieve significant direct financial benefits following the introduction of longer semi-trailer equipment. This will particularly be the case should the rail freight sector also take advantage of the greater payload capacity offered by longer intermodal units. For option 12 (15.65m semi-trailers combined with longer intermodal units), the Central Case estimates that industry will achieve £5,111.5 million of direct benefits (NPV) over the years 2011 to 2025.

An apparent anomaly can be noted in these economic results; that industry benefits are slightly greater when a restriction is introduced to only allow single-deck longer semi trailers, as compared to also allowing longer double-deck semi trailers. This appears to be counter-intuitive; it is natural to assume that a restriction would *increase* industry costs.

The economic benefit results have been calculated using the *road and rail cost models* developed for the project (Section 4.1). These are intended to replicate market 'rates' incurred by the logistics industry i.e. pure financial cost. The traffic forecasts and modal split analysis (as described in Section 4.4) use g*eneralised costs*, which account for the quality of service and flexibility characteristics of a particular mode in addition to the actual transport operating costs. For example, between a particular origin and destination intermodal rail freight may offer marginally lower transport rates than road haulage in pure financial terms, however it may have a higher generalised cost given road haulage's in-built flexibility and convenience. Consequently, the cargo will move by road haulage. As a general rule of thumb, the following currently applies:

- Over long distances, intermodal rail has both lower operating costs and generalised costs;
- Over short distances, road haulage has both lower operating costs and generalised costs; and
- Over medium distances, intermodal rail has marginally lower operating costs but marginally higher generalised costs.

In this particular case, the difference in the scenarios is largely within the medium and long distance market that chooses between double-deck semi-trailers and rail. If a restriction is introduced such that longer double-deck semi-trailers are not allowed, there is a mode-switch to rail which has lower operating costs over these medium/long distances, and therefore overall operating costs decrease. Without the restriction, this traffic goes by road (on a longer double-deck semi-trailer). Road is more expensive than rail in pure *financial* terms but was the chosen mode because its *generalised costs* were lower i.e. quality of service and flexibility characteristics encouraged the use of road even though the financial (operating) costs were higher.

The development of rail-served warehousing and other factors (without road haulage becoming more efficient) will over time lower the distance at which rail freight becomes more competitive than road haulage, both in terms of operating costs and generalised costs. Conversely, the introduction of longer semi-trailers (without a similar response by intermodal rail freight) will increase the distance at which rail freight becomes more competitive than road haulage.

5.4 Environmental Benefits and Total Economic Impact

Assessing direct economic benefits for industry is only part of the equation and the wider impact also needs to be assessed and quantified.

As noted above, the estimation of direct industry costs/benefits has included indirect taxation. However, it is standard practice when undertaking impact assessments (i.e. cost to industry and wider impacts combined) to consider changes to business costs net of taxation (i.e. direct and indirect taxation removed). On this basis, the taxation elements of the estimated direct industry benefits were removed. Tables A32 to A35 therefore show the direct industry benefits net of indirect taxation for each year, together with the NPV of the benefits 2011 to 2025 for the Central, High, Low and Single Deck scenarios. The table below summarises the NPV of the direct industry benefits net of indirect taxation for each scenario.

Table 5.3: NPV of Direct Industry Benefits 2011 to 2025 (net of indirect taxation) for Central, High, Low and Single Deck Scenarios

		£ Millions			
		NPV of Direct Benefits 2011-2025 (net indirect tax)			
	Option	**Central**	**High**	**Low**	**Single**
1	14.6m Fixed Axles	£519.52	£777.71	-£72.87	£550.04
2	14.6m Single Self-steer Axle	£1,592.19	£2,094.34	£357.30	£1,582.10
3	14.6m Active Steering	£1,177.10	£1,560.81	£231.38	£1,185.22
4	15.65m 2 x Self-steer Axles	£3,541.15	£4,625.95	£859.09	£3,507.84
5	15.65m 1 x Command-steer Axle	£3,586.72	£4,682.79	£878.78	£3,551.28
6	15.65m 2 x Command-steer Axles	£3,314.96	£4,334.37	£793.48	£3,291.50
7	15.65m Active Steering	£3,002.34	£3,963.31	£661.60	£2,969.54
8	14.6m Fixed Axles	£1,068.52	£1,349.88	£485.52	£1,127.25
9	14.6m Single Self-steer Axle	£2,121.25	£2,616.49	£906.65	£2,140.03
10	14.6m Active Steering	£1,710.82	£2,091.11	£780.66	£1,747.19
11	15.65m 2 x Self-steer Axles	£4,449.07	£5,393.61	£1,844.35	£4,565.14
12	15.65m 1 x Command-steer Axle	£4,492.68	£5,560.37	£1,862.71	£4,606.43
13	15.65m 2 x Command-steer Axles	£4,227.69	£5,221.04	£1,779.04	£4,352.69
14	15.65m Active Steering	£3,928.72	£4,865.51	£1,652.66	£4,044.65

