High Speed Line Study

Summary Report

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A Vision for the High Speed Line

THE CASE FOR HSL

Over the next 15 to 30 years, current demand forecasts suggest that unless action is taken there will be substantial overcrowding problems on the strategic rail network, against a background of increasing congestion on the road network. While these problems can be deferred or managed to a degree by capacity allocation or pricing mechanisms, this is only likely to secure short-term relief.

When the stage is reached at which new rail infrastructure capacity is required, a new High Speed Line is effective in relieving rail crowding problems and performs better in respect of relieving rail crowding than alternative investments such as upgrades of the existing networks, new lower-speed lines or highway upgrade programmes. HSL also has the potential to reduce some of the forecast growth in domestic air travel within the UK.

The appraisal of HSL has concluded that there is a business case for HSL and that in economic, safety and accessibility terms, HSL performs better than the alternative interventions considered:

- HSL is capable of delivering substantial economic benefits to the UK, covering costs by a ratio of between 1.9 and 2.8 to 1;
- depending on route option, HSL is expected to improve the wider economic performance of regions in the Midlands the North, and Scotland that are currently lagging, but not the more successful regions of the Southwest and Southeast. London and the other major cities are the prime beneficiaries;
- a reduction in transport-related accidents can be expected upon the introduction of HSL, arising from the forecast mode shift from road to rail-based transport;
- accessibility to the public transport network could be substantially widened by HSL, as it is capable of delivering a step-change in service frequency, population catchment and journey speeds;
- HSL has a good fit with transport and land use policy as long as the services that use it serve city centres. If road user charging is introduced, the net benefits of HSL are increased;

However, there are some difficult issues that need to be addressed:

- in environmental terms it is difficult to construct a new railway without adverse effects upon the natural and built environment – these would need to be carefully managed and appropriate actions taken to minimise and mitigate adverse impacts where possible;
- the nature of the scheme and its high capital cost means that a very large public sector financial contribution would be required to support its construction and/or operation. A staged approach to implementation is therefore recommended.
**Potential Capabilities of the HSL**

HSL has the potential to contribute to a range of economic, social, environmental and political objectives, and the analysis carried out during this study has illuminated which of these high level objectives HSL could be most effective at delivering:

- **Meeting the nation’s north-south transport needs effectively** – HSL could be very successful both in relieving forecast crowding problems on the strategic rail network and in making a step-change in the quality of rail travel in terms of speed, reliability, accessibility and frequency;

- **Enabling mode shift to more sustainable forms of transport** – HSL can make a contribution towards mode shift to public transport, although the direct effects on the road network will not be substantial;

- **Stimulating or supporting national economic growth** – there is a clear national economic gain from HSL, as captured in the cost-benefit analyses reflecting the efficiencies to be had from the use of faster more reliable means of transport;

- **Enabling regeneration in assisted areas** – the HSL could be beneficial to the Government’s urban renaissance and regional policy agendas by improving the performance of the lagging regions and conurbations, although it will not fundamentally alter the forecast geographical pattern of economic activity;

- **Supporting effective land use** – HSL is consistent with land use policies as long as it is developed along appropriate guidelines, the most important of which is to serve city centres rather than new out-of-town parkway stations;

- **Making optimal use of resources: value for money** – the economic appraisal has shown that despite the considerable capital cost of HSL, it has a positive business case and delivers better value for money than upgrading the existing rail network;

- **Promoting safety on the transport network** – HSL provides safety benefits to the transport system, by reducing the number of accidents on the highway network, although the net gain from these benefits is not large in relation to other benefits;

- **Contributing towards environmental improvements** – this is one area where HSL does not perform as strongly, since a scheme requiring such substantial new infrastructure would inevitably have significant negative landscape, biodiversity and heritage impacts, with relatively small benefits to air quality and noise levels.

On this basis, it is clear that the strengths of HSL are in meeting future transport needs and in delivering value for money while doing so. Secondary objectives could include enabling mode shift to public transport, supporting economic regeneration policies and promoting safer modes of travel.
Key aspects

While this study has not been an exhaustive review of all factors that affect the viability of HSL, the characteristics that improve the case for HSL can be set out, taking into account the various policy reviews and environmental and economic appraisals that have been carried out throughout the study:

Product issues

◆ a premium service compared with existing rail services;
◆ a market-based fares policy that may involve premium fares but only where HSL provides significant advantages over classic services;

Technology choices

◆ a passenger-only line, without capability for freight traffic;
◆ fast journey times;
◆ careful specification of HSL and residual classic services, to ensure that the advantages of HSL are extended as widely as possible, without compromising either HSL journey times or residual classic rail services;
◆ use of high speed technology compatible with operation over conventional rail networks to contain capital costs, aid phased development and extend the benefits of HSL;
◆ tunnelled alignments through environmentally sensitive areas;

Geographical options

◆ routes to the north west and north east are both attractive and both could support onward services to Scotland over existing routes;
◆ however, easterly options are potentially more viable than westerly ones judged against committed investments on the existing rail network;
◆ either one or two north – south high speed lines linking London with the north east and north west of the country (but not a core route with high speed branches);
◆ a central London terminus probably adjacent to an existing main line terminus
◆ connections to both airports (for example Heathrow) and CTRL offer valuable additional benefits;
◆ in the first instance, a new line that could link London to either Yorkshire or Cheshire/Lancashire serving destinations further north via the existing network;
◆ in the long term, when affordability constraints permit, a line that serves Scotland.

Policy context

◆ city centre stations rather than parkway stations to serve the main cities;
◆ additional intermediate stations only where these can be justified on regional planning policy and environmental grounds;
**Deliverability issues**
- phased development, to improve affordability of the scheme.
1. **Introduction**

1.1 Atkins was commissioned by the Strategic Rail Authority (SRA) to carry out the High Speed Line Study Stage 2, a feasibility study to establish whether there is a transport and business case for constructing a new high speed line (HSL) in the UK from London to the north. This study took place between August 2001 and February 2003.

1.2 The objectives of the study were to:

- develop an in-depth understanding of the transport case;
- understand whether there is a realistic and defensible business case;
- determine whether there is support from a wide range of stakeholders for HSL;
- determine a realistic forward plan; and
- based on the foregoing, establish a strategic vision for the HSL.

1.3 It was agreed at the outset of the study that the scope of the study would be focused on:

- a railway/guided transit system, rather than air- or road-based transport;
- north-south movements from London, thereby excluding corridors to the west of England and East Anglia;
- long-term forecasts, after the current 10 Year Plan period;
- passenger rail services, although with consideration of the impact on both passenger and freight markets;
- strategic issues and appraisals, rather than detailed option testing or design.

1.4 The study was carried out by a consortium of consultants, working very closely throughout the study with the SRA:

- Atkins – lead consultant and responsible for project management, option development and appraisal, and stakeholder consultation;
- Ernst & Young – project structuring and finance;
- Berwin Leighton Paisner – project authorisation issues;
- Roger Tym & Partners – wider economic impacts;
- Institute of Transport Studies – specialist advice on demand forecasting and passenger surveys;
- Japan Railway Technical Service – high speed rail technology and operations.

1.5 The study was carried out in three phases:
Phase 1 – project inception, review of high speed rail systems and development of the detailed study methodologies;

Phase 2 – interim appraisals, using a simple demand model and preliminary tests of the transport, business and financial cases of a wide-ranging set of options;

Phase 3 – detailed appraisal, incorporating development of a detailed demand model and full business case appraisals and the production of a forward plan.

1.6 The study encompassed a wide range of activities to ensure that the broadest consideration was given to the potential capabilities and the impacts of HSL. In summary, the main workstreams were:

- option development and costing, including rail engineering and operations;
- demand modelling and forecasting, and passenger surveys;
- economic analysis, incorporating cost-benefit analysis and consideration of wider economic impacts;
- environmental assessment;
- financial modelling and project structuring advice;
- risk management;
- stakeholder consultation.
The three areas of change can be summarised as follows:

- Revisions to the Treasury’s Green Book guidance for project appraisal;
- Re-scoping of the East Coast Main Line Upgrade; and
- Need for greater consideration of Road User Charging (RUC).

A summary of these results is attached in the addendum.
2. **North-South Travel in the UK**

**BACKGROUND**

2.1 In the UK, the road networks carry over 90% of passenger traffic, while the rail and air networks have relatively small market shares, even though the traffic carried by rail has been expanding quite substantially since rail privatisation in the mid-1990s.

2.2 The comparative market share of road, rail and air networks alters, however, when we focus on longer distance journeys, as shown in the table below.

**Table 2.1 – Mode Share of Long Distance Trips**

<table>
<thead>
<tr>
<th>Distance Range</th>
<th>Car (%)</th>
<th>Bus &amp; Coach (%)</th>
<th>Rail (%)</th>
<th>Air (%)</th>
<th>Other (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-75 miles</td>
<td>86</td>
<td>4</td>
<td>8</td>
<td>-</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>75-100 miles</td>
<td>85</td>
<td>5</td>
<td>8</td>
<td>-</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>100-150 miles</td>
<td>83</td>
<td>7</td>
<td>8</td>
<td>-</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>150-250 miles</td>
<td>80</td>
<td>7</td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>250-350 miles</td>
<td>69</td>
<td>12</td>
<td>13</td>
<td>4</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>&gt;350 miles</td>
<td>46</td>
<td>9</td>
<td>20</td>
<td>22</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>6</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: National Travel Survey 1998/2000

2.3 For journeys beyond 150 miles, rail’s market share becomes considerably stronger, while above 350 miles, the air sector becomes a strong competitor to the surface transport modes.

2.4 The average person now travels over 50% further in a year compared with during the 1970s. This change is reflected in a 30% increase in the number of trips over one mile and a 40% increase in average trip length. However, the total time spent travelling over a year has remained broadly constant. These shifts have taken place as a result of major changes in the methods of transport used: trips on foot and by bus have been replaced by longer but faster trips by car, facilitated by an increase in car ownership and a reduction in motoring costs relative to public transport costs.

2.5 The type of traffic carried by the rail network varies considerably according to the services operated. The long distance operators on the strategic routes provide 20% of total rail services, but only carry 8% of total rail passengers. However, these passengers make comparatively long journeys, so in passenger-km terms the long-distance operators have a 33% share of the rail market.

2.6 The north-south rail routes of most relevance to HSL are the West Coast Main Line (WCML), the Midland Main Line (MML) and the East Coast Main Line (ECML), illustrated in Figure 2.1. The strategic passenger operators on these routes are Virgin West Coast (VWC), Midland MainLine and GNER.
2.7 **BASE CASE SCENARIO**

Our assumptions on the future shape and characteristics of the rail, road and air networks are based on the current 10 Year Plans developed by the Department for Transport (DfT), the SRA and the Highways Agency. The HSL base case scenario remains constant from 2011 onwards, which allows us to understand the transport implications of not upgrading the strategic networks over the study period and to assess the relative merits of different interventions, whether these be investments in upgrades in rail, other modes or policy interventions.

2.1 It has been assumed that the strategic routes on the classic rail network will undergo the following improvements over the next ten years:

- **WCML** – the West Coast Route Modernisation, as set out in the SRA’s West Coast Strategy (October 2002);
- **MML** – no major infrastructure improvements, but some improvements to service patterns and capacity;
- **ECML** – the Phase 2+ upgrade (although it is noted that this is now under review by the SRA and a de-scoped upgrade is now more likely).

2.2 Our base case for the road network assumes that key elements of the 10 Year Plan are implemented – these chiefly comprise the Highways Agency’s Targeted...
Programme of Improvements (TPI), totalling 150 miles of improvements, and a further 360 miles of trunk road and motorway widening.

2.3 The scope of our demand forecasting model is strategic passenger travel movements by rail, road and air in Great Britain. Future year travel demand was based upon forecasts from the DfT’s National Trip End Model, which is consistent with official projections of car ownership, population and household growth.

2.4 Our nationwide demand forecasts by mode show that rail demand is forecast to grow by 70% over current levels by 2031, an average growth rate of 1.8% a year. These levels are higher than the forecast growth rates for car travel, but lower than air travel growth (which is modelled unconstrained by congestion or crowding).

