Planning and Regulation

Route Planning

New Lines Programme

Strategic Business Case

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Executive Summary

1. Network Rail has commissioned the New Lines Programme and appointed Steer Davies Gleave as Programme Management Consultants. The aim of the programme is to investigate whether there is a Strategic Business Case for continuing to develop the concept of building one or more new line(s) as additions to the national rail network.

2. The key aim of the New Lines Programme is to meet future needs for additional rail capacity. A new line will provide additional capacity in two ways:

   - Through the provision of capacity on the New Line itself; and
   - Through the associated release of capacity on the classic rail network.

3. A complete Programme of work has been undertaken to support the development of the Strategic Business Case, including creation of bespoke decision support models. The suite of documents supporting the business case is available on Network Rail's website.

4. Through an examination of capacity constraints on the current rail network, and an analysis of markets, it has been established that the key targets to be served by a New Line are London, Birmingham and Manchester.

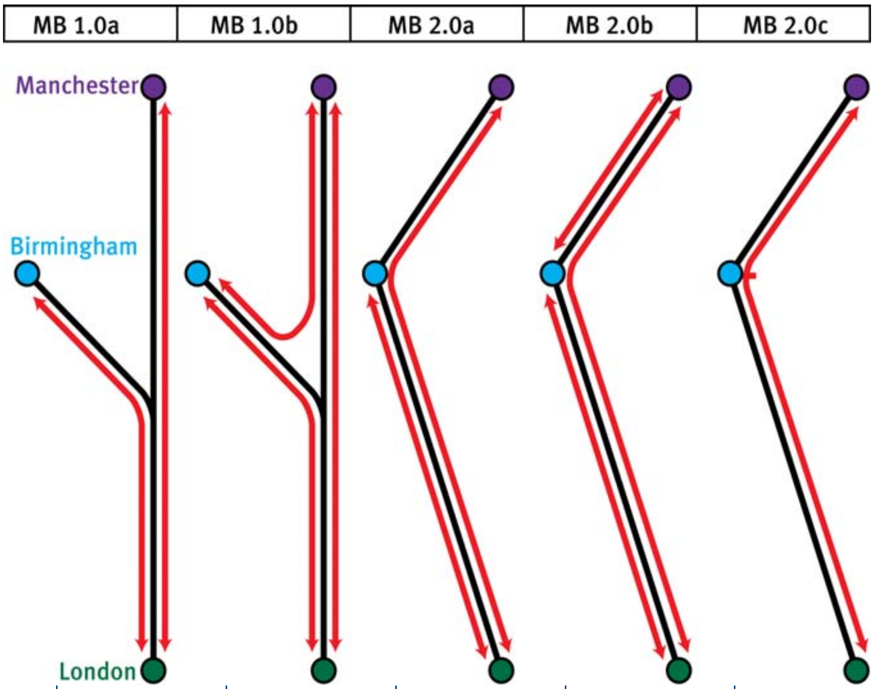
5. Option assessment was undertaken to determine the core route for the New Line. This tested the following options:

   - MB1.0a: Main line to Manchester with a diverging main line to Birmingham and services from London to Birmingham and from London to Manchester;
   - MB1.0b: Main line to Manchester with a diverging main line to Birmingham and services from London to Birmingham and from London to Manchester plus services between Manchester and Birmingham;
   - MB2.0a: Main line to Birmingham that then continues on to Manchester with services from London to Birmingham and from London to Manchester;
   - MB2.0b: Main line to Birmingham that then continues on to Manchester with services from London to Birmingham and from London to Manchester plus services between Manchester and Birmingham; and
   - MB2.0c: Main line to Birmingham that then continues on to Manchester with services from London to Birmingham that then continue on to Manchester.

6. This identified the best performing core route option as MB1.0b: a main line between London and Manchester with a diverging main line to Birmingham with services between all three cities. Even though the option links the top target markets, the economic analysis shows that the case for a route and service between London, Manchester and Birmingham alone appears marginal. However, this option has not been optimised as a stand-alone scheme. It includes infrastructure costs that a railway requiring just the capacity for eight trains per hour in each direction would not need.