Tables A32 to A35 also show the environmental benefits for the Central, High, Low and Single Deck scenarios, as calculated using the methodology outlined in Section 4.9. Further environmental results on comparisons of CO2 equivalent emissions between options are presented in Deliverable 6: Impact Assessment report. The table below summarises the NPV of the environmental benefits for each scenario.

Table 5.4: NPV of Environmental Benefits 2011 to 2025 (net of indirect taxation) for Central, High, Low and Single Deck Scenarios

		£ Millions			
		NPV of Environmental Benefits 2011-2025			
	Option	**Central**	**High**	**Low**	**Single**
1	14.6m Fixed Axles	-£150.50	-£49.64	-£428.01	£28.60
2	14.6m Single Self-steer Axle	£357.74	£547.82	-£194.12	£515.69
3	14.6m Active Steering	£334.22	£516.70	-£194.12	£493.03
4	15.65m 2 x Self-steer Axles	£794.13	£1,170.54	-£297.85	£1,082.45
5	15.65m 1 x Command-steer Axle	£787.09	£1,161.22	-£297.85	£1,075.67
6	15.65m 2 x Command-steer Axles	£776.36	£1,147.03	-£297.85	£1,065.34
7	15.65m Active Steering	£773.85	£1,143.70	-£297.85	£1,062.92

8	14.6m Fixed Axles	£587.52	£686.21	£315.98	£831.91
9	14.6m Single Self-steer Axle	£1,084.68	£1,270.68	£544.70	£1,308.37
10	14.6m Active Steering	£1,061.28	£1,239.84	£544.30	£1,285.75
11	15.65m 2 x Self-steer Axles	£2,018.33	£2,380.93	£966.38	£2,649.85
12	15.65m 1 x Command-steer Axle	£2,011.43	£2,371.85	£966.26	£2,643.17
13	15.65m 2 x Command-steer Axles	£2,000.92	£2,358.00	£966.08	£2,632.99
14	15.65m Active Steering	£1,998.46	£2,354.76	£966.04	£2,630.60

Tables A32 to A35 also show the overall economic impact for the Central, High, Low and Single Deck scenarios, as calculated using the methodology outlined in Section 4.11. The table below summarises the NPV of the total economic benefits for each scenario.

Table 5.5: NPV of Total Economic Benefits 2011 to 2025 (net of indirect taxation) for Central, High, Low and Single Deck Scenarios

		£ Millions NPV of Total Economic Impact 2011-2025			
	Option	**Central**	**High**	**Low**	**Single**
1	14.6m Fixed Axles	£369.01	£728.07	-£500.88	£578.65
2	14.6m Single Self-steer Axle	£1,949.93	£2,642.16	£163.17	£2,097.79
3	14.6m Active Steering	£1,511.32	£2,077.51	£37.25	£1,678.25
4	15.65m 2 x Self-steer Axles	£4,335.28	£5,796.49	£561.25	£4,590.30
5	15.65m 1 x Command-steer Axle	£4,373.81	£5,844.02	£580.93	£4,626.95
6	15.65m 2 x Command-steer Axles	£4,091.32	£5,481.40	£495.64	£4,356.84
7	15.65m Active Steering	£3,776.18	£5,107.01	£363.75	£4,032.46
8	14.6m Fixed Axles	£1,656.04	£2,036.09	£801.50	£1,959.15
9	14.6m Single Self-steer Axle	£3,205.94	£3,887.17	£1,451.35	£3,448.40
10	14.6m Active Steering	£2,772.10	£3,330.94	£1,324.96	£3,032.94
11	15.65m 2 x Self-steer Axles	£6,467.40	£7,774.54	£2,810.73	£7,214.99
12	15.65m 1 x Command-steer Axle	£6,504.11	£7,932.22	£2,828.97	£7,249.60
13	15.65m 2 x Command-steer Axles	£6,228.62	£7,579.04	£2,745.12	£6,985.68
14	15.65m Active Steering	£5,927.17	£7,220.26	£2,618.70	£6,675.25

Overall, one of three broad outcomes was expected, namely:

- Direct cost benefits for industry and environmental benefits, resulting in an overall economic benefit;
- Direct cost benefits for industry and additional environmental costs. However, the additional environmental costs are less than the direct industry benefits, meaning that there will be an overall economic benefit; or
- Direct cost benefits for industry and additional environmental costs. However, the additional environmental costs are more than the direct industry benefits, meaning that overall there is a negative economic impact.