**Figure 2.2 – Base Case Demand Forecasts**

<table>
<thead>
<tr>
<th></th>
<th>Daily Passenger Trips (thousand)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2016</td>
<td>2031</td>
</tr>
<tr>
<td>Rail demand</td>
<td>1,929</td>
<td>2,484</td>
<td>3,301</td>
</tr>
<tr>
<td>growth from 2000</td>
<td>-</td>
<td>29%</td>
<td>71%</td>
</tr>
<tr>
<td>Car demand</td>
<td>8,473</td>
<td>11,524</td>
<td>13,044</td>
</tr>
<tr>
<td>growth from 2000</td>
<td>-</td>
<td>36%</td>
<td>54%</td>
</tr>
<tr>
<td>Air demand</td>
<td>28</td>
<td>49</td>
<td>66</td>
</tr>
<tr>
<td>growth from 2000</td>
<td>-</td>
<td>75%</td>
<td>134%</td>
</tr>
</tbody>
</table>

**Table 2.2 – Forecast Rail Demand on Strategic Routes**

<table>
<thead>
<tr>
<th></th>
<th>Daily passenger-km (million)</th>
<th>Average capacity utilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2016</td>
</tr>
<tr>
<td>VWC</td>
<td>10.8</td>
<td>22.2</td>
</tr>
<tr>
<td>growth from 2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MML</td>
<td>3.4</td>
<td>4.5</td>
</tr>
<tr>
<td>growth from 2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNER</td>
<td>13.6</td>
<td>23.7</td>
</tr>
<tr>
<td>growth from 2000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.5 On the key north-south rail routes, the planned upgrades will deliver frequency, journey time and capacity improvements to passengers that are expected to stimulate additional demand growth. This means that demand on VWC, GNER and MML could more than double over the next 30 years.

2.6 If crowding on intercity-type routes is taken to occur at average loadings of 50% for the whole TOC route length, then these forecasts suggest that VWC services will be suffering from crowding, over the whole route length, from 2016 and MML and GNER services by 2031.
2.7 Demand on each route section is illustrated graphically for each route in the following figures, for 2000, 2016 and 2031. When considering sections of route, our analysis of average loadings currently experienced suggests that crowding in the peak – full and standing conditions on the busiest trains at the busiest times of day – is likely to occur when all-day load factors reach 60% or more.

2.8 The figures highlight the concentration of demand on the southern sections of each route, where even at today’s demand levels capacity is insufficient to ensure that load factors remain below 60%.

2.9 It can also be seen quite clearly that significant sections of the north-south strategic rail network are likely to suffer considerable levels of crowding in the future.

♦ on the ECML, the entire section from London-York is likely to be overcrowded in 2031, although there are unlikely to be significant problems in 2016;

♦ on the WCML, the southern-most route sections between London and Milton Keynes and the northern section from Preston to Glasgow are forecast to be overcrowded in 2016. By 2031, the whole route is likely to be suffering from extreme overcrowding;

♦ on the MML, the route is unlikely to be crowded in 2016, but by 2031 the London-Loughborough section is forecast to be crowded.
Figure 2.4 – Rail Demand 2016

LEGEND
Load Factor
- < 30 %
- 30% - 39%
- 40% - 49%
- 50% - 59%
- > 60%

Loading factor represented by line colour
Number of Daily Trips
- 0 - 10000
- 10001 - 20000
- 20001 - 30000
- 30001 - 40000
- 40001 - 50000
- 50001 - 60000
- 60001 - 100000

Number of trips represented by line thickness
Existing rail network

Figure 2.5 – Rail Demand 2031

LEGEND
Load Factor
- < 30 %
- 30% - 39%
- 40% - 49%
- 50% - 59%
- > 60%

Loading factor represented by line colour
Number of Daily Trips
- 0 - 10000
- 10001 - 20000
- 20001 - 30000
- 30001 - 40000
- 40001 - 50000
- 50001 - 60000
- 60001 - 100000

Number of trips represented by line thickness
Existing rail network
2.10 To establish the potential range of outcomes beyond our core base case scenario, we have examined a set of alternative scenarios:

- a Capacity Utilisation Policy that delivers 10% more paths for VWC and GNER services;
- a lesser ECML upgrade implemented in the next 10 years, based on the “1C” upgrade;
- a set of four future world scenarios, based on research carried out by the DfT, with different combinations of growth rates and demand management strategies;
- demand management – simplistically, through increasing rail fares in 2031 to remove rail crowding on the strategic routes.

2.11 The forecasts under these alternative scenarios show that there are only two scenarios under which rail crowding problems will be avoided in 2031 – and these have somewhat extreme assumptions of very low growth (the Local Stewardship scenario) or a doubling of rail fares.

2.12 Under the ECML 1C upgrade, rail crowding conditions on GNER services in 2016 is forecast to be nearly as severe as for VWC services, with an average loading of 55%. Some GNER passengers would transfer to other TOCs, worsening the crowding on VWC or MML services as well.

### Table 2.3 – Impact of Other Base Case Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>VWC</th>
<th>MML</th>
<th>GNER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesser ECML upgrade</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Capacity Utilisation Policy</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Future World Scenarios</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>World Markets</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Global Sustainability</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Provincial Enterprise</td>
<td>−</td>
<td>✓</td>
<td>−</td>
</tr>
<tr>
<td>Local Stewardship</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Doubling rail fares</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Key: + increases rail crowding, − reduces rail crowding, ✓ eliminates rail crowding.

### Demand on the Highway and Air Networks

2.13 On the strategic highway network, demand for car travel is expected to increase by over 50% over the period to 2031, and even with a substantial programme of motorway and trunk road widening over the next ten years, increasing road congestion will lead to falls in average speeds of ten percent or more. It is clear therefore that the forecast increase in rail patronage cannot be accommodated on the highway network.
2.14 The domestic air network, even if allowed to grow unconstrained as under our forecasts, is not capable of handling significant mode shifts from surface transport. Of all trips over 50 miles, air services carry only 1%; air’s market share does not become significant until trip lengths reach 250-350 miles.

CONCLUSION: IS THERE A PROBLEM?

2.15 Our analyses suggest that, to meet forecast increases in demand, an expansion in rail capacity is required, on the WCML by 2016 and on all three north-south routes by 2031. Failure to address this problem would have serious implications in terms of crowding problems to passengers, adverse impacts on the performance of the rail network and the potential suppression of demand.

2.16 The planned increases in capacity on the highway and air networks are unlikely to make a substantial contribution to meeting this expansion in rail demand.

2.17 We have considered a range of future scenarios, which have demonstrated that the need for additional rail capacity can be managed or may be deferred in the short term. However, on balance, demand growth cannot be accommodated in the medium term by the rail and road networks without further intervention.

2.18 The next stage of the study was to consider whether HSL can effectively address these problems and whether any alternative schemes could do so too. First, we considered what is “high speed rail”, drawing from international experience.
3. High Speed Rail Systems

**High Speed Rail Technology**

3.1 High speed guided surface transport technologies fall into two categories:

- a) those based on conventional railway technology, where trains run on a pair of steel rails using flanged wheels. These systems can be either segregated or integrated with an existing rail network;

- b) those adopting an alternative means of guidance and support, of which the only system currently under development or available is magnetic levitation (maglev). These will be totally separate from existing railway networks.

3.2 High speed rail systems have been developed in a number of countries worldwide, including the UK (CTRL), France (TGV), Germany (ICE), Belgium, Netherlands, Spain, Italy, Japan (Shinkansen) and Korea. All of these are based on conventional railway technology. Key features of some of these systems are presented in the adjacent table.

<table>
<thead>
<tr>
<th>Country</th>
<th>System</th>
<th>Degree of Segregation</th>
<th>Key Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>Channel Tunnel Rail Link from Folkstone to</td>
<td>Systems integrated with UK rail network and Channel Tunnel</td>
<td>109 km long, max speed 300 kph</td>
</tr>
<tr>
<td></td>
<td>London</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>TGV – several lines developed since 1976,</td>
<td>Incremental approach to project development is based on a system integrated with rest</td>
<td>Around 1,700 km of route. The earlier</td>
</tr>
<tr>
<td></td>
<td>largely radiating from Paris</td>
<td>of network</td>
<td>lines operate at 270 kph, recent ones at</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>300 kph, but with capability of 320 kph.</td>
</tr>
<tr>
<td>Japan</td>
<td>Shinkansen – five lines, developed and</td>
<td>Fully segregated, because of limitations of classic narrow gauge network</td>
<td>1,900 km of lines in total, operating at</td>
</tr>
<tr>
<td></td>
<td>upgraded since 1964</td>
<td></td>
<td>up to 300 kph and up to 11 trains per</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hour.</td>
</tr>
<tr>
<td>Germany</td>
<td>ICE – three routes linking major cities</td>
<td>Non-segregated network</td>
<td>450 km route length in total, normally</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>operating at 300 kph but with potential for 330 kph.</td>
</tr>
<tr>
<td>Netherlands</td>
<td>HSL Zuid, linking Antwerp and Amsterdam</td>
<td>Non-segregated line</td>
<td>Not yet operational, but 300 kph operation planned. Developed under PPP arrangements</td>
</tr>
<tr>
<td>Spain</td>
<td>AVE – Madrid-Seville, plus Madrid-Barcelona</td>
<td>Segregated, except for some gauge-convertible Talgo services</td>
<td>Initial line 471 km, with 855 under</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>construction. 300 kph operation.</td>
</tr>
</tbody>
</table>
3.3 Our review of high speed rail systems identified the following main features of high speed lines:

- adoption of standard track gauge (1435mm);
- use of traditional ballasted track with sleepers or slab track, the latter being significantly more expensive to install but with lower ongoing maintenance costs;
- design speeds in curves based on conventional railway curve formulae, with higher levels of allowable cant than for UK classic rail due to the passenger-only nature of most high speed lines;
- civil engineering support structures similar to those on conventional railways, but with greater width of formation and much larger tunnel cross sections;
- junction/turnout design based on conventional railway practice with large radii turnouts allowing high speeds on diverging routes and no restrictions on straight routes;
- station design following standard railway practice, but the avoidance of platforms on lines used by trains travelling at high speed.

3.4 Both conventional rail and maglev based systems are technically possible for a future UK HSL. However, despite its potential speed advantages, there are a number of technology and financial risks associated with maglev technology and it is as yet unproven in daily revenue service. For this reason, the development of HSL options has been based on conventional high speed rail technology.

SEGREGATION OF HIGH SPEED RAIL FROM CLASSIC RAIL

3.5 A segregated high speed network is defined as a network that is dedicated to the operation of high speed services alone, whose services do not share track infrastructure with the classic rail network and do not interact operationally with classic rail train operations during normal circumstances.

3.6 The choice between a segregated or non-segregated high speed network has significant implications for rail operations. In general, a segregated network can be expected to operate with a higher degree of reliability and service punctuality because train delays and problems on the classic rail network cannot be directly transferred to, or interfere with, operations on the separate high speed tracks. However, development of a segregated network normally requires significantly more new infrastructure and is therefore likely to be substantially more costly than non-segregated networks which are able to make use of existing rail infrastructure.

3.7 The European Commission has developed two directives on railway interoperability as part of its policy of achieving a single market in the European railway industry. The implications of the directives is that all new high speed rail lines would need to be built to Category I standards – which are for specially built high speed lines for speeds generally equal to or greater than 250 km/h.
However, existing infrastructure can be upgraded to allow high speed trains to access destinations beyond any new high speed lines, thereby allowing both fully segregated and non-segregated network options to be developed.

3.8 Existing high speed railways in other countries include examples of both segregated and non-segregated systems. Factors which have influenced these choices include:

- track and structure gauge of the classic rail network;
- capacity on the classic rail network – non-segregated systems clearly require there to be spare capacity on the classic network to accommodate high speed trains;
- ability/inaability to upgrade existing key sections of the classic network;
- desire/need for high speed rail operations to be totally isolated from classic services, and thus achieve higher levels of reliability and punctuality;
- desire/need to phase high speed network construction in a way which allows the benefits from a limited initial investment to be experienced by a large range of services which are able to operate beyond the new construction.

3.9 However, the UK does not experience the constraints of other countries that have forced them into either segregated or non-segregated solutions. The segregation issue was therefore addressed during the appraisal stages of the study.

TECHNICAL CRITERIA

3.10 The HSL schemes considered and appraised in this study were developed on the basis of:

- infrastructure design for all new route to the EU Directive;
- alignments between cities designed for up to 360km/h, in line with that assumed in the Stage 1 study. This is similar to current European practice and would allow use of the potential next generation of trains which are likely to be capable of 350km/h commercial operation;
- trains capable of operating at up to 300km/h, as European/Japanese current practice;
- passenger-only high speed alignments;
- development of options for both segregated and non-segregated access to city centres;
- different train lengths and double/single deck sizes tested on segregated and non-segregated networks as appropriate to platform length and infrastructure gauge to test effects on costs and capacity (i.e. trains of 320 and 400m length in line with EU Directive);
identification of any sections of potential high speed alignments that would be compatible with a new freight route being built alongside to allow the same corridor to be exploited.

**NETWORK DEVELOPMENT**

3.11 High speed rail networks are at their most developed stages in Japan and France. When examining how these systems were conceived and phased, and comparing them with the UK motorway system and UK railway networks, it can be seen that all four systems share some similarities in their development:

- generally, the first line of each system took some time from initial concept to come to fruition;
- either right from the start or fairly shortly after the first lines were built, a vision for a whole network was adopted, in most cases at a national level;
- the initial success, both in terms of usage and financially, of the first line or lines was a spur to further development of the system;
- the pace of development then gained momentum and generally the time individual projects took to come to fruition decreased;
- then the pace slowed and the length of time taken by individual schemes increased, for a number of reasons, including increased public participation in the process, increased requirements for environmental and other assessments, the most necessary parts of the network had already been built, change in transport policy or financial constraints.