7. The results of the options are shown below:

FIGURE 0.1 CORE NEW LINE SERVICE OPTIONS - HIGH LEVEL RESULTS



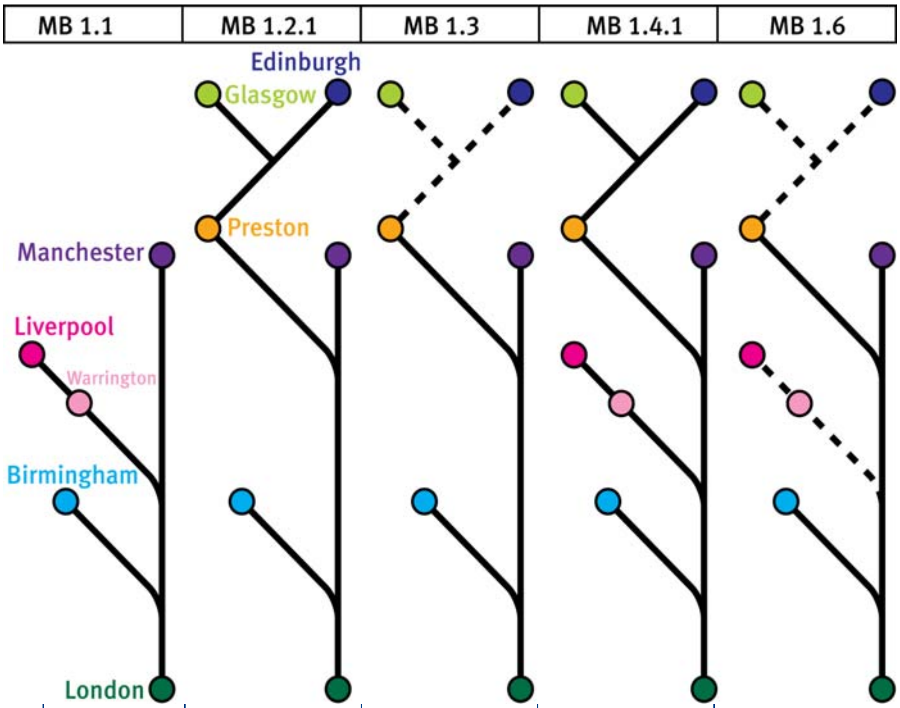
NPV (£ bn)	**-0.6**	**-0.5**	**-3.8**	**-2.9**	**-1.8**
BCR	0.9:1	0.9:1	0.6:1	0.7:1	0.8:1

8. The best performing core route option (MB1.0b) has been developed further by the addition of other target market destinations. This process has focused on markets within reasonable geographic reach of a New Line serving Birmingham and Manchester. This leads to a cohesive New Line proposition, and maximises the potential for utilisation of the classic network (by freeing up considerable capacity on the West Coast Main Line). The variants considered are:

- MB1.1: Self contained New Lines to London, Manchester and Birmingham plus Warrington and Liverpool;
- MB1.2.1: Self contained New Lines to London, Manchester and Birmingham plus Preston and Scotland;
- MB1.3: New Lines to London, Manchester and Birmingham plus Preston with trains running through to and from the classic line to Scotland;
- MB1.4.1: Self contained New Lines to London, Manchester and Birmingham plus Liverpool, Warrington and Scotland; and
- MB1.6: New Lines to London, Manchester and Birmingham plus Preston, with trains running through to and from the classic lines to Warrington, Liverpool and Scotland.

9. These are shown diagrammatically below. The dotted line indicates where New Line services would run over existing infrastructure.

FIGURE 0.2 FURTHER DEVELOPED NEW LINE SERVICE OPTIONS – HIGH LEVEL RESULTS



	MB 1.1	MB 1.2.1	MB 1.3	MB 1.4.1	MB 1.6
NPV (£ bn)	**4.9**	**8.8**	**3.5**	**13.5**	**8.7**
BCR	1.4:1	1.5:1	1.3:1	1.8:1	1.9:1

10. When additional target markets are added to the core route, the incremental value means that the options perform better, all achieving Benefit:Cost Ratios (BCRs) above 1:1. The fundamental reason for this is that the majority of the core infrastructure costs can be offset against the increased overall revenue and benefits – making the incremental economic case very attractive (affordability being a separate matter to consider). The best performing options in economic terms are the full options (MB1.4.1 and MB1.6) which serve all the target markets including Scotland and increase the use of the potential line capacity. These options achieve comparable BCRs of 1.8:1 and 1.9:1 respectively.

11. Adding additional targets to the New Line also gives the opportunity to address demand capability gaps on the West Coast Main Line. This is especially true of MB1.4.1 as a self-contained option with no classic line running, as it would relieve capacity at the current significant pinch points across the WCML. MB1.6 would introduce operational challenges on the classic lines, particularly when considering the pathing of services to Warrington and Liverpool via a classic line route.

12. The New Line achieves modal shift from road with all options. The options that run to Scotland also achieve modal shift from air, particularly the all New Line options, thereby providing support to the government's climate change objectives.

13. From the two full options, MB1.4.1 has the highest Net Present Value (NPV). However, although offering excellent revenue and benefits, as well as addressing the broad objectives of this study, MB1.4.1 also raises considerable affordability issues. MB1.6 delivers a similar BCR, but with a lower NPV and lower capital costs.

14. Options that serve Heathrow have also been considered. Firstly, by routeing the services in Option MB1.4.1 via Heathrow (Option MB3.4.1) or by providing a diverging main line to Heathrow (Option MB1.7.1) and extending two existing services to and from Heathrow. Both these options led to an increased transfer of air and car trips to rail. The diverging high speed line connection to Heathrow has a better case than routeing the line through Heathrow, although it had a marginal detrimental effect upon the BCR. This is due to the proportional increase in costs being greater than the increase in benefits and revenue.

15. Options for through train operation to and from High Speed 1 have also been considered. If the New Line London terminal was in close proximity to London St Pancras, passengers could easily transfer between the New Line and high speed services to Europe even in the absence of a through link. This itself can lead to up to half a million additional trips shifting from air to rail.

16. It was concluded that available capacity on the New Line would be best used for services to and from London Central.

17. The recommendation of this report is that there is a case to take the London to North West and Scotland corridor forward for further investigation.