For most of the Central Case, High and Single Deck options, the first outcome is the result, as it generates both industry cost benefits and environmental benefits. For options 2-7 for the Low scenario, the second outcome is the result. Option 1 for the low scenario produces an overall negative economic impact. Again, Option 12 produces the highest overall economic benefits for each scenario (between £2,829 million and £7,932 million of economic benefits NPV from 2011 to 2025).

Tables A36 to A39 show the environmental benefits and overall economic impact for the Sensitivity Tests 5 to 8 (which are based on the direct industry benefits for the Central Case net of indirect taxation). The tables below summarise by option the NPV of the environmental benefits and of the overall economic impact for each sensitivity test.

Table 5.6: NPV of Environmental Benefits 2011 to 2025 (net of indirect taxation) for Sensitivity Tests 5 to 8

		£ Millions NPV of Environmental Benefits 2011-2025				
		Test 5	Test 6	Test 7	Test 8	Central Case
1	14.6m Fixed Axles	£26.07	-£62.22	-£238.79	-£327.08	-£150.50
2	14.6m Single Self-steer Axle	£714.57	£536.16	£179.32	£0.90	£357.74
3	14.6m Active Steering	£691.36	£512.79	£155.65	-£22.93	£334.22
4	15.65m 2 x Self-steer Axles	£1,502.99	£1,148.56	£439.70	£85.27	£794.13
5	15.65m 1 x Command-steer Axle	£1,496.14	£1,141.62	£432.57	£78.05	£787.09
6	15.65m 2 x Command-steer Axles	£1,485.69	£1,131.03	£421.70	£67.04	£776.36
7	15.65m Active Steering	£1,483.24	£1,128.54	£419.15	£64.46	£773.85
8	14.6m Fixed Axles	£761.47	£674.49	£500.54	£413.56	£587.52
9	14.6m Single Self-steer Axle	£1,434.80	£1,259.74	£909.63	£734.57	£1,084.68
10	14.6m Active Steering	£1,411.69	£1,236.48	£886.07	£710.87	£1,061.28
11	15.65m 2 x Self-steer Axles	£2,702.52	£2,360.42	£1,676.23	£1,334.13	£2,018.33
12	15.65m 1 x Command-steer Axle	£2,695.80	£2,353.62	£1,669.25	£1,327.06	£2,011.43
13	15.65m 2 x Command-steer Axles	£2,685.56	£2,343.24	£1,658.60	£1,316.28	£2,000.92
14	15.65m Active Steering	£2,683.16	£2,340.81	£1,656.11	£1,313.75	£1,998.46

Table 5.7: NPV of Environmental Benefits 2011 to 2025 for Sensitivity Tests 5 to 8 v Central Case

		£ Millions +/- v Central Case			
	Option	Test 5	Test 6	Test 7	Test 8
1	14.6m Fixed Axles	£176.57	£88.29	-£88.29	-£176.57
2	14.6m Single Self-steer Axle	£356.84	£178.42	-£178.42	-£356.84
3	14.6m Active Steering	£357.14	£178.57	-£178.57	-£357.14
4	15.65m 2 x Self-steer Axles	£708.86	£354.43	-£354.43	-£708.86
5	15.65m 1 x Command-steer Axle	£709.04	£354.52	-£354.52	-£709.04
6	15.65m 2 x Command-steer Axles	£709.32	£354.66	-£354.66	-£709.32
7	15.65m Active Steering	£709.39	£354.70	-£354.70	-£709.39
8	14.6m Fixed Axles	£173.95	£86.98	-£86.98	-£173.95
9	14.6m Single Self-steer Axle	£350.11	£175.06	-£175.06	-£350.11
10	14.6m Active Steering	£350.41	£175.20	-£175.20	-£350.41
11	15.65m 2 x Self-steer Axles	£684.19	£342.10	-£342.10	-£684.19
12	15.65m 1 x Command-steer Axle	£684.37	£342.18	-£342.18	-£684.37
13	15.65m 2 x Command-steer Axles	£684.64	£342.32	-£342.32	-£684.64
14	15.65m Active Steering	£684.70	£342.35	-£342.35	-£684.70
		% Change v Central Case			
		Test 5	Test 6	Test 7	Test 8
1	14.6m Fixed Axles	-117.3%	-58.7%	58.7%	117.3%
2	14.6m Single Self-steer Axle	99.7%	49.9%	-49.9%	-99.7%
3	14.6m Active Steering	106.9%	53.4%	-53.4%	-106.9%
4	15.65m 2 x Self-steer Axles	89.3%	44.6%	-44.6%	-89.3%
5	15.65m 1 x Command-steer Axle	90.1%	45.0%	-45.0%	-90.1%
6	15.65m 2 x Command-steer Axles	91.4%	45.7%	-45.7%	-91.4%
7	15.65m Active Steering	91.7%	45.8%	-45.8%	-91.7%
8	14.6m Fixed Axles	29.6%	14.8%	-14.8%	-29.6%
9	14.6m Single Self-steer Axle	32.3%	16.1%	-16.1%	-32.3%
10	14.6m Active Steering	33.0%	16.5%	-16.5%	-33.0%
11	15.65m 2 x Self-steer Axles	33.9%	16.9%	-16.9%	-33.9%
12	15.65m 1 x Command-steer Axle	34.0%	17.0%	-17.0%	-34.0%
13	15.65m 2 x Command-steer Axles	34.2%	17.1%	-17.1%	-34.2%
14	15.65m Active Steering	34.3%	17.1%	-17.1%	-34.3%