**Figure 3.1 – Shinkansen and TGV Development**

Note: assumes initial lines were developed over 15 years.

3.12 The CTRL can be considered the UK’s first high speed railway, and has indeed exhibited the long lead time experienced by the initial phases of the other rail and road networks. It might therefore be hoped that experience gained during the promotion of CTRL would enable the development time of the next high speed railway in the UK to be shorter.
4. Development of HSL Options

**Rationale behind Option Development**

4.1 The main rail planning objectives for HSL were:

- to provide additional rail capacity for north-south travel;
- to improve north-south journey times.

4.2 These objectives implicitly underpin the development of the HSL options within this study. The key principles behind the HSL options are that they should:

- link key centres of population between London and Scotland;
- cater for strategic long-distance journeys;
- provide benefits in relieving expected congestion on the classic rail network.

4.3 In addition, following our initial Phase 2 appraisals, some key issues were identified which materially affected the case for HSL, and so the options needed to be able to test these issues:

- whether HSL should be segregated from or integrated with the classic network;
- how far north HSL should be developed as new railway rather than using classic rail infrastructure;
- how development of the HSL should be phased.

**Factors incorporated in Option Development**

4.4 The option development process required indicative alignments and station proposals to be drawn up, although these are not preferred or proposed schemes, but are purely for the purposes of establishing technical feasibility and preparing cost estimates. The HSL options were developed to meet the objectives described above, but a set of key factors influenced the actual design and specification process.

**Environmental Constraints and Habitats**

4.5 All options were designed to minimise environmental impacts and impacts on habitats where possible. The study’s Geographical Information System (GIS) was used to develop a database of designated environmental sites.

4.6 The HSL alignments were required to avoid all sites of international importance for nature conservation, AONBs or National Parks, or had to mitigate the adverse impacts through, for example, tunnelling. In addition, the alignments were required to avoid other sites of national importance and built-up areas where possible. The environmental appraisal described later assessed the success of this process.
Synergy with Land Use and Transport Policy

4.7 A systematic review of Regional Planning Guidance (RPG) was carried out to identify the main policies that are affected by HSL. An example of policies and planning issues taken into account is illustrated below. The HSL options are designed to be compliant with these policies - in some cases this required modification of the options.

4.8 The most critical issue highlighted by the RPG review was the importance of serving city centres rather than constructing new out-of-town parkway stations, unless there are overriding economic regeneration or transport interchange objectives that can be met by out-of-town developments.

Technical Constraints and Affordability

4.9 The design specification for a high speed railway imposes a set of technical constraints as described in the previous chapter. Within these constraints, the HSL options were developed in order to minimise cost, through:

♦ working with the topography to minimise gradients and hence the need for tunnelling or viaducts;

♦ providing the shortest possible route between the destinations;

♦ making effective use of classic rail infrastructure, particularly to access city centres using existing stations.

Stakeholder Concerns

4.10 At key points during the study, we consulted a range of stakeholders, including Regional Government Offices, Passenger Transport Executives, Regional Development Agencies, Regional Assemblies, special interest groups (such as the CBI and the Highways Agency) and environmental protection groups. As part of this process we presented the HSL options to stakeholders and invited comments on their acceptability.

4.11 A number of concerns were raised, many of which mirrored the issues raised during the RPG review, others of which were more local concerns aiming to maximise benefits to a particular region. Where necessary the options were adjusted.

Findings from Earlier Appraisals

4.12 In the initial Phase 2 appraisals, we reached some early conclusions on the key factors that improve the viability of HSL, and these were built into the final HSL options:

♦ city centre stations are preferred to parkway stations to serve the key cities;
- additional stations to serve intermediate destinations add value;
- non-segregation – the use of classic rail to serve furthest destinations is more economic/affordable;
- a route that facilitates cross-country (i.e. non-London based) services adds benefits;
- phased development improves the economics;
- there is value in serving the West or East Midlands, even though they are relatively near to London.

**HSL OPTIONS**

4.13 The result of this process is a potential HSL network, shown in figure 4.1.

4.14 The route sections indicated can be combined into options in various ways, using sections of WCML and ECML where necessary, to allow services between London and Scotland to be operated.

4.15 Most options have the London to West Midlands section as a core route section. However, to ensure the widest geographical range of options is considered, an alternative first section to the east was also used for some options.

4.16 The way the route sections were combined into various options is illustrated opposite. Option 1 comprises new HSL infrastructure only for the route section from north London to the West Midlands and Stafford, where it would link in to the WCML. This would allow HSL services to be operated from London to Birmingham, Manchester, Liverpool and Glasgow.
4.17 Option 8 is a potential “end-game” as an HSL network. It provides new HSL infrastructure from London to the West Midlands and Manchester on one branch and to the East Midlands, Yorkshire, the north-east and Scotland on an easterly branch. This option would require new infrastructure into central London, to provide the necessary capacity and is therefore capable of offering near-segregated services to most destinations.

Figure 4.2 – Indicative HSL Options

Station Access

4.18 Accessing city centres is a critical issue for new railways, as capacity on existing routes is often limited, but if new tunnelled access is required this can be very costly. In the first instance, HSL options were developed on a non-segregated basis, in order to contain capital costs – this involved the use of existing tracks into cities and existing city centre stations, with varying degrees of remodelling, to accommodate HSL services.

4.19 In general terms, the HSL station options fall into three categories:

♦ existing stations which require major remodelling to accommodate HSL trains – specific proposals were developed to demonstrate feasibility;
♦ existing stations which require little if any remodelling;
♦ new build stations, either parkway stations between the major cities, or new city centre stations if remodelling existing stations does not provide sufficient capacity or segregation.

4.20 For our fully segregated HSL option, segregated station solutions had to be developed. In the main these are based on new build stations, although it is possible in some cases to provide segregated platforms for HSL within existing stations.
HSL Costs

4.21 Our HSL capital cost estimates incorporate the costs of construction of a new railway, the provision of interfaces with classic rail, the acquisition of land, the purchase of rolling stock and project management and design costs.

4.22 The unit rates underpinning the cost estimates are mainly derived from emerging costs of the CTRL, at the time of the study being undertaken. In addition, a number of items were costed on the basis of a specification provided by engineering specialists on, for example, station remodelling plans.

4.23 A risk contingency of 30% was applied to total capital costs, based on a quantified risk assessment of HSL. The resulting unit cost estimates (for new-build infrastructure only) generally ranged between £30 million and £34 million per route-km.

4.24 The average cost for CTRL Section 1, which is comparable to our HSL options, is £19 million per route-km, although this excludes some major cost items associated with station works and Section 1 sunk costs. Section 1 of the CTRL, with significant lengths of new-build railway through open countryside, largely at grade but including some tunnelled works, is considered to be characteristic of a likely HSL extending north from London. (If all costs, for Sections 1 and 2, are included, the average cost of CTRL is £48 million per route-km – this includes the costs of the extensive London tunnels of Section 2.)

Table 4.1 – HSL Capital Cost Estimates

<table>
<thead>
<tr>
<th></th>
<th>Option 1 £ million, Q3 2001 prices</th>
<th>Option 8 £ million, Q3 2001 prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSL route infrastructure</td>
<td>3,300</td>
<td>14,200</td>
</tr>
<tr>
<td>Classic rail upgrades</td>
<td>600</td>
<td>200</td>
</tr>
<tr>
<td>HSL junctions</td>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>Stations &amp; depots</td>
<td>700</td>
<td>1,600</td>
</tr>
<tr>
<td>Land acquisition</td>
<td>300</td>
<td>700</td>
</tr>
<tr>
<td>Possession costs</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Professional fees</td>
<td>1,800</td>
<td>6,000</td>
</tr>
<tr>
<td>Rolling stock</td>
<td>600</td>
<td>1,500</td>
</tr>
<tr>
<td>Sub-total</td>
<td>7,624</td>
<td>25,200</td>
</tr>
<tr>
<td>Risk contingency</td>
<td>2,300</td>
<td>7,600</td>
</tr>
<tr>
<td>Total capital costs</td>
<td>9,900</td>
<td>32,700</td>
</tr>
</tbody>
</table>

HSL Capabilities

4.25 Significant journey time improvements are achievable with HSL, compared with post-upgrade journey times on the classic rail network. The HSL journey times in the following table are based on the most extensive HSL option; for shorter networks, only some of these journey time improvements will be achievable, depending on the destinations served. These journey times are “typical”,
rather than best, and are dependent on assumptions on stopping patterns.

**Table 4.2 – HSL Journey Time Improvements**

<table>
<thead>
<tr>
<th>Origin</th>
<th>Destination</th>
<th>Base Case Journey Time (mins)</th>
<th>HSL Journey Time (mins)</th>
<th>Improvement (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>Birmingham</td>
<td>80</td>
<td>55</td>
<td>25</td>
</tr>
<tr>
<td>London</td>
<td>Manchester</td>
<td>125</td>
<td>80</td>
<td>55</td>
</tr>
<tr>
<td>London</td>
<td>Liverpool</td>
<td>130</td>
<td>95</td>
<td>35</td>
</tr>
<tr>
<td>London</td>
<td>Leeds</td>
<td>125</td>
<td>85</td>
<td>40</td>
</tr>
<tr>
<td>London</td>
<td>Sheffield</td>
<td>140</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>London</td>
<td>Newcastle</td>
<td>170</td>
<td>120</td>
<td>50</td>
</tr>
<tr>
<td>London</td>
<td>Edinburgh</td>
<td>255</td>
<td>155</td>
<td>100</td>
</tr>
<tr>
<td>London</td>
<td>Glasgow</td>
<td>285</td>
<td>180</td>
<td>105</td>
</tr>
<tr>
<td>Birmingham</td>
<td>Manchester</td>
<td>105</td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td>Manchester</td>
<td>Leeds</td>
<td>55</td>
<td>25</td>
<td>30</td>
</tr>
</tbody>
</table>

**Table 4.3 – Summary of HSL Services for Option 8**

<table>
<thead>
<tr>
<th>Service</th>
<th>Trains per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
</tr>
<tr>
<td>London-Manchester</td>
<td>2</td>
</tr>
<tr>
<td>London-West Midlands</td>
<td>2</td>
</tr>
<tr>
<td>London-Liverpool</td>
<td>1</td>
</tr>
<tr>
<td>London-Glasgow</td>
<td>3</td>
</tr>
<tr>
<td>London-Sheffield</td>
<td>1</td>
</tr>
<tr>
<td>London-Newcastle</td>
<td>1</td>
</tr>
<tr>
<td>London-Leeds</td>
<td>1</td>
</tr>
<tr>
<td>London-Carlisle</td>
<td>1</td>
</tr>
<tr>
<td>West Midlands-Glasgow</td>
<td>1</td>
</tr>
<tr>
<td>Total: western branch</td>
<td>7</td>
</tr>
<tr>
<td>Total: eastern branch</td>
<td>6</td>
</tr>
<tr>
<td>Total: into London</td>
<td>12</td>
</tr>
</tbody>
</table>

4.26 HSL service frequencies to each destination were set according to forecast demand levels, in an attempt to optimise service levels. Where necessary, additional services are assumed to be introduced in 2031, to accommodate increasing demand.

4.27 The underlying rationale behind the service planning of HSL is to serve all destinations with a standard interval pattern, with generally a whole number of trains per hour and at least one train per hour for each destination/stopping pattern.

4.28 The nominal capacity of a two-track high speed line has been assumed to be 12 trains an hour, based on international experience and current technical capabilities. It can be seen from the table above that demand forecasts for some options imply that higher
frequencies than can theoretically be accommodated are required, which has implications in terms of additional infrastructure requirements or limitations on service levels.

4.29 In order to avoid direct competition between HSL and classic services, and to allow HSL to make use of sections of the classic rail network, the base case service patterns for VWC and GNER were also revised, using the following principles:

- where HSL services require the use of an existing train path on WCML or ECML, the classic service is removed and replaced with a fast HSL service to that destination;
- where both HSL and classic services operate to a destination, classic services are amended to a semi-fast or stopping service;
- where possible, intermediate destinations not served by HSL are served by an enhanced classic service, to maximise the indirect benefits of HSL.