18. We believe that any New Line would form the first stage of a network of high speed lines.

1 Introduction

Context

1.1 The demand for rail transport has grown by more than 40% for passenger traffic and more than 60% for freight traffic in the last ten years. The long term forecast is that demand for rail travel will continue to grow. This is based on the assumption that the drivers for rail demand, such as, economic growth and environmental concerns, will in the long term, continue to be favourable to rail.

1.2 There is a need to look ahead to identify the challenges that will face the railways in the future and to examine the options available to meet these challenges through value for money and affordable interventions.

1.3 There is an opportunity for Network Rail to contribute to this strategic long term planning in the rail context.

1.4 Network Rail has commissioned the New Lines Programme and appointed Steer Davies Gleave as Programme Management Consultants. The aim of the programme is to investigate whether there is a Strategic Business Case for continuing to develop the concept of building one or more new line(s) as additions to the national rail network.

1.5 Over the course of this study, the need for an intervention to provide further capacity to meet expected demand was established and a potential New Line identified. The purpose of this report is to set out, at a strategic level, the Strategic Business Case for the new line and make a recommendation as to whether the concept should be taken forward for further consideration.

New Lines Programme

1.6 The primary objectives for the programme are to relieve the capacity issues on the existing (classic) network and provide additional passenger capacity through the development of a new line (or a network of new lines). To deliver this, any new line(s) would need to be consistent with the government's long term policies for transport. Therefore, the following broad objectives have been identified as providing a consistent basis against which the options can be assessed. The objectives are to:

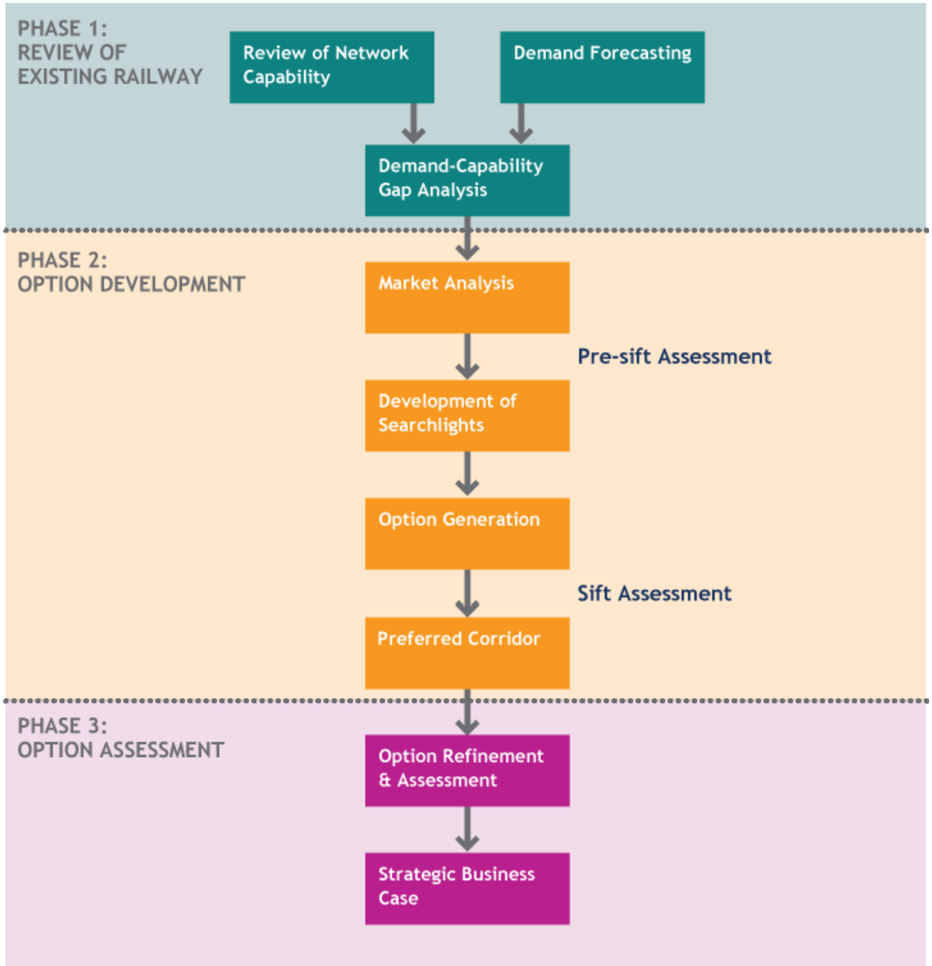
- Provide the necessary future additional passenger capacity on the national rail network through the development of a value for money new line intervention;
- Relieve future passenger and freight capacity constraints and improve connectivity on the classic rail network;
- Support national economic competitiveness and growth by improving connectivity between key economic markets;
- Support the government's targets for reducing transport emissions of carbon dioxide and other greenhouse gases, by encouraging modal shift from air and road to rail; and
- Promote greater equality of opportunity by improving accessibility to key markets through the significant reduction of journey times between them.

1.7 The preferred scheme identified within this report is considered to be the line that is assessed as being the most suitable that best meets the objectives described above.

Developing the Strategic Business Case

1.8 This Strategic Business Case report is the culmination of sixteen workstreams. The workstreams include identifying a need for additional capacity on the classic railway, consideration of the most appropriate intervention and the generation and assessment of a range of options. The outcome is a recommendation as to whether a potential new line scheme should be taken forward for further consideration. This process is shown in Figure 1.1.