6. CONCLUSIONS

The main conclusions to be drawn from this analysis are as follows:

1. Higher capital costs for longer semi-trailer equipment compared with existing length semi-trailers. For a 15.65m semi-trailer and taking into account the various axle steering systems, the capital costs are around £6,000-£7,000 higher compared with an existing tri-axle semi-trailer;

2. The higher capital costs and additional length (drag) and tare weight of the longer semi-trailers do marginally increase vehicle operating costs. For a standard 6x2 tractor unit and 15.65m semi-trailer plated at 44 tonnes gross, the fixed operating costs are around £0.40-£0.60 higher (depending on steering axle system) per operating hour, while running costs are approximately 2.5% higher.

3. However, the most important figure to consider is the consequent cost per pallet-kilometre, which is the measure of the vehicle's overall efficiency when fully laden. Due to the longer load-platform capacity, in terms of pallet-kilometre costs, a 15.65m semi-trailer combined with a 6x2 tractor unit is around 12% more efficient when fully laden. Similarly, a 14.6m semi-trailer is around 7% more efficient.

4. Under the 'Base Case' option, domestic intermodal rail freight is estimated to grow to around 14.3 million tonnes-lifted by 2025 (from 2.0 million tonnes in 2009), with road freight increasing from 430.8 million tonnes-lifted (in 2009) to 450.9 million tonnes lifted by 2025. The large growth in domestic intermodal rail freight is primarily due to the assumed development of distribution centre floor space on rail-linked sites.

5. The introduction of longer semi-trailers in the road haulage sector but with domestic intermodal continuing to use existing length units results in a switch to road freight transport. For 15.65m semi-trailers, domestic intermodal rail freight would be around 9.2 million tonnes-lifted lower compared with the Base Case option. The road haulage market would gain efficiency savings associated with the greater payload capacity offered by the introduction of longer semi-trailers, but the rail freight sector would not benefit. As a result, the road haulage sector is able to 'win' traffic back from domestic intermodal.

6. The introduction of longer semi-trailers in the road haulage sector and with domestic intermodal adopting the use of longer intermodal units results in a further (marginal) switch to domestic intermodal rail freight. For the 15.65m option, rail is forecast to gain an additional 1.0 million tonnes-lifted by 2025 compared with the Base Case option. The domestic intermodal sector is able to secure a slightly higher level of efficiency savings associated with the greater payload capacity compared with the road transport market. Assuming the widespread adoption of longer intermodal units,

it would appear that at worst the impact will be neutral on the domestic intermodal sector, while there may actually be some marginal benefits.

7. In the Central Case scenario, for the existing length intermodal units options (Options 1-7), the estimated annual direct industry benefits in 2025 range from:

- -£34.2 million (i.e. a cost penalty compared with a do-nothing scenario) for 14.6m semi-trailers with fixed axles; through to
- £293 million for 15.65m semi-trailers with one Command-steer axle. This figure represents an annual saving of 2.6% compared to the Base Case option.

8. In the Central Case scenario, for the longer intermodal units options (options 8-14), the estimated annual direct industry benefits in 2025 range from:

- £136 million for 14.6m semi-trailers with Active Steering; through to
- £574.7 million for 15.65m semi-trailers with one Command-steer axle. This figure represents an annual saving of 5.1% compared to the Base Case option.