**NON-HSL SCENARIOS**

4.30 Alternatives to HSL were developed and appraised to provide a comparison between HSL and other potential solutions:

- **Alternative 1: a new classic rail line** - based on a new line from London to the West Midlands, but with trains operating at 225 kph, so focusing more on providing capacity than on maximising speeds;

- **Alternative 2: classic rail upgrade** – to establish what improvements in capacity or capability can be achieved from the existing infrastructure. Initially a programme of train lengthening is assumed, followed by more extensive infrastructure works to enable additional train paths to be generated;

- **Alternative 3: roads programme** – a non-rail alternative to HSL, based on further “10 Year Plans” for the highway network;

- **Alternative 4: airports programme** – drawing on the DfT’s RASCO and SERAS work, a comparison is drawn between the demand impacts of airport investment compared with an HSL.
5. The Transport Case

**HSL Demand Forecasts**

5.1 Our forecasts of HSL demand in 2016 range between 12 billion and 46 billion passenger-km per day, depending on option; which for HSL single-line options is comparable to the VWC franchise.

5.2 Between 2016 and 2031, HSL demand is forecast to grow by 60-70%, or 3.5% per annum. This compares with a 40% growth rate over the same period in VWC and GNER demand in the absence of HSL, suggesting that crowding on the classic rail network is suppressing some demand in 2031, which can be released when new HSL capacity is introduced.

5.3 The pattern of demand for Option 8, in terms of volumes and load factors, shows the concentration of demand on the southern core section of route from the West Midlands to London. However, demand does still hold up well even to Scotland under this option. As HSL service frequencies were adjusted to accommodate forecast demand levels, the average loadings are relatively high, but still below 60%, and therefore uncrowded on average.

---

**Figure 5.1 – Forecast HSL Demand, 2031**

---

**Legend**

- Load Factor
  - < 30%
  - 30% - 35%
  - 35% - 45%
  - 45% - 55%
  - > 55%

- Loading factor represented by the color

- Number of Daily Trips
  - 0 - 10000
  - 10001 - 20000
  - 20001 - 30000
  - 30001 - 40000
  - 40001 - 50000
  - 50001 - 60000
  - > 60000

- Number of trips represented by the color
5.4 More than half of forecast HSL demand arises from passengers shifting from classic rail services – given the scaling back of VWC and GNER services to remove competing services, this is perhaps not surprising.

**Table 5.1 - Source of HSL Demand, Option 8**

<table>
<thead>
<tr>
<th>Market</th>
<th>2016</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual</td>
<td>% of Total</td>
</tr>
<tr>
<td></td>
<td>trips (m)</td>
<td></td>
</tr>
<tr>
<td>Shift from Classic Rail</td>
<td>33.0</td>
<td>68%</td>
</tr>
<tr>
<td>Shift from Air</td>
<td>1.0</td>
<td>2%</td>
</tr>
<tr>
<td>Shift from Car</td>
<td>6.3</td>
<td>13%</td>
</tr>
<tr>
<td>Generated demand</td>
<td>8.0</td>
<td>17%</td>
</tr>
<tr>
<td>Total</td>
<td>48.3</td>
<td>100%</td>
</tr>
</tbody>
</table>

5.5 The capture of passengers from the air market is lower than might be expected – this market forms only 2-4% of HSL demand. This in part reflects the small domestic air market, but also the relatively small amount of the domestic air market that is contestable by rail.

5.6 A sensitivity test was run with increased airfares. This had the impact of increasing HSL revenue and economic benefits by £4.8bn.

5.7 Around 13% of HSL demand in 2016 arises from mode shift from car travel, rising in 2031 – when road congestion has worsened – to around 20%. It appears that in 2031, road congestion has worsened to such an extent that mode shift is also occurring from car to classic rail (more easily substitutable given that classic rail services serve more diverse destinations than does HSL).

5.8 New generated demand forms only 17-18% of total HSL demand – a relatively conservative forecast compared with international experience on other high speed lines.

5.9 Clearly, demand varies considerably by HSL option and generally moves in line with HSL route length. Figure 5.2 groups the demand results into categories of options: westerly (Options 1, 3 and 4), easterly (Options 15 and 16), two-branched (Options 2, 6, 7, 8 and 10) and segregated (Option 11).

5.10 The results by option reveal that:

- the westerly options have similar but slightly higher levels of patronage than the easterly options. When the ECML Upgrade is de-scoped, however, patronage levels on the easterly options are higher. In this case the demand figures for these tests appear higher due to the increase in journey time savings potentially available via HSL;
- the two-branched options are not quite as successful in attracting demand as two single-branched options which is caused by the compromise to journey times – in this case to east coast destinations – that arises from having one core route section from London to the West Midlands;
a fully segregated network, because it does not serve the wider destinations of a non-segregated network, involves a loss of demand, despite the journey time and performance advantages.

**Figure 5.2 – HSL Demand by Option**

5.11 An extensive set of sensitivity tests was carried out to understand the impacts upon demand of the characteristics of the high speed line, policies on management of the rail network, different base case scenarios and demand modelling parameters. It was found that the factors that have the most impact on HSL demand are:

- underlying growth levels, as demonstrated by the tests of alternative future world scenarios;
- the level of journey time improvements that can be achieved by HSL;
- fares policy – we assumed a fare premium over existing rail services, but this could be optimised to increase both demand and revenues.

5.12 In contrast, other factors, such as level of services operated on the classic network, HSL frequency and fare competition from other modes do affect HSL demand, but to a much more limited degree.

**IMPACT OF HSL ON OTHER MODES**

**Rail Network**

5.13 HSL has the greatest impact on the classic rail mode, in terms of demand shift. This is both because classic rail passengers tend to have the type of journey patterns that easily transfer to high speed rail, and also, as discussed earlier, classic rail service patterns and levels have been amended for each HSL option in order to remove excessive duplication of classic and HSL services.

5.14 For one of the larger options, the modification of service patterns results in a 50% reduction in seat capacity on Virgin West Coast (VWC) and GNER services, but the introduction of HSL leads to a greater reduction in demand, of 67% on VWC and 52% on GNER in 2016. Services on Midland Main Line (MML) have not been altered, but the greater competitiveness of HSL, particularly to Nottingham, has led to a 33% reduction in demand.
Table 5.2 – Impact on TOCs of HSL Option 8

<table>
<thead>
<tr>
<th>Daily passenger-km (million)</th>
<th>2016</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Case</td>
<td>With HSL</td>
</tr>
<tr>
<td>VWC</td>
<td>22.2</td>
<td>7.3</td>
</tr>
<tr>
<td>MML</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>GNER</td>
<td>23.7</td>
<td>11.3</td>
</tr>
<tr>
<td>Total (1)</td>
<td>50.4</td>
<td>21.6</td>
</tr>
</tbody>
</table>

(1) The total in this table is the total of these three TOCs; the total impact on the classic rail sector will be somewhat larger due to the accumulation of small impacts on other TOCs.

5.15 These shifts in demand will generally have a beneficial impact on capacity utilisation, in terms of reducing overcrowding. The potential impact of Option 8 is illustrated in Figure 5.3 for 2031 and comparison with Figure 2.5 shows the reduction in the sections of route that are high stress:

- on the WCML, the whole route is no longer crowded in 2016, and in 2031 crowding (but at lower levels than in the base case) is only occurring between London and Milton Keynes;
- on the MML, services are no longer crowded over any of the route in 2031;
- on the ECML, the only remaining crowded section in 2031 is London-Peterborough, although because of the withdrawal of classic services, this route section is also crowded in 2016.
5.16 Any residual crowding on the WCML or the ECML could be reduced further by utilising some of the freed capacity for VWC and GNER services, rather than assume it is taken up by other users. However, as a first pass, it was assumed that there is substantial benefit to be gained from freeing some capacity for other types of rail service, such as regional or local passenger services or for freight.

5.17 The reduction in classic rail patronage under each HSL option inevitably leads to revenue losses to the TOCs. Annual revenue losses range from £300 million to £1,700 million according to option, even when taking into account revenue gains on TOCs such as Virgin Cross Country.

5.18 These revenue losses clearly have an adverse effect on the viability of the West Coast, East Coast and Midland Main Line franchises. The TOCs will be able to make some savings in operating costs – which are taken into account in the economic appraisal – but these cost savings are relatively modest compared with the revenue losses. However, it is possible that some restructuring of the franchises, or optimisation of residual classic rail services, could reduce these net operating losses.

Highway Demand

5.19 In terms of overall highway demand, HSL has a minimal impact, even Option 8 affecting less than 1% of all highway trips within the demand model. However, when considering trips within scope of HSL, there is a more significant impact. Table 5.3 shows for selected origin-destination pairs the change in strategic travel movements by car. For destinations served by HSL, the reduction in highway demand is around 10% in 2016 and 20% in 2031.

Table 5.3 – Impact on Highway Demand of HSL Option 8

<table>
<thead>
<tr>
<th>Daily passenger trips</th>
<th>2016</th>
<th>% change</th>
<th>2031</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Case</td>
<td>With HSL</td>
<td></td>
<td>Base Case</td>
</tr>
<tr>
<td>London-Manchester</td>
<td>3,340</td>
<td>2,986</td>
<td>-11%</td>
<td>3,999</td>
</tr>
<tr>
<td>London-Leeds</td>
<td>4,049</td>
<td>3,749</td>
<td>-8%</td>
<td>4,446</td>
</tr>
<tr>
<td>London-Edinburgh</td>
<td>408</td>
<td>384</td>
<td>-6%</td>
<td>499</td>
</tr>
<tr>
<td>Manchester-Newcastle</td>
<td>588</td>
<td>525</td>
<td>-11%</td>
<td>643</td>
</tr>
<tr>
<td>Birmingham-Leeds</td>
<td>3,675</td>
<td>3,615</td>
<td>-2%</td>
<td>4,326</td>
</tr>
</tbody>
</table>

5.20 On a localised basis the effects on the highway network are minor (as in practice strategic movements are outweighed by local journeys), but still noticeable. Highways flows on competing north-south routes before and after HSL show that flows could be reduced by up to 5%.

5.21 However, the effect of this reduction in car traffic upon highway congestion, as measured by average speeds, is minimal, largely because there is such an underlying
increase in demand and congestion occurring in the base case scenario, particularly in 2031, that any freed-up capacity tends to be filled by suppressed trips.

**Air Market**

5.22 The impact of HSL on specific air markets clearly varies, according to how competitive HSL can be with that air market. Under Option 8, HSL provides a very competitive journey time from London to Edinburgh for example, and is slightly less competitive to Glasgow, which is reflected in the shift from the air market to HSL.

**Table 5.4 – Impact on Air Markets of HSL Option 8**

<table>
<thead>
<tr>
<th>Daily trips</th>
<th>2016</th>
<th>2031</th>
<th>% change</th>
<th>2016</th>
<th>2031</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Case</td>
<td>With HSL</td>
<td>% change</td>
<td>Base Case</td>
<td>With HSL</td>
<td>% change</td>
</tr>
<tr>
<td>London – Glasgow</td>
<td>12,909</td>
<td>12,352</td>
<td>-4%</td>
<td>17,067</td>
<td>14,924</td>
<td>-13%</td>
</tr>
<tr>
<td>London – Edinburgh</td>
<td>13,614</td>
<td>12,358</td>
<td>-9%</td>
<td>19,482</td>
<td>14,735</td>
<td>-24%</td>
</tr>
<tr>
<td>London – Manchester</td>
<td>2,979</td>
<td>2,649</td>
<td>-11%</td>
<td>3,673</td>
<td>3,004</td>
<td>-18%</td>
</tr>
<tr>
<td>Birmingham – Scotland</td>
<td>3,447</td>
<td>3,148</td>
<td>-9%</td>
<td>4,449</td>
<td>3,964</td>
<td>-11%</td>
</tr>
</tbody>
</table>

5.23 Overall, however, the impact of HSL on air demand is relatively modest, forecast to reduce total UK domestic point-to-point air travel by up to 7%. When domestic interlining traffic at UK airports is taken into account, the overall effect of HSL on UK domestic airport traffic is much less significant.

5.24 There is forecast to be a greater impact on the time-sensitive business market than in the leisure market. The leisure market will be deterred to some extent from shifting to HSL by the fare premium assumed for HSL services.

**Central London Dispersal**

5.25 A critical issue in assessing the viability of HSL is whether there is sufficient terminal capacity at London (and other key congested destinations) to handle forecast passenger flows, particularly in terms of onward travel by London Underground or other surface access modes.

5.26 To assess the potential impact of HSL on the number of passengers accessing London, passenger arrivals/departures on VWC, MML and GNER services were examined. Under the base case, peak arrivals into London from the strategic TOCs are forecast to increase by 82% to 2016 and by a further 40% to 2031 – this will place considerable strains on London’s transport network.

5.27 The net impact of HSL, taking into account mode shift from the strategic TOCs to HSL as well as the additional HSL passengers, is to increase these base case flows by up to 14% in 2016 and 29% in 2031.
5.28 These increases in passenger flows on London’s transport network clearly need to be taken into account in any future planning of HSL and London Underground capacity. However, our forecasts show that even without HSL, it is difficult to envisage how the increasing demands on the central London transport system will be handled without increasing passenger congestion levels.

**CONCLUSIONS**

5.29 Our demand forecasts suggest that HSL could attract considerable levels of demand, driven by the step-change in journey time and quality that HSL could deliver over current services.