FIGURE 1.1 DEVELOPING THE STRATEGIC BUSINESS CASE



1.9 The programme has been undertaken in three phases and a brief overview of each phase and the key findings are outlined below.

Phase 1: Review of Existing Railway

1.10 As the study hypothesis only considers lines from London to the north and west, the study geography is bound by five ‘classic line’ route corridors. These are the Great Western Main Line (GWML), Chiltern (Marylebone to Birmingham via High Wycombe), West Coast Main Line (WCML), Midland Main Line (MML) and East Coast Main Line (ECML).

1.11 The first phase reviewed the five in-scope lines and developed forecasts for a future planning year of 2020. A baseline route and passenger carrying capability of the railway system in the future was established from existing published data, including Route Utilisation Strategies and the Strategic Business Plan from Network Rail, HLOS from the Department for Transport and as agreed in a series of capacity baselining workshops with Network Rail route planners. The baseline not only included currently committed schemes, but also those considered likely to be delivered before 2020 and capacity enhancing schemes that could be undertaken such as train lengthening and the introduction of new rolling stock. The WCML, MML, ECML, GWML and Chiltern Main Line were all found to be forecast to be running at near line capacity.

1.12 Using this baseline, a demand-capability gap analysis was undertaken that considered the capability of the in-scope rail lines to satisfy passenger and freight demand both today and in 2020. It assessed whether further intervention was necessary, such as the construction of a new line.

1.13 From this work it was concluded that consideration of an intervention should primarily focus on relieving the demand-capability gap on the WCML, followed by the MML and ECML. An intervention on the GWML was seen as a lower priority and there was no requirement for an intervention on the Chiltern Main Line.

Phase 2: Option Development

1.14 Once the (supply side) need for an intervention had been identified, a range of options were developed and assessed in order to select a preferred corridor. A multi-criteria approach to assessment was developed based on the broad objectives and the principles of feasibility, suitability and acceptability. It set out the criteria used to identify key markets and market potential and was used to make an initial high level sift of the wide range of (generated) options to select the preferred corridor.

1.15 The gap analysis from the previous work was used as a starting point, but most importantly, a market analysis exercise was also undertaken. Any new line will need to both address supply side constraints (capacity) ***and*** provide opportunities to make a 'step change' in access for, and attractiveness of, rail travel (both through modal shift and trip generation) in order to underpin sustainable economic growth and wider policy objectives. The work identified the top target markets that a new line could serve (based on existing and future potential demand, revenue and benefits). These top targets were then grouped geographically to form ranging 'searchlights' which gave the basis for the generating plausible options, taking into account the realities of practical railway operations. The searchlights covered three geographical corridors:

- London – West;
- London – North West and Scotland; and
- London – North East.

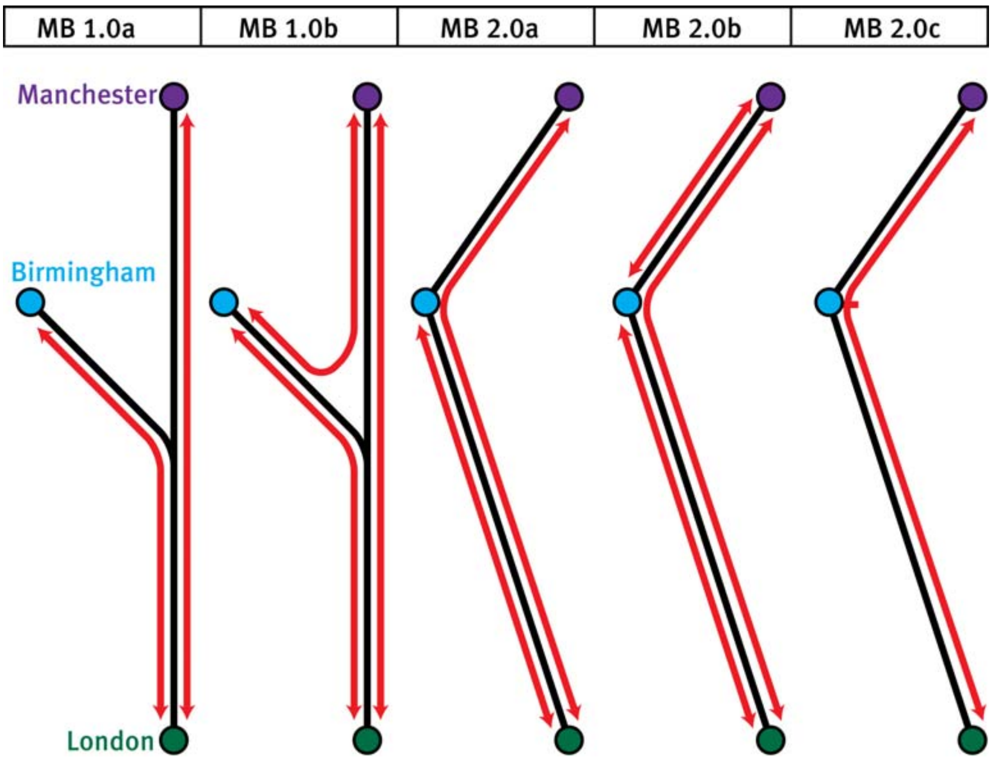
1.16 A range of options were built up from the searchlights taking the highest priority target first and then adding on other targets until line capacity was exhausted. The options were then assessed incrementally to ensure the value of each market was captured. Finally, the sift criteria was applied to each option to identify the most suitable corridor. The best performing corridor was the London to North West corridor, with a core route of London to Manchester and Birmingham. The other markets within this corridor (in order of rail market size) are Liverpool, Edinburgh, Preston and Glasgow.