9. We can conclude that industry is likely to achieve significant direct financial benefits following the introduction of longer semi-trailer equipment. This will particularly be the case should the rail freight sector also take advantage of the greater payload capacity offered by longer intermodal units. For option 12 (15.65m semi-trailers and intermodal units), the Central Case estimates that industry will achieve £5,111.5 million of direct benefits (NPV) over the years 2011 to 2025.

10. For the Central Case scenario, both industry cost benefits and environmental benefits are generated. Option 12 produces the highest overall economic benefits for each scenario (£6,504 million of total economic benefits NPV from 2011 to 2025 for the Central Case, with a range between £2,829 million and £7,932 million for alternative scenarios).

6.1 Issues Potentially Affecting Introduction of Longer Intermodal Units

There are a number of issues (which have been raised by industry during the evidence gathering exercise) which may prevent the introduction, in the short/medium term, of longer intermodal units. These are summarised below.

Construction and strength. In order to be compatible with existing lifting equipment, a longer intermodal unit will need to be fitted with the 'lifting points' in the same position as a standard 40/45ft maritime shipping container. It has been suggested that it may not be possible to construct such a unit with the required 'rigid strength'.

However, we understand that Wincanton have commissioned a design for a 15.6m intermodal unit which is compatible with existing lifting equipment and has sufficient in-built rigid strength.

Compatibility with skeletal trailers. Longer skeletal semi-trailers (to convey longer intermodal units by road) will need to be 'flexible' and compatible with existing standard 40/45ft maritime shipping containers. Otherwise, industry will be required to operate two types of skeletal trailers (which will add to industry costs).

We understand that Wincanton have commissioned a design for a 15.6m skeletal semi-trailer which is universal and is able to convey 40/45ft maritime shipping containers, 13.6m swap-bodies and their design for the longer intermodal unit.

Dispose of existing length units. Operators would be forced to dispose of existing length intermodal units before the end of their economic/operational life i.e. before they had been fully depreciated. The second-hand market would consequently be 'flooded' with partially depreciated 13.6m/45ft units which would be difficult/impossible to sell. Such units may ultimately have to be scrapped. Operators would be forced to partially write-off recent capital investments.

Also, many existing intermodal units were partly funded through Freight Facility Grants (FFG), and must therefore run throughout the commitment period without replacement. Replacing these units would generate additional costs for operators.

This is a realistic argument and operators would potentially have to write-off equipment before the end of its useful life in order to adopt longer intermodal units. However, the road haulage industry is in the same position, with road haulage operators potentially needing to write-off existing trailer equipment early to benefit from longer semi-trailers. With regards to FFG, the DfT would have to reach a judgement on whether replacing older units with a longer intermodal unit would fall foul of the original FFG award conditions. The DfT could agree to write-off the 'balance' of any FFG funding if the older units were being replaced by newer longer intermodal units.

Investment in new equipment. Similar to the above argument, the rail industry would need to invest in a new fleet of longer intermodal units in order to achieve the forecast benefits. Again, this is a realistic argument and operators would need to invest in new equipment. However, the road haulage industry is in the same position, with road haulage operators potentially needing to invest in new semi-trailers to benefit from any efficiency savings. A growth is forecast for domestic intermodal rail freight under the do-nothing options, meaning that industry would in any case have to invest in new equipment to deliver this forecast growth. It may be that industry simply invests in new longer units instead of the existing length units it would have purchased anyway.

Cranes. Cranage equipment at some intermodal terminals might not be suitable for longer intermodal units. In particular, they might not longitudinally 'fit through' the gap between rail-mounted gantry crane 'legs'. Discussions with Freightliner appear to suggest that their cranes are able to 'twist' container units when being lifted so that they 'fit through' the gap between rail-mounted gantry crane 'legs' lengthways. In any case, this problem would be over-come by using reach-stacker lifting equipment.

In terms of introducing longer semi-trailer equipment, the DfT could consider the following four alternative 'solutions'.

1. Limit the use of longer semi-trailers to moving longer intermodal units to/from the nearest rail terminal (similar to the old 44 tonnes gross rule circa early 1990s);
2. Limit the use of longer semi-trailers to moving longer intermodal units to/from the nearest rail terminal for an initial period of time, say five years, before extending the concept to the wider road haulage market;
3. Limit the use of longer semi-trailers to 'intermodal compatible equipment' only i.e. longer semi-trailers moving longer intermodal units, regardless of the journey being undertaken. In this case, operators could use the longer equipment purely on road haulage movements. However, in order to benefit from the efficiency savings industry would be forced into investing in equipment which would be compatible with domestic intermodal rail freight; and
4. Allow the use of longer semi-trailers for all operations (effectively as examined by this report).