5.30 Much of the patronage on HSL services would be passengers shifting from existing VWC, MML and GNER services. Even if these competing TOCs’ services are scaled back, HSL could reduce crowding quite substantially. Moreover, the capacity on the existing network that is released can be used to generate further benefits:

- either to existing VWC or GNER passengers, by retaining as many of these long-distance services as possible, thereby providing considerable capacity for strategic travel and choice for long-distance passengers;

- or to stimulate new rail markets by providing new local or regional passenger services or additional freight paths.

5.31 The potential impact of HSL on road congestion is much more muted than the impact on classic rail and any global benefits in terms of journey time reductions are difficult to detect. Similarly, the impacts on the air market are unlikely to have a substantial impact on total UK airport flows.

5.32 The potential impacts of HSL on London’s transport network – and any other city centre networks that are near capacity – could be significant and will need to be addressed in future planning decisions.
6. The Business Case for HSL

**APPRAISAL APPROACH**

6.1 The purpose of the business case appraisal of HSL is to understand whether there is a case for High Speed Line against the Government’s key criteria for transport schemes:

(i) **Environment** – an assessment of the impact of HSL on landscape, heritage, biodiversity, water, noise and air quality;

(ii) **Safety** – an assessment of the impact of HSL on accidents occurring on public and private transport;

(iii) **Economy** – a cost-benefit analysis of the user and non-user benefits of an HSL scheme, compared with the net resource costs of scheme implementation and operation. This is supplemented by an analysis of the wider economic effects of HSL;

(iv) **Accessibility** – an assessment of the strategic impacts on accessibility of the HSL;

(v) **Integration** – an assessment of the HSL’s integration with land use and other government policies, and of integration between transport modes.

**ENVIRONMENT**

6.2 The environmental impacts of HSL can be divided between the impacts on land use that arise from the construction of new infrastructure, and those impacts that affect air quality and noise, arising from the operation of high speed trains and changes in travel patterns.

**Land Use Issues**

6.3 The study’s GIS was used to identify the HSL’s potential impacts on landscape, biodiversity, heritage, urban areas and water, based on the indicative alignments. The key issues arising under each heading are summarised below, indicating which route sections give rise to the most significant impacts, although it should be noted that the actual impacts will depend upon the final alignments selected.

6.4 The main areas of potential impact on landscape issues are:

- Due to its location and close proximity to London, the Chilterns AONB would, therefore, be difficult to avoid but could be tunnelled. This affects the London to West Midlands core route section;

- In the sections containing a cross country route section from Manchester to Leeds, the Peak District National Park could be severed, but again this could be tunnelled;
Any potential alignment into Manchester is likely to pass in close proximity to Cannock Chase AONB, and similarly some route sections to Newcastle could pass, but not sever, the Northumberland National Park;

various pockets of Ancient Woodland are likely to be severed, the severity of the impact generally dependent on the length of different options;

the longest options generally have the greatest impact on open countryside, Tranquil Areas and Green Belts.

6.5 The main areas of potential impact on biodiversity issues are:

- the Dark Peak/South Pennine Moors SPA/SAC. This may be severed by a segregated trans-Pennine line, although the impact would, to a large extent, be mitigated through tunnelling;

- the Cannock Extension Canal SAC may be severed in small part by the West Midlands-Stafford route section;

- the North Shotts Moss SAC, between Edinburgh and Glasgow, would be severed by a segregated line between Edinburgh and Glasgow;

- a number of SSSIs are severed under most options.

6.6 The main areas of potential impact on heritage issues are:

- Edinburgh City Centre World Heritage Site, which is severed by the route section serving Scotland, although the impact could be mitigated to some extent by tunnelling;

- a number of conservation areas may be affected by options which provide connections to city centre stations. It can also be expected that a number of listed buildings will be affected by new routes passing through urban areas.

6.7 The impact on urban areas ranges from approximately 12 km to 100 km. The length of HSL route passing through urban areas is closely correlated with route length and the number of city centre stations. Large sections of the routes can however be placed in tunnel and the current HSL options allow for between 50% and 75% of the length in urban areas being placed in tunnel.

6.8 The impact on the water environment is assessed through examination of how much route crosses floodplains. All options cross floodplains, the number and extent being closely related to the option length. The length of floodplain affected ranges from approximately 10 km to approximately 56 km. Floodplains are most extensive on the eastern side of the country and the route section from London through Peterborough to Nottingham has a proportionately greater impact on floodplains. The impact on fluvial floodplains is much greater than tidal floodplains.
6.9 There is scope for mitigation of many of these impacts at a more detailed design stage, by route realignment, by tunnelling (particularly effective in minimising landscape impacts) or by more detailed mitigation measures such as landscaping or noise insulation.

**Noise**

6.10 Analysis of the HSL demand forecasts demonstrated that the predicted mode shift from roads, classic rail and air transport to HSL would be unlikely to make a material difference at properties currently affected by noise from those transport modes. As it is assumed that new rail lines would be designed with appropriate noise mitigation, the greatest effect would probably be of a localised nature, brought about by changes in road traffic movements in the vicinity of some of the stations serving HSL.

**Air Quality**

6.11 With respect to air quality, emissions of carbon dioxide, oxides of nitrogen and particulate matter (PM₁₀) from classic rail and road vehicles are expected to decrease with all HSL options. (Carbon dioxide is the most important greenhouse gas and oxides of nitrogen and PM₁₀ are of particular concern in relation to local air quality.) The largest reductions in emissions are associated with the more extensive HSL options which are likely to bring about the largest decreases in distance travelled by road – Option 8 for example, is expected to reduce passenger travel by road by 650,000 passenger-km per day. Although the modal shift from air travel to HSL is expected to reduce passenger kilometres travelled by air, the reduction is likely to be insufficient to reduce the number of flights; hence, emissions from air transport are unlikely to be affected by HSL.

**SAFETY**

6.12 The impact of HSL on safety was assessed through forecasting the change in the number of accidents that are likely to occur. This will be affected by:

- the reduction in accidents that arises from transfer of passengers from road to rail;
- any offsetting increases in accidents on HSL;
- the degree of segregation of the HSL network – a new segregated network has the potential for considerably higher levels of safety than a system that is integrated with the existing rail network.

6.13 The safety assessment was therefore based on the demand shifts between modes and the different levels of traffic under each HSL option.

6.14 As an example, the mode shift that is forecast to occur in 2016 under Option 1 results in the avoidance of 374 accidents per annum, the vast majority of which are categorised as Slight. This leads to an annual accident saving benefit of £17 million, with 64% of this benefit arising from the highly valued Fatal accidents.
6.15 The sources of the accident savings, in terms of the modal shift, are shown above. This demonstrates that, in line with the demand forecasts, the most significant mode shift is in classic rail to HSL – and this drives the majority of the accident savings. As Option 1 is non-segregated, this reduction in accidents on non-HSL modes is offset to some extent by accidents on HSL, a total of 157 in 2016 and 323 in 2031. (Fully segregated HSL options are assumed to have a negligible accident rate.)

6.16 Assessing safety impacts across options shows clearly that those options that attract the highest demand onto HSL and hence the greatest transfer from road to rail modes show the greatest benefits. HSL options which have a greater degree of segregation also show greater benefits.

**ECONOMY**

**Cost-Benefit Analysis**

6.17 The key components of the cost-benefit analysis of HSL are:

- net revenues, taking into account HSL revenue, offset by reductions in revenues for existing TOCs;
- non-financial benefits, primarily journey time savings to users, but also including savings in accident costs and non-user benefits;
- any benefits arising from the freed capacity on WCML and ECML – which in the first instance is assumed to be utilised by regional, local or freight services
- capital costs of developing and constructing the HSL, including risk contingencies;
- the costs of operating and maintaining the line, again, including risk contingencies, net of any cost savings that can be made on classic rail services.

6.18 For Option 1, presented as an example of the results, there is clearly a surplus of benefits over costs, leading to a net benefit of £3.5 billion over the 50-year appraisal
period. The ratio of benefits to costs is 1.4 to 1. The undiscounted capital cost of this option – which is one of the shorter options considered – is £9.9 billion.

### Table 6.1 – Cost-Benefit Analysis, HSL

<table>
<thead>
<tr>
<th>NPV, £ billion</th>
<th>HSL Option 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net revenue</td>
<td>£2.0 bn</td>
</tr>
<tr>
<td>Non-financial benefits</td>
<td>£8.8 bn</td>
</tr>
<tr>
<td>Released capacity</td>
<td>£1.1 bn</td>
</tr>
<tr>
<td>Total benefits</td>
<td>£11.8 bn</td>
</tr>
<tr>
<td>Capital costs</td>
<td>£5.8 bn</td>
</tr>
<tr>
<td>Net operating costs</td>
<td>£2.6 bn</td>
</tr>
<tr>
<td>Total costs</td>
<td>£8.4 bn</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>£3.5 bn</td>
</tr>
<tr>
<td>Benefit: Cost ratio</td>
<td>1.41</td>
</tr>
</tbody>
</table>

6.19 The key factors that affect the viability of HSL are illustrated below, with factors that affect only HSL highlighted in red, and factors that would affect any rail scheme in yellow.

6.20 Aside from the discount rate, the key factor that affects the case for HSL is the underlying growth rate, as modelled in the four future world scenarios. If growth materialises at the level of the Provincial Enterprise or Local Stewardship scenarios, then there is no business case for HSL, unless implementation is deferred.

However, if growth is higher than our central case, this clearly improves the business case.

**Figure 6.2 – Sensitivity Tests, Impact on HSL Option 1**

6.21 The case for HSL has the potential to be improved by:

- fine-tuning the changes to the classic rail service – it was found that using freed capacity on WCML and ECML for inter-city VWC or GNER services instead of new regional, local or freight services would significantly improve the journey time benefits to rail users - and could increase the BCR to 1.70;
- adopting a suitable targeted fare strategy – the sensitivity tests demonstrated that the fare premium as modelled (at 30-50% above classic rail fares) has
an excessive impact in deterring passengers, so that passengers and revenues could be improved by a lower premium to some destinations – together with fine-tuning the changes to classic rail services, this could improve the BCR up to 2.00;

- air travel costs – if instead of unconstrained air demand growth we model an increase in the costs of air travel (that might arise, for example, from the imposition of environmental taxes), this improves the mode shift of air passengers to HSL;

- trip generation – a more optimistic assumption on the proportion of new passengers attracted by HSL (as experienced on other high speed lines) would improve the economic case.

6.22 However, the tests also show that the case for HSL could be seriously damaged if:

- the estimated journey time improvements are not achieved;
- fares policy is not optimised, so that passengers are priced off the HSL;
- customers do not perceive HSL as an inherently attractive premium product.

6.23 Other factors, such as cost increases, HSL service frequencies, the SRA’s Capacity Utilisation Policy and construction delays, have little overall impact on the economic case.

6.24 An indication of the range of results for different HSL options is set out below, for some of the key options.

Figure 6.3 – Cost Benefit Analysis, HSL Options

6.25 The implications of these option results are that:

- the longer routes that serve Scotland directly (e.g. Option 8) can yield very high net benefits, although the capital cost of this scheme, at £33 billion, could be considered to be prohibitive;

- westerly routes serving Birmingham and Manchester (Options 1 and 3) perform better than easterly routes that serve Leeds (Option 16). It should be noted that if the ECML were only upgraded to the “1C” level,
then the benefit-cost ratio of Option 16 would improve from 1.23 to 1.31;

- a two-branched option (Option 6) performs worse than two single lines (Option 3 plus Option 16), due largely to the additional cost required for Option 6 to provide sufficient capacity on the core route;

- a fully-segregated route (Option 11) is viable, although the nature of such a scheme means that a relatively large scheme (this option costs £27 billion) needs to be constructed in one phase in order to produce the necessary demand and economic benefits.

6.26 Other tests also provided some important conclusions:

- providing links to either the Channel Tunnel Rail Link or to Heathrow Airport improves the case for HSL, in large part by expanding the number of HSL termini in London;

- phasing development has little impact on the cost-benefit analysis, but would clearly aid affordability.

- a parallel freight route is unlikely to generate sufficient revenues or benefits to cover the incremental capital costs of construction;

6.27 In economic terms, it is clear that there is a case for the construction of HSL as long as economic growth continues to drive the demand for rail travel over the long term. The characteristics that improve the HSL case are:

- a passenger-only line, without provision for dedicated freight lines;

- either a single line into London or two single lines, rather than a core southern section with two branches east and west;

- a westerly orientation (although easterly options can also be viable, particularly if the full 2+ upgrade is not implemented on ECML);

- more than one London terminus, particularly if these provide connections for international travel;

- faster journey times;

- a perception of premium service.

6.28 In the long term, a line serving Scotland and full segregation are both viable and attractive options. However, the costs of constructing these options are considerable and affordability constraints are likely to mean that these are desirable “end states” rather than realistic options in the first stages.