Phase 3: Option Assessment – Strategic Business Case

1.17 The preferred corridor and core route identified through the sift assessment were then taken forward for further consideration. Although no alignments have been designed during this Strategic Business Case assessment, high level analysis was undertaken to determine whether the best route would serve Manchester via Birmingham or via a direct line to Manchester and a diverging main line to Birmingham. The options considered are outlined in Figure 1.2. The relevant service patterns for each option are described in Section 2.

1.18 Demand and revenue and capital and operating costs were forecast for each option and run through the business case model to determine the best performing option in terms of relative economic value (Net Present Value {NPV}). Option MB1.0b was selected and this formed the basis of the next stage of option refinement.

FIGURE 1.2 STAGE 1 OPTION ASSESSMENT: LONDON TO MANCHESTER AND BIRMINGHAM



1.19 The options shown above have the following assumed service pattern:

- MB1.0a: Main line to Manchester with a diverging main line to Birmingham and services from London to Birmingham and from London to Manchester;
- MB1.0b: Main line to Manchester with a diverging main line to Birmingham and services from London to Birmingham and from London to Manchester plus services between Manchester and Birmingham;

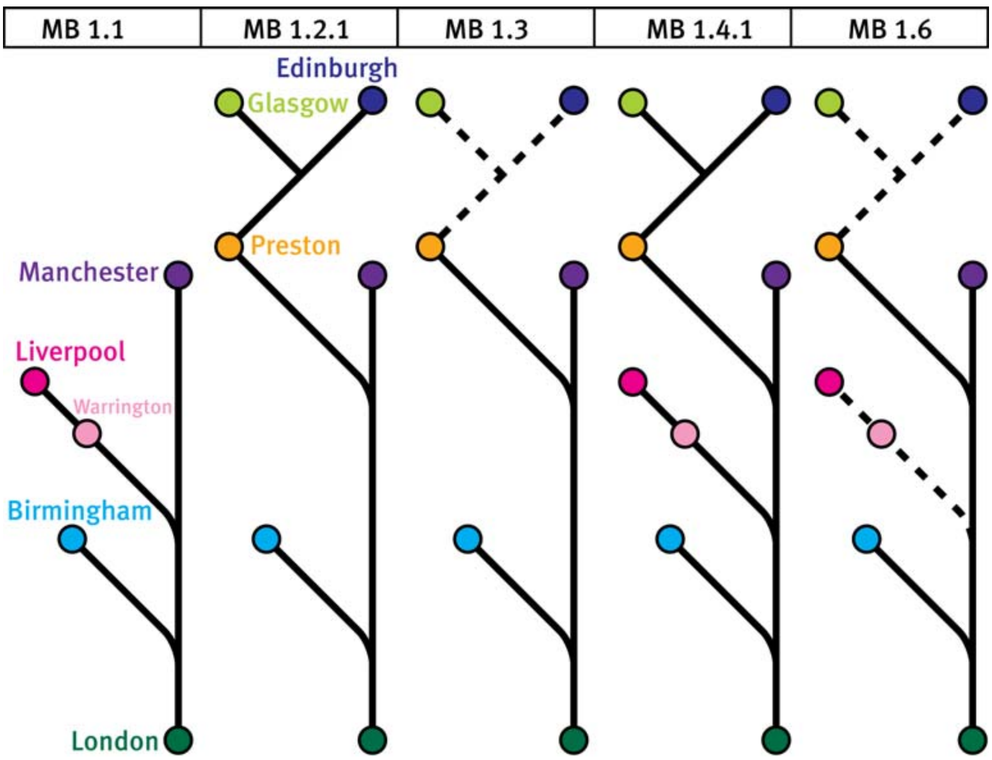
- MB2.0a: Main line to Birmingham that then continues on to Manchester with services from London to Birmingham and from London to Manchester;
- MB2.0b: Main line to Birmingham that then continues on to Manchester with services from London to Birmingham and from London to Manchester plus services between Manchester and Birmingham; and
- MB2.0c: Main line to Birmingham that then continues on to Manchester with services from London to Birmingham that then continue on to Manchester.

1.20 Once the core route option was selected, additional markets were added incrementally to test the incremental value of these markets on the Strategic Business Case. The options are a mix of new line only and new line/classic line running.

1.21 The options taken forward for detailed assessment are shown in Figure 1.3. These are

- MB1.1: Self contained New Lines to London, Manchester and Birmingham plus Warrington and Liverpool;
- MB1.2.1: Self contained New Lines to London, Manchester and Birmingham plus Preston and Scotland;
- MB1.3: New Lines to London, Manchester and Birmingham plus Preston with trains running through to and from the classic line to Scotland;
- MB1.4.1: Self contained New Lines to London, Manchester and Birmingham plus Liverpool, Warrington and Scotland; and
- MB1.6: New Lines to London, Manchester and Birmingham plus Preston, with trains running through to and from the classic lines to Warrington, Liverpool and Scotland.

FIGURE 1.3 STAGE 2 OPTION ASSESSMENT: STRATEGIC BUSINESS CASE OPTIONS



1.22 The final stage of work developed options that considered connectivity to Heathrow and included an assessment of the impact of connecting to High Speed 1 and Europe. These options are described in greater detail later in the document.

1.23 All of the options have been assessed in accordance with DfT guidance and are presented within this Strategic Business Case.

1.24 The Business Case is the culmination of a programme of works undertaken in three phases. The supporting documents prepared in the course of this exercise are placed on Network Rail's website. These documents are:

- High speed rail investment; an overview of the literature: Literature review by Prof. Chris Nash on the motivation of other countries that have invested in high speed rail and the lessons learnt
- Capacity analysis: Document testing the hypothesis that in future there will be a gap between railway demand and capacity to meet the demand.
- Option development: Explanation of the assessment criteria and the approach taken for option development
- Demand forecasting technical note: Technical note describing the approach taken for demand and revenue forecasting
- Stated preference survey report: Description of the stated preference survey conducted for New Lines
- Comparing environmental impact of conventional and high speed rail: A comparison between conventional rail and high speed rail with respect to energy and environmental effects

Business Case Report

1.25 The remainder of this report is structured as follows:

- Section 2 – Approach
- Section 3 - Scheme Description
- Section 4 – Cost Modelling
- Section 5 – Demand, Revenue and Benefit Forecasting
- Section 6 – Economic Assessment
- Section 7 – Heathrow Options
- Section 8 – HS1 Options
- Section 9 – Statement of Outputs
- Section 10 – Environmental Impact Assessment
- Section 11 – Risks and Opportunities
- Section 12 – Conclusions.

2 Approach

Strategic Business Case

2.1 This Strategic Business Case is undertaken within the framework set out by the Network Rail Guide to Railway Investment Projects (GRIP) and is, technically, a pre-stage 1 GRIP study. The GRIP process sets out Network Rail's approach to managing and controlling projects that enhance or renew the national rail network and is divided into specific stages that cover the project lifecycle.

2.2 The Pre-GRIP stage is undertaken before a complex project is initiated and is defined by Network Rail thus:

Pre-GRIP involves the Pre entry criteria that are to be met by the Client and Sponsor prior to project initiation in GRIP 1. Key planning activities and products such as Business planning, Planning the Work bank, the Business Case and Business Plan Entries should happen before entering project time.

2.3 The purpose of the Pre-GRIP stage is to validate the concept being considered as a project and allow it to be taken forward and developed through the GRIP process. At such an early stage in the development of a potential scheme, the analysis is of a strategic nature, establishing the expected value of the concept before large investments in further development are made.

2.4 Therefore, this Strategic Business Case provides a platform to set out that value and to inform the decision to take the concept forward (or not) for further consideration and develop it as a Network Rail project.

Strategic Assessment of Option

2.5 Essential to this Strategic Business Case is the requirement to ensure consistency within and between the options and to produce the required inputs for their assessment. In order to achieve this, a set of decision support tools have been developed. These tools produce the associated forecast costs and benefits for each option.

2.6 It is important that these tools are fit for purpose and provide the right balance between detail and strategy, namely proportionality. As the study is at Pre-GRIP, no infrastructure plans or timetables have been developed. The proposed New Line and alterations to the classic line have been specified at a high level, based on a series of assumptions. Therefore, all the benefit forecasting and costing has been undertaken at a level commensurate with the specification available.

2.7 Therefore the Train Service Specifications that have been developed are not operational timetables. The specifications have only been developed to a level appropriate to this analysis in order to enable a comparative assessment between options and to provide inputs to the decision support tools. Timetables would need to be developed in later stages of the project lifecycle when further design and analysis has taken place.

2.8 Similarly, infrastructure plans have not been developed for this work and would be required in the future as part of the development of a potential scheme. The cost inputs that have been developed are based on a series of assumptions as described in detail within Section 4 of this report and also in the High Level Technical Specification.

2.9 Consistent with this approach all the benefit forecasting and costing for the Strategic Business Case has been undertaken at a level commensurate with the specification available and appropriate at this stage of the project lifecycle.

2.10 A more detailed explanation of the decision making tools and their underlying assumptions can be found in the relevant sections of this report.