**Wider Economic Impacts**

6.29 The potential wider economic impacts of the HSL have been assessed by considering recent and future trends in economic competitiveness across the regions, conurbations and towns that may be served by the HSL and appraising how these might change with HSL, taking into account current thinking on the links between transport infrastructure and economic performance.
6.30 Assessing changes in accessibility before and after HSL, weighted by population, HSL is projected to stimulate the highest absolute gains in jobs and population – compared to Government forecasts – in London. The other regions for which there is a positive impact on jobs and population benefit to a lesser degree, but include most of the lagging regions – Scotland, Yorkshire and Humber, the North East, the West Midlands and the North West. The losers are Wales and the fast growing regions – the South West, South East and the East of England.

6.31 Thus HSL is anticipated to take some of the heat out of the fastest growing regions and fits in well with regional policy to improve the performance of the lagging regions. Moreover, HSL is also projected to assist all of the English conurbations, but with London being the greatest beneficiary in absolute terms.

6.32 Overall therefore, we consider that HSL will be beneficial to the Government’s urban renaissance and regional policy agendas. Nevertheless, the impact of HSL will not be strong enough to fundamentally alter the projected geographical pattern of jobs. Greater London and the conurbations gain jobs and population because it is in these locations where the concentration of businesses in the producer services sectors are found, and it is these business activities which stand to gain most from the introduction of HSL.

ACCESSIBILITY

6.33 The accessibility impacts of HSL were considered in four categories:

♦ Service frequency;
♦ Crowding effects;
♦ Speed;
♦ Interchange.

6.34 The potential improvement in crowding levels on classic rail services that arises from the introduction of HSL was discussed in chapter 5. Clearly, not all options will be as effective as the Option 8 presented in Figure 5.3. Some HSL options only serve the west or the east of the country and so would still leave either the WCML, the MML or the ECML with crowding problems. However, on balance, HSL makes a significant contribution to addressing rail crowding issues and would itself be unlikely to suffer from crowding before 2031.

6.35 Interchange has been assessed by considering the population that would have easy access to an HSL station. This ranges from 3.4 million people for the shorter options, to a maximum of 5.6 million people for the large two-branched options.
6.36 **Speed** impacts are affected both by the improvements in journey time that HSL could deliver and by the revisions to classic rail service patterns. These impacts on the catchment area of selected cities was analysed using the GIS – and demonstrates the potential impact of Option 8 on the expansion of the catchment area for London.

6.37 The figures overleaf illustrate how many areas (based on demand model zones) are now brought within one, two or three hours travel of the capital, and illustrate the significant improvement that HSL could deliver.

6.38 In terms of **service frequency**, all destinations that are served by HSL benefit from increases in the numbers of trains per hour, even when taking into account the removal of competing classic rail services. Some destinations on the classic network benefit from an improvement in service levels from the revisions to the residual services.

6.39 However, for many destinations not served by HSL, the residual classic services in some cases are slower to enable additional destinations to be served, and in some cases significant reductions in frequency occur. It was noted in the cost-benefit analysis that reinstating some of the classic services has the potential to improve the economic case, and it appears from our accessibility analysis that a detailed review of classic rail service patterns is necessary to avoid disadvantaging passengers who remain on classic rail services.

6.40 Overall then, HSL has the potential to improve public transport accessibility considerably, when considering service frequencies, crowding, interchange and speed. Unsurprisingly, the longer HSL options have the largest impacts, although impacts even for the shorter options show significant improvements over the base case.

6.41 There are potentially adverse effects, however, on accessibility levels for those classic rail passengers not served by HSL. If HSL were to be progressed to the next stage of development, then considerable option development effort would need to be put into minimising or mitigating these impacts.
Figure 6.5 – Accessibility to London: Base Case

Figure 6.6 – Accessibility to London: HSL Option 8
INTEGRATION

6.42 HSL’s potential integration with national and regional policy on economic development, urban development environment and transportation has been reviewed. Overall, HSL has the potential for a good fit with national and regional policies on economic development, urban development, environment and transportation. However, much of the policy benefit of HSL will depend on the routeing, characteristics and design of any preferred scheme.

6.43 The integration of HSL with other modes of transport would be an essential part of the design process. The best integration with public transport will be provided by the provision of HSL services at existing classic rail stations, followed by new build stations in city centres (which are assumed to be adjacent to or beneath the existing main classic station). Parkway stations, although not preferred in policy terms, will tend to have less integration with public transport networks, but provide good connectivity for private car travellers. It may be possible to create “transport hubs” at certain locations, even if these be out-of-town.

6.44 In the main, particularly for the shorter options, HSL is served using existing main line city centre stations, some of which will require some remodelling for HSL. This remodelling provides opportunities for improvements to existing passenger and interchange facilities and so could provide wider benefits.

CONCLUSION

6.45 Looking at HSL as a concept, on balance there does appear to be a reasonable business case for HSL:

♦ Safety on the transport network has the potential to be improved by HSL, when the shift of traffic from road to rail leads to a net reduction in total accidents. Safety benefits will be maximised when the HSL is segregated from the classic network;

♦ There is an economic case for HSL, which could be improved significantly from our estimates by optimising fares structures and HSL/classic rail service patterns. The economic case deteriorates under lower demand growth forecasts or if the modelled improvement in journey times is not achieved. However, there is potential upside under different forecasting assumptions on, for example, trip generation rates or changes in the air sector; moreover, the case for HSL improves considerably over time;

♦ Accessibility to the public transport network could be substantially widened by HSL, which delivers a step-change in service frequency, population catchment and speed. The potential downside, which would need careful examination at the next stage of project development, arises from the modification of classic rail services;
- **HSL has a reasonable level of integration with land use and transport policy**, as long as the line serves city centres and seeks to minimise significant adverse effects upon the environment. In transport terms, the HSL can be designed to be well integrated with other transport networks.

6.46 However, the environmental issues clearly need to be addressed:

- **In environmental terms, it is difficult to construct a new railway without significant adverse impacts upon the natural and built environment.** These adverse impacts can in many cases be mitigated, by, for example, tunnelled rather than at-grade construction. However, some or all of our current HSL options affect a number of important natural and heritage resources, such as the Chilterns AONB, the Peak District National Park as well as several SSSIs and blocks of ancient woodland. The HSL would also cause severance over a considerable distance of hitherto undisturbed open countryside. While there are potentially some environmental benefits through improvements to air quality, noise levels and reductions in greenhouse gas emissions, these are likely to be relatively modest.
7. The Business Case for Alternatives to HSL

7.1 Comparing HSL with alternative investment scenarios – a new classic line, upgrades of the existing classic railway, a roads programme or an airport programme – shows that HSL compares differently under the five appraisal criteria.

7.2 The summary table overleaf provides an explicit comparison of HSL with the alternatives:

- **Environment** – HSL is potentially more damaging than other rail-based schemes, but is likely to be better than a road investment programme. The environmental case for HSL vs air travel is unproven;

- **Safety** – HSL delivers a greater reduction in total accidents than any of the alternatives;

- **Economy** – HSL performs better in cost-benefit analysis terms than other rail or road schemes, but is difficult to compare on a like-for-like basis with airport investments;

- **Accessibility** – unlike the alternatives, HSL has the potential to deliver a big step-change in accessibility, which means it is capable of addressing rail crowding problems as well as triggering a range of wider social and economic benefits;

- **Integration** – in common with the rail alternatives, HSL has a good policy fit, except for HSL’s greater environmental disadvantages, but is preferred to road and airport schemes.

7.3 On balance, on safety, economic and accessibility grounds, the case for HSL is stronger than the alternatives considered here. Upgrading the existing classic railway performs better in environmental terms, but cannot provide the greater opportunities of HSL in restructuring the rail network, which could result in substantial economic and accessibility gains.
### Table 7.1 – Appraisal of Alternatives to HSL

<table>
<thead>
<tr>
<th></th>
<th>HSL</th>
<th>New Classic Line</th>
<th>Classic Upgrades</th>
<th>Roads Programme</th>
<th>Airport Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environment</strong></td>
<td>Adverse impacts on natural and built</td>
<td>Similar to HSL, but adverse impacts are</td>
<td>Much more limited land-take and hence</td>
<td>Actual and perceived impacts are likely</td>
<td>Local impacts are site- and scheme-specific. A greater impact on greenhouse gases, but comparison of local air quality and noise impacts with HSL is inconclusive.</td>
</tr>
<tr>
<td></td>
<td>environment are likely, while</td>
<td>easier to avoid. However, benefits will</td>
<td>fewer adverse impacts than HSL.</td>
<td>to prove contentious, even though road</td>
<td></td>
</tr>
<tr>
<td></td>
<td>improvements to noise and air quality</td>
<td>also be of a lower scale.</td>
<td></td>
<td>widening is probably less intrusive than</td>
<td></td>
</tr>
<tr>
<td></td>
<td>will be modest.</td>
<td></td>
<td></td>
<td>HSL. Noise and air quality impacts will</td>
<td></td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>An overall reduction in forecast</td>
<td>Slightly negative impact as mode shift</td>
<td>Slightly negative impact as mode shift</td>
<td>Negative impact from increase in road</td>
<td>Any impacts likely to be modest as mode</td>
</tr>
<tr>
<td></td>
<td>casualties, arising from mode shift and</td>
<td>from car is outweighed by increase in</td>
<td>from car is outweighed by increase in</td>
<td>travel.</td>
<td>shifts are low compared with HSL.</td>
</tr>
<tr>
<td></td>
<td>segregation of HSL.</td>
<td>accidents from generated traffic.</td>
<td>accidents from generated traffic.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Economy</strong></td>
<td>A positive economic case, depending</td>
<td>On balance, a positive case, but lower</td>
<td>A positive case for a WCML upgrade, but</td>
<td>A positive case for a road investment</td>
<td>Very airport-specific, the economics</td>
</tr>
<tr>
<td></td>
<td>on option, with BCRs up to 2:1</td>
<td>speeds means that it performs less well</td>
<td>delivers lower net benefits than HSL</td>
<td>programme, but delivers lower net</td>
<td>tending to be more favourable (and positive) for extensions rather than new airports.</td>
</tr>
<tr>
<td></td>
<td>achievable.</td>
<td>than HSL when compared on a like-for-like</td>
<td></td>
<td>benefits than HSL.</td>
<td></td>
</tr>
<tr>
<td><strong>Accessibility</strong></td>
<td>Considerable improvements in service</td>
<td>Improvements are likely to be similar to</td>
<td>Service frequencies and crowding</td>
<td>Minimal improvements compared with rail</td>
<td>Some potential for benefits from air</td>
</tr>
<tr>
<td></td>
<td>frequencies, crowding, interchange and</td>
<td>HSL for comparable schemes, but speed</td>
<td>benefits can be secured, but on</td>
<td>schemes, except at a local level.</td>
<td>service frequencies and interchange, but</td>
</tr>
<tr>
<td></td>
<td>speed are achievable.</td>
<td>benefits will be lower.</td>
<td>interchange and speed upgrades</td>
<td></td>
<td>crowding and speed benefits likely to be</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>Good fit with policy and potential for</td>
<td>Similar policy fit to HSL, but beneficial</td>
<td>Good fit with policy. Again, development</td>
<td>Performs relatively poorly in terms of fit</td>
<td>Fit with policy and integration with other</td>
</tr>
<tr>
<td></td>
<td>integration with other modes,</td>
<td>development impacts are likely to be</td>
<td>benefits will be lower than for HSL, but</td>
<td>with environmental policy and delivery of</td>
<td>modes is very scheme-specific, but on</td>
</tr>
<tr>
<td></td>
<td>depending on scheme design.</td>
<td>less pronounced.</td>
<td>fit with environmental policy is better.</td>
<td>benefits.</td>
<td>balance likely to be more difficult to</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>support than HSL.</td>
</tr>
</tbody>
</table>
8. Planning the HSL

**PROJECT DEVELOPMENT**

8.1 If the SRA wishes to progress the HSL project, the next stage of project development would be to develop and appraise more detailed options in order that decisions can be made on the geography of the scheme. Ideally, this would be a phased process to select:

- Firstly, the regions or markets HSL should access;
- Then, the destinations HSL should serve;
- And finally, the route corridor HSL should use.

8.2 A process that encompasses these appraisal stages and decision points is set out in the figure opposite. The key phases are:

- **Development of a high level HSL strategy**, with long term goals for future development and a chosen authorisation route. Input from regional policies and plans and from the Strategic Environmental Assessment will aid the SRA in selecting the key markets or regions that should be served by HSL;

- **Assessment of HSL operations and performance**, to understand the various operational solutions that could serve the selected markets by HSL or classic rail services, taking into account operational constraints and the interfaces with the classic rail network. This will allow the SRA to identify the destinations to be served by HSL and residual classic services and will result in an outline service delivery specification;

- **Development and design of HSL infrastructure** to meet the service delivery specification, in order to appraise a long-list of route corridor options and sub-options. This should identify a preferred scheme that will go forward for the application of legal powers.