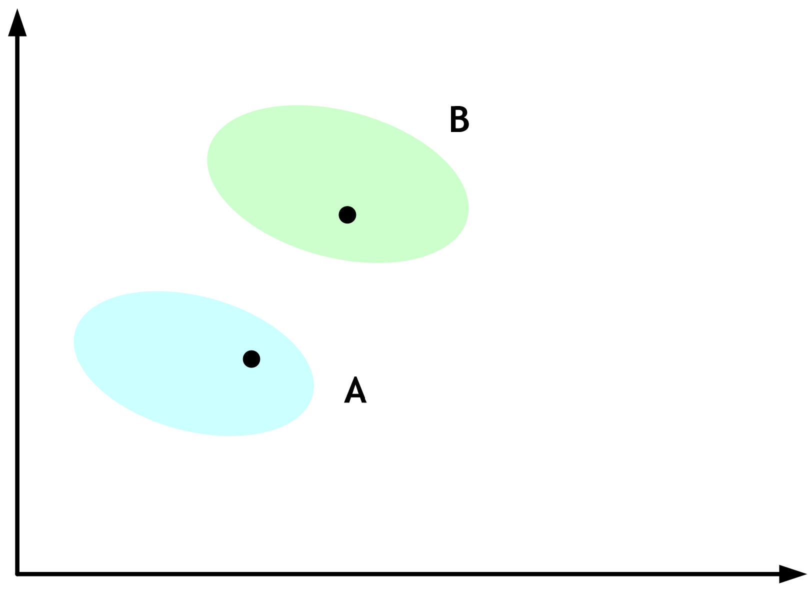
Risk

2.11 The high level nature of the assessment means that there is considerable uncertainty over the forecasts and costs. The considered risks have been outlined in detail in the Risks and Opportunities section (Section 11), however there is still inherent risk in any assessment and it is important to consider these risks in order to manage the uncertainty.

2.12 In order to allow decision makers to take decisions with confidence, they need to understand whether within a margin of uncertainty, one option performs better than another, namely whether there is ‘clear water’ between them, e.g. even if it can’t be established that the answer is 16, it can be established that “14-20” is greater than “5-9”.

2.13 Figure 2.1 illustrates the concept of uncertainty around a forecast result and hence informs the level of confidence with which a decision could be taken.

FIGURE 2.1 ILLUSTRATION OF FORECAST UNCERTAINTY



2.14 In order to address uncertainties around key parameters (e.g. GDP growth, X and Y) the sensitivity of key performance indicators (e.g. BCR, NPV) to plausible variations is tested. The results provide an indication of the robustness of the case for an intervention.

Benchmarking

2.15 The benchmarking of inputs and assumptions employed in the assessment of a potential scheme against empirical data enables greater confidence in them to be gained, and hence in the assessment of likely outcomes. Throughout this study an ongoing process of benchmarking has been conducted.

2.16 Unit rates for each asset and apportionment of non construction costs were developed in conjunction with the estimating team from the Infrastructure Investment department of Network Rail. The calculated average cost per kilometre has been benchmarked against international high speed schemes, including High Speed 1. The resultant forecast cost per kilometre is comparable with other schemes and provides comfort that the quantities and rates are within a reasonable range.

2.17 A review has been undertaken of the available literature on international experience of the introduction of high speed rail. This indicates that the introduction of high speed rail can lead to significant increases in rail demand. For example when air passengers transferring to other flights are excluded Eurostar services are estimated to carry 80% of the London to Paris market. Other information such as the journey elasticities implied by observed changes in behaviour have also been utilised to ensure that the input parameters to the New Line forecasts are robust.

3 Scheme Description

Overview of New Line Option Development

3.1 For each option there are two elements required to support development of the Strategic Business Case:

- A full description of the New Line inputs; and
- A full description of the Classic Lines changes assumed.

3.2 Whilst this is a Strategic Business Case it is necessary to make detailed assumptions in a number of key areas in order to populate the various models used to assess the performance of each option. Whilst many of these are straightforward, others have required a management judgement made by the project team.

3.3 At this stage of programme development it is not appropriate or desirable to consider New Line alignments, however it is necessary to calculate realistic distances between station stops and intermediate junctions in order to populate the infrastructure and operating cost models and as a basis for establishing journey times to input to both the Operating Cost Model and the Demand and Revenue Modelling Suite.

3.4 Similarly it has also been necessary to create notional timetables to test and develop the operational planning assumptions made and to support the modelling through an iterative process. This is particularly important in options where the capacity on the New Line is more intensively used and where it is necessary to demonstrate that:

- Rolling stock balances are feasible and realistic;
- New Line paths can be achieved within reasonable 'Rules of the Route' for a New Line; and
- Platform working is deliverable with the assumed platform quantum at termini and intermediate stations.

3.5 This section of the report describes the technical and operating assumptions made and the New Line conceptual route strategy.

Technical Assumptions

Route Configuration

3.6 The New Line is assumed to be twin track with bi-directional capability throughout. It will have full engineering and emergency access with single line working capability, at line speed, on the adjacent line. It should be noted that no benefits of this have been quantified at this stage of project development. The New Line is assumed to comply with the various national and international standards. It is also assumed that track spacing shall be 6m centre line to centre line. It shall therefore be possible to maintain one line under possession without closing the adjacent line.

Signalling and Control

3.7 The signalling system is assumed to be ERTMS/ETCS level 2 and the assumed 'blocks' are 1 km long. The New Line network is assumed to have one separate control centre for real time management of all route sections.

Maximum Gradient

3.8 The maximum gradient is assumed to be 1 in 55 on the 200mph route sections. This represents the maximum gradient that a train with AGV performance and traction characteristics can negotiate without compromising this speed of operation, and therefore, point to point journey times. This has been established through a RailSys simulation.