![Figure 8.1 – HSL Project Development Process](image)
COMMUNICATION STRATEGY

8.3 Communication and consultation with stakeholders will be necessary throughout the development of the HSL scheme and should build on the consultation already carried out during this study. Effective communication can engender a sense of ownership among consultees, reduce positions of entrenchment and can facilitate the process of implementation of a scheme or strategy.

8.4 It will be important for the SRA to be clear about what message it is presenting and how much involvement stakeholders can realistically have in the decision making processes, as consultation raises expectations among groups or individuals who have been engaged.

8.5 Communication and consultation on the HSL will be a continual ongoing process which will evolve as the scheme develops, both in terms of the information being communicated and the stakeholders that will be included. For example, during the initial feasibility phases it is only necessary to involve those stakeholders involved in shaping policy such as regional government agencies, whereas once a number of routes have been developed it will be important to involve the general public. The groups that should be consulted include:

♦ the wider SRA organisation – throughout the development of the project;

♦ central Government – particularly when key decision points are reached;

♦ local government and regional bodies - for input into the selection of markets and route corridors;

♦ organisations involved in the provision of transport services, such as PTEs or TOCs – to ensure that the HSL schemes developed are operationally viable;

♦ statutory environmental bodies – for input into the Strategic Environmental Assessment and the selection of route corridors;

♦ the private sector, in terms of the rail construction industry and financiers – to ensure that the HSL procurement and financing strategy is workable;

♦ the general public – at key points during the study to allow participation in the decision-making process.

8.6 It is recommended the SRA produce a communication strategy for the HSL project, which details critical points at which information will have to be disseminated and appropriate groups and organisations consulted.

PROJECT AUTHORISATION

Procedural Routes

8.7 Once a preferred HSL scheme has been selected, the necessary statutory authorisations to obtain powers to construct, operate and use the railway will need to be
obtained. There are four possible procedural routes currently available for promoting the project:

- Hybrid Act of Parliament;
- Private Act of Parliament;
- Transport and Works Act (TWA) Order;
- Scottish Provisional Order.

**Table 8.1 - Principal Characteristics of the Four Authorisation Routes**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Hybrid Act</th>
<th>Private Act</th>
<th>TWA Order</th>
<th>Scottish Provisional Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available in England</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Available in Scotland</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Promotable by SRA independently</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Promotable only by the Government</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Public Inquiry</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Procedures wholly within Parliament</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Parliamentary stage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Challengable in High Court</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Capable of amending public legislation</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Subject to environmental assessment</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

8.8 A Hybrid Act is likely to have practical benefits, in that it can include a wider range of powers, and is likely to be less costly and much quicker than a TWA Order.

**Phasing of HSL**

8.9 If the implementation of HSL is phased, there are factors which affect the choice of promotion route:

- the shorter and more straightforward the stretch of railway to be constructed, the more difficult it would be to persuade the Government that a Hybrid Bill is justified in principle, particularly in the face of competing priorities on the legislative programme;

- the greater the number of phases of HSL that require separate promotions, the more likely it is that Government will insist on all phases – or (perhaps) all phases other than the first – being promoted by TWA Order;

- the more powerful the arguments on the non-availability, insufficiency or inappropriateness of other procedural routes, the greater the chance that the Government will be more willing to countenance a Hybrid Bill.

**Promotion Strategy**

8.10 It will be particularly important for the SRA to develop a promotion strategy if the project is to be phased. If this means that the project has to be divided between promotion instruments,
♦ it should be done logically and to a clear strategy;
♦ the division of powers between instruments will need to be considered carefully at the outset and dovetailed accordingly;
♦ the manner of division will impact upon the practical availability of the various promotion routes.

8.11 If the project is phased it will be important to “sell” the whole concept as well as the particular phase being promoted. It will also be important to sell the benefits to be derived at more remote locations, even while only part of the whole concept is operational.

**Recommendations**

8.12 The pre-procedural stages of a Hybrid Bill may take longer than those of a TWA Order and the Government may be reluctant to contemplate a route other than a TWA Order. However, if the Government can be persuaded to include an HSL bill in its legislative timetable at the required time, there are immense advantages in being able to rely on a swift, Government-led, powerful promotion method such as a Hybrid bill. Subject to monitoring the Human Rights Act situation this is the recommended promotion vehicle for the earliest, longest and most important phase.

8.13 Subsequent phases would almost certainly have to be promoted by TWA Order (and in Scotland a Scottish Provisional Order) as the Government is unlikely to be willing to promote more than one Hybrid Act. It would therefore be sensible to try and get as much as possible included within the initial Hybrid Bill.

8.14 It is important to recognise that wider political considerations and changing priorities of key players will fundamentally affect HSL progress. They will be even more critical if a Hybrid Bill is used as the means of promotion and for any project of this scale and significance the Cabinet and senior civil servants will wield profound influence.

**PROJECT DEVELOPMENT TIMESCALES**

8.15 During the course of the study we have assumed that the HSL could be operational by the beginning of 2016, i.e. within 13 years. As our indicative project development programme shows, this means that project development would need to begin immediately, in order to allow sufficient time for the application for legal powers and for the construction period. This assumes that authorisation for the first phase of development is obtained through a Hybrid Act process; should this not be possible, then the timescales for authorisations and applications approvals are likely to increase.
8.16 On the basis of this programme therefore, it is achievable, if challenging, to develop and construct a High Speed Line by 2016, although if delays occur in the development of the scheme or at key decision points, the programme could easily slip beyond this date.
9. Conclusion

Is there a Transport Case for HSL?

9.1 Our forecasts of north-south travel movements in the UK show that the strategic rail network is likely to experience considerable overcrowding in the long-term unless action is taken. This holds true under a range of scenarios and suggests that the West Coast Main Line will be overcrowded by 2016 and the East Coast and Midland Main Lines by 2031.

9.2 This is taking place against a forecast increase in congestion on the highway network, leading to a reduction in average travel speeds for car journeys.

9.3 Depending on route option, an HSL is capable of relieving much of the crowding on competing rail routes. Similar improvements could also be secured by upgrading the existing strategic rail network, but HSL has the advantage of also being able to free capacity on the existing rail network that can be used to open up new local, regional or freight markets.

9.4 We therefore conclude that there is a good transport case for HSL.

Is there a Business Case for HSL?

9.5 In economic terms, HSL has a positive case, generating a benefit: cost ratio of at least 1.4 to 1\(^1\) – and it is possible to improve this significantly by optimising the use of freed classic rail capacity and by fine-tuning the fare strategy.

9.6 Other alternative investments do not deliver the journey time or capacity benefits of HSL and so do not perform as well economically as HSL. HSL also has the potential to provide substantial safety and accessibility benefits which other schemes cannot match.

9.7 HSL’s key weakness is in its environmental impact – the construction of a new railway will inevitably lead to significant impacts upon the environment. However, our appraisal has shown that it is possible to develop a scheme that avoids the most critical environmental designations and mitigates the worst impacts.

9.8 On balance, therefore, there is a good business case for HSL, and it is capable of delivering greater net benefits than other rail or highway schemes.

\(^1\) Original tests had ratio between 1.4 and 2 to 1, however, when they were re-run, using the revised Green book guidelines, this increased to between 1.9 and 2.8 to 1. See addendum for further details.
How can HSL be Delivered?

9.9 If the SRA wishes to progress the HSL project and wishes to achieve an opening date of 2016, project development would need to commence without delay. Securing the legal powers through a Hybrid Bill is the recommended route, as it has considerable advantages in terms of practicality and timing. However, this route is only likely to be practicable for the first and most important phase of HSL, so it will be important to secure a strong statement of government support for the HSL concept as a whole.
APPENDIX A
Appendix A

**Options**

Brief descriptions of each option are available below and an indicative route network is available in figure 4.1 of the main report.

Please note, however, that options 5 and 9 were rejected in the first round of testing.

**Option 1**

This is the core network, with new build track from northwest London to Staffordshire. Spurs join the classic network for services to Birmingham, Manchester, Liverpool and the northwest via WCML.

**Option 2**

The core network from London to Staffordshire, as option one, but with an additional branch to serve the East Midlands, Sheffield and Leeds. From Leeds access is available to the ECML.

**Option 3**

The core network is extended northwards into Lancashire allowing connections north via WCML. Connections are also possible via the classic network into Liverpool. A separate HSL branch serves Manchester.

**Option 4**

Building upon Option 3 with a link across the Pennines to Leeds. Connections beyond to the northeast are available via ECML.

**Option 6**

Option 6 combines of the infrastructure in Options 2 and 3 to serve Manchester and the East Midlands, Sheffield and Leeds. Onward connections available to both the ECML and WCML.

**Option 7**

This option builds on Option 6 by extending northwards from Lancashire and Leeds to Tyne and Wear. Again, onward connections available to both the ECML and WCML.

**Option 8**

This is an extension of option 7, with HSL added between Tyne and Wear all the way to Edinburgh and Glasgow.

**Option 10**

A complete network north south HSL network adding a cross Pennine link between Manchester and Leeds to Option 8. This option would allow several cross country routings.
Option 11
This is a fully segregated option with no connections to the classic network. A ‘Y’ shape network serving the West Midlands and Manchester via one spur, and an easterly alignment to serve Nottingham, Leeds and Newcastle.

Option 12
This variant builds on Option 7, with the addition of a link to the CTRL in London allowing links to Europe.

Option 13
This variant builds on Option 7, with the addition of a link between Heathrow airport and the main HSL line north of London.

Option 14
Using Option 3 as a base, in this case a pair of parallel two track sections, to allow for additional freight services is assumed between London and Manchester.

Option 15
A short easterly alignment, from northwest London to East Midlands via Peterborough, with a connection for services to the north via the ECML near Peterborough.

Option 16
Another but more extensive easterly alignment from London via the East Midlands Leeds, with a connection for services further north via ECML.

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APPENDIX B

ADDENDUM TO SUMMARY REPORT
High Speed Line Study

Addendum to Summary Report

Contents

1. Introduction
2. Revisions to the ‘Green Book’
3. Re-scoping of the ECML Upgrade
4. Road User Charging
5. Conclusions
1. Introduction

1.1 This document sets out the results of supplementary work undertaken by Atkins for the SRA following completion of the main High Speed Line (HSL) study in February 2003. The work was undertaken in the light of changed circumstances since the bulk of technical work was carried out in 2002, to assist the SRA in determining how to progress future project planning. The document therefore sits as an addendum to the main study report.

1.2 The three areas of change considered can be summarised as follows:

- Revisions to the Treasury’s ‘Green Book’ guidance for project appraisal;
- Re-scoping of the East Coast Main Line Upgrade project; and
- Need for greater consideration of Road User Charging (RUC).

1.3 Each of these areas is discussed in turn in the remainder of this document.

2. Revisions to the ‘Green Book’

2.1 A new Treasury ‘Green Book’ was published in 2003. This document fundamentally changed the parameters used in standard appraisals, with measures such as reductions to the accepted discount rate, and the introduction of an optimism bias to inflate estimated scheme costs.

2.2 The HSL options were therefore re-appraised in the light of the revised guidelines. The main parameters altered in the revised HSL appraisal were as follows:

- Discount rate of 3.5% p.a. for the first 30 years, 3% p.a. thereafter;
- Optimism bias of 66% was applied uniformly to the capital costs of all options, replacing the risk allowance of 30% used in Phase 3 of the main study;
- Programme bias of 25% to be applied.

2.3 In addition a further change was made to the treatment of capital costs in the new appraisal. In the main study capital costs were treated as an annuity charge across the entire project life. This included a cost of capital. For this updated analysis, it has been assumed that the entire capital cost would be charged upfront, via a capital grant, during the pre-power and construction period. The new appraisal therefore excluded any financing costs, in addition to including the changes in the revised ‘Green Book’.
2.4 The results of the analysis for options 1 and 8 are summarised in Table 2.1. The table also shows the results of the original appraisal for the two options to allow comparison with the new revised appraisal.

Table 2.1 – Cost Benefit Analysis, HSL Options 1 and 8

<table>
<thead>
<tr>
<th>£ Bn (PV)</th>
<th>Previous (December 2002)</th>
<th>Revised Green Book</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Option 1</td>
<td>Option 8</td>
</tr>
<tr>
<td>Net revenue</td>
<td>2.0</td>
<td>9.4</td>
</tr>
<tr>
<td>Non-financial benefits</td>
<td>8.8</td>
<td>26</td>
</tr>
<tr>
<td>Released capacity</td>
<td>1.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Total benefits</td>
<td>11.9</td>
<td>38.5</td>
</tr>
<tr>
<td>Capital costs</td>
<td>5.8</td>
<td>18.8</td>
</tr>
<tr>
<td>Net operating costs</td>
<td>2.6</td>
<td>9.7</td>
</tr>
<tr>
<td>Total costs</td>
<td>8.4</td>
<td>28.5</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>2.4</td>
<td>9</td>
</tr>
<tr>
<td>Benefit: Cost ratio</td>
<td>1.41</td>
<td>1.44</td>
</tr>
</tbody>
</table>

2.5 Applying the new Green Book guidance, the following key points emerge:

- The lower discount rate results in higher present values of all costs and benefits.
- Capital cost values do not increase in the same proportion as other costs and benefits.
- While the increased optimism bias has increased capital costs, the removal of the capital charge has resulted in a net reduction in capital costs.
- Benefit-Cost Ratios (BCRs) have increased by typically 45%-50% across all options.

3. Re-Scoping of the ECML Upgrade

3.1 At the time of the work on the main HSL study the ECML Upgrade was seen as a series of incremental phases, which would have culminated in the full ECML Phase 2+ Upgrade. One of the interim stages in the upgrade, known as Phase 1c, consisted of the a series of works necessary to allow the Leeds ECML service to operate twice hourly. Phase 2+ then built upon this and provided capacity for three Edinburgh and two Newcastle services per hour. Additional capacity was also to be available during the peaks with Phase 2+, allowing for an additional (third) Leeds service. Various infrastructure and power upgrades were also due to take place to boost the capacity for local services, especially between Peterborough and London.

3.2 The SRA is shortly to publish a franchise specification for the Inter-City East Coast franchise, which will include options for enhanced services. The baseline timetable in this document is, however, broadly similar to that of today, but with some very minor enhancements. It will
then include an option to provide a half-hourly service to Leeds (roughly equivalent to the Phase 1c Upgrade described above).

3.3 In was therefore decided to re-run the HSL options with the ECML Phase 1c Upgrade. The revised Do–Minimum ECML specification used in these re-run HSL tests, however, may still provide a higher level of service than that envisaged in the forthcoming franchise specification, as the half-hourly service to Leeds is still an option at this stage, and not a commitment.

3.4 Given the uncertainty over the ECML Upgrade at the time of the main study, a sensitivity test was undertaken on one of the HSL options to examine the impact on the assessment of a re-scoped ECML project. This sensitivity test incorporated the reduced level of train service operating under the Phase 1c Upgrade. In the additional work described in this addendum tests for the other HSL options were undertaken to determine the impact of the re-scoped ECML in more detail.

3.5 For these tests, the train service envisaged under the ECML Phase 1c upgrade was substituted for that planned for Phase 2+ in the Do Minimum, and the HSL option was re-evaluated against this scenario.

3.6 HSL service patterns were assumed to be as per the original specifications in the main study.

3.7 The impacts on HSL demand of the re-scoped ECML is shown in Table 3.1, for Option 16, one of the main HSL options on the east of the country.

**Table 3.1 – Daily HSL Demand – Option 16**

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECML 2+</td>
<td>51,457</td>
<td>84,113</td>
</tr>
<tr>
<td>ECML 1c</td>
<td>52,676</td>
<td>91,790</td>
</tr>
</tbody>
</table>

3.8 High Speed Line demand in 2016 for Option 16 is forecast to increase by just over 2% as a result of the re-scoped ECML Upgrade. By 2031, however, the figures for the re-scoped option are 9% higher at 91,790, reflecting the increased crowding on the ECML by 2031, and thus the increased switching to HSL.

3.9 The impact on passenger kilometres on the three major inter-city TOCs of the re-scoped ECML Upgrade is shown in Table 3.2.

**Table 3.2 – Impact on TOCs of HSL Option 16, with a re-scoped ECML**

<table>
<thead>
<tr>
<th></th>
<th>Passenger Km (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2031</td>
</tr>
<tr>
<td>ECML 2+</td>
<td>ECML 1c</td>
</tr>
<tr>
<td>GNER</td>
<td>17.3</td>
</tr>
<tr>
<td>Midland Mainline</td>
<td>4.4</td>
</tr>
<tr>
<td>Virgin West Coast</td>
<td>37</td>
</tr>
<tr>
<td>HSL</td>
<td>20.8</td>
</tr>
</tbody>
</table>
3.10 As can be seen in Table 3.2 the impact of the re-scoped ECML Upgrade, as expected, is forecast to have very little impact on the West Coast and Midland Mainline TOCs in 2031. The impact is concentrated on the interaction between the East Coast Mainline and the High Speed Line.

3.11 In 2031 increased levels of rail demand, and therefore crowding, are forecast to result in a marked decline in ECML demand, with a corresponding marked increase in HSL demand.

3.12 The increase in crowding levels can be seen by the reduced seat kilometres, and subsequent increased loads, on the ECML. In 2031 the seat kilometres on ECML decrease by just under 10 million from 29.7m to 19.8m; with a consequent load increase from 58.2% to 76.8%.

3.13 The evaluation of the re-scoped ECML HSL tests was undertaken using the revised ‘Green Book’ guidance, as discussed in section 2 of this addendum.

3.14 The results of the evaluation for Option 16, the main easterly HSL option, are shown in Table 3.3.

3.15 Table 3.3 shows that HSL revenues increase by 5-10% in response to the greater service improvement offered by HSL relative to the re-scoped ECML Upgrade. This increase is as a result of a higher level of transfer of East Coast passengers to HSL. This is further reflected in the greater non-financial benefits (mainly journey time savings) to passengers who use HSL. These passengers see a greater incremental service improvement compared with the re-scoped ECML Upgrade.

### Table 3.3 – Cost Benefit Appraisal, HSL Option 16

<table>
<thead>
<tr>
<th>£ Bn (PV)</th>
<th>ECML Phase 2+ (Gr Bk)</th>
<th>ECML Phase 1c (Gr Bk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net revenue</td>
<td>5.9</td>
<td>8.5</td>
</tr>
<tr>
<td>Non-financial benefits</td>
<td>24.5</td>
<td>36</td>
</tr>
<tr>
<td>Released capacity</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total benefits</td>
<td>30.4</td>
<td>44.5</td>
</tr>
<tr>
<td>Capital costs</td>
<td>10.6</td>
<td>10.6</td>
</tr>
<tr>
<td>Net operating costs</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Total costs</td>
<td>18.9</td>
<td>18.9</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>13.6</td>
<td>27.3</td>
</tr>
<tr>
<td>Benefit: Cost ratio</td>
<td>1.81</td>
<td>2.59</td>
</tr>
</tbody>
</table>

3.16 The overall impact on the cost benefit ratio for HSL with a re-scoped ECML Upgrade is marked, with the resulting Benefit to Cost ratios around 35% higher. These benefits will only apply to easterly HSL options, resulting in HSL options to the east now performing better in economic terms than those to the west.
4. Road User Charging

4.1 The London Congestion Charging scheme took effect in February 2003, and preliminary indications suggest a reduction in car use in the capital. This has led to heightened interest in the potential for wider road user charging as a means of demand management and securing worthwhile mode shift away from private cars.

4.2 A series of tests were run on HSL options to examine the impact on HSL of the impact of an inter-urban road user charge. These tests were run with the ECML Phase 1c train service assumptions substituted for ECML Phase 2+ in the Do Minimum, thus reflecting the re-scoped ECML Upgrade. The appraisals were also carried out using the revised parameters as set out in the latest Green Book guidance.

4.3 At the time of testing there were no inter-urban road user charging schemes within the UK (subsequent to this the M6 Toll has opened). Analysis undertaken for the HSL study produced a flat rate charge of 7 pence per kilometre for highway trips, based on the experience of toll roads in Europe. The increased travel cost was formulated by applying this flat rate to the distance between zonal pairs, and included within the highway model as an increased vehicle operating cost (VOC).

4.4 The impact of Road User charging was studied for a number of the HSL options. The impact on forecast HSL demand for Option 3 are summarised in Table 4.1:

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ECML 1c</td>
<td>RUC</td>
</tr>
<tr>
<td>70,594</td>
<td>77,505</td>
<td>117,600</td>
</tr>
</tbody>
</table>

4.5 As Table 4.1 shows, overall HSL patronage is forecast to increase with the introduction of inter-urban road user charging. The percentage increase is around 10% in 2016, and 5% in 2031. By 2031, the HSL services are becoming crowded so the benefits of switching from car are less.

4.6 The forecast impacts upon passenger kilometres on the main inter-city TOCs are shown in Table 4.2.

<table>
<thead>
<tr>
<th></th>
<th>Passenger Km (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
</tr>
<tr>
<td></td>
<td>ECML 1c</td>
</tr>
<tr>
<td>GNER</td>
<td>19.6</td>
</tr>
<tr>
<td>Midland Mainline</td>
<td>4.8</td>
</tr>
<tr>
<td>Virgin West Coast</td>
<td>7.4</td>
</tr>
<tr>
<td>HSL</td>
<td>18.8</td>
</tr>
</tbody>
</table>

4.7 Passenger kilometres for all TOCs are forecast to increase with the introduction of road user charging, highlighting both the scale of the increase in costs for
road users, and the increased competitiveness of rail compared with road for strategic movements. High Speed Line passenger kilometres are forecast to increase with RUC by around 7-8% in 2016, in line with the increased demand shown in Table 4.1.

4.8 The additional demand on rail caused by the introduction of Road User Charging also results in a marked increase in rail congestion, to possibly unsustainable levels. The ECML, for example, is forecast to experience load factors of over 95% in some options, with the other main lines experiencing load factors of between 55 and 70% across the whole ECML.

4.9 In terms of overall highway demand, HSL has a minimal impact, even for a full HSL system such as that represented by Option 8. The overall shift from highway is in the order of 1% of all highway trips within the demand model. The demand model does cover the whole country, however. When considering trips within scope of HSL, there is a more significant impact forecast. Table 4.3 shows for selected origin-destination pairs the change in strategic travel movements by car. For destinations served directly by HSL, the further reduction in highway demand is around 10% in 2016 and 20% in 2031.

4.10 On a localised basis the effects on the highway network are minor (as in practice strategic movements are outweighed by local journeys), but still noticeable. Highway flows on competing north-south routes before and after HSL show that flows could be reduced by up to 5%.

4.11 However, the effect of this reduction in car traffic upon highway congestion, as measured by average speeds, is minimal, largely because there is such an underlying increase in demand and congestion occurring in the base case scenario that any freed-up capacity tends to be filled by suppressed trips.

4.12 Finally, Table 4.4 compares the results of the evaluation of Option 3, in the situation with and without Road User Charging.
Table 4.4 – Cost Benefit Appraisal with the introduction of Road User Charging, HSL Option 3 (ECML 1c Base)

<table>
<thead>
<tr>
<th>£ Bn (PV)</th>
<th>Without RUC (Green Book)</th>
<th>With RUC (Green Book)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net revenue</td>
<td>9.4</td>
<td>9.7</td>
</tr>
<tr>
<td>Non-financial benefits</td>
<td>36.8</td>
<td>39.8</td>
</tr>
<tr>
<td>Released capacity</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Total benefits</td>
<td>48.4</td>
<td>51.7</td>
</tr>
<tr>
<td>Capital costs</td>
<td>11.4</td>
<td>11.4</td>
</tr>
<tr>
<td>Net operating costs</td>
<td>9.2</td>
<td>9.3</td>
</tr>
<tr>
<td>Total costs</td>
<td>20.6</td>
<td>20.7</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>27.7</td>
<td>30.9</td>
</tr>
<tr>
<td>Benefit: Cost ratio</td>
<td>2.62</td>
<td>2.78</td>
</tr>
</tbody>
</table>

4.13 For Option 3, the introduction of Road User Charging results in increases in both HSL revenues and non-financial benefits. The cost benefit ratio also increases. The increases with Road User Charging are not as marked, however, as those associated with the other options considered in this document, such as the de-scoping of the ECML Upgrade.

5. Conclusions

5.1 The introduction of the new ‘Green Book’ guidelines, in addition to the revised treatment of project financing, results in a significantly improved case for the introduction of a High Speed Line. The Benefit Cost Ratios, for instance, improve by 45% to 50% to well over 2:1, across all options.

5.2 The re-scoping of the ECML Upgrade from the 2+ to the 1c scheme also results in a significantly improved case for HSL. In this case, however, the improvement is not uniform across all options, but more geographically focussed, with the major benefits accruing to those HSL options to the east of the country. The improvement resulting from the re-scoped ECML Upgrade is such that those HSL options to the east of the country now have higher benefit to cost ratios than those to the west of the country. This obviously contradicts the findings of the main study which concluded that westerly options should befavoured in progressing the project.

5.3 The introduction of inter-urban Road User Charging results in increased passenger demand across the rail network, including that for HSL. Such a scheme further improves the economic case for a new HSL system, with a further increase in benefit to cost ratios.

5.4 Finally, applying a combination of the changes examined in the additional work examined in this addendum, results in a benefit to cost ratio approaching 3:1 for some of the HSL options to the east of the country.