Grade Separation

3.9 All junctions with diverging main lines are assumed to be fully grade separated. The diverging route has a reduced maximum speed of 125mph across the junction with line speed maintained for trains on the non-diverging main route. No grade separation has been assumed on the approaches to either London or other city terminal stations, as it is considered unnecessary with the maximum quantum of trains it is planned to operate at these locations.

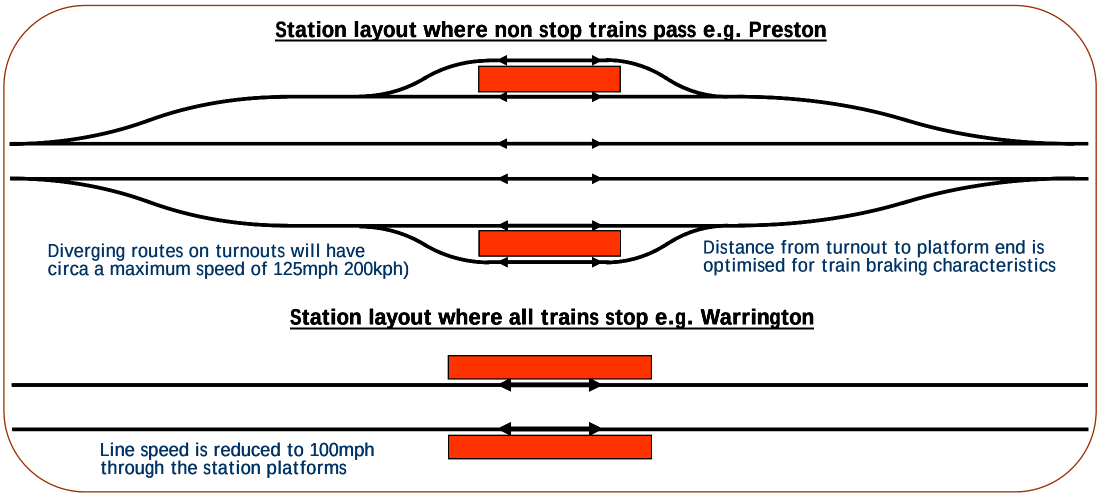
Stations

3.10 In line with European interoperability regulations, all station platforms on the New Line are assumed to accommodate 400m length trains. In most options the maximum train length is assumed to be 260m although in one, Option 2.0c, the maximum train length is assumed to be 390m in order to provide sufficient capacity to meet the demand on the New Line route section between London and Birmingham.

3.11 At intermediate stations, where non-stop trains are assumed to pass, the platforms are situated on separate platform loops. Where it is not planned for trains to pass each other in the same direction, and where planned headways between trains is at least 10 minutes, the platforms faces are assumed to be adjacent to the main running line.

3.12 These two alternative configurations are shown in Figure 3.1.

FIGURE 3.1 PLATFORM AND TRACK LAYOUT AT INTERMEDIATE STATIONS



Network Connections

3.13 Where train services are self contained to the New Line, connections to the classic network are assumed to be provided for engineering access only.

3.14 Where through services are planned to operate between the New Line and the classic network, the junctions between the two routes are assumed to be grade separated.

Traction Power and Rolling Stock

3.15 The route is assumed to be electrified at 25kv ac throughout.

3.16 The Rolling Stock type is unspecified but it is assumed to have AGV traction and performance characteristics. Power consumption is based on an analysis of traction energy consumption on HS1 provided by Network Rail and assumes some reduction on that achieved currently with Class 373 Eurostar units. The same rolling stock type has been assumed in all options irrespective of whether the services operate wholly on the New Line or run through to the classic line(s). Options that are self contained to the New Line may give an opportunity of utilising standard rolling stock deployed on other European networks and this may give cost benefits that have not been considered in the Strategic Business Case.

3.17 Trains are assumed to be formed of 5-car (130m), 10-car (260m) or 15-car (390m) sets. These trains are assumed to carry 325 seated passengers in a 5-car set, 650 seated passengers in a 10-car set and 975 seated passengers in a 15-car set.

Operating and Operation Planning Assumptions

Planning Headway and Planning Capacity

3.18 A planning headway of three minutes has been assumed on all sections of the New Line. The technical headway, the minimum separation between trains with a safety margin, has been calculated as 79 seconds with a 350m train travelling at the maximum line speed of 200mph. It is assumed for planning purposes that all trains have identical performance characteristics when deployed on the New Line. This ensures that the New Line is utilised most efficiently up to realistic maximum quantum of trains per hour (tph) in each direction.

3.19 For self contained options that have no through services to the classic network, and that also have a simple repeating even interval service pattern, a maximum route planning capacity of 16tph in each direction has been assumed. This provides a margin, equivalent to 4tph in each direction, as white space on the route for performance and for planning flexibility at the approaches to terminal stations.

3.20 In options that have through running to the classic line network a maximum capability of 14tph in each direction is assumed. This reduced capability is to reflect the significant additional performance risk and the difficulty of integrating the respective route timetables.

3.21 Whilst it has not been necessary to develop options that have more complex service or intermediate station calling patterns there would be a further reduction in route capacity were any to be seriously considered. It has been calculated that at least two paths per hour in each direction would be lost if an intermediate station on the core route section, between London and the diverging junction for Birmingham, were to be served by some trains only. If all trains stop at the intermediate station then there is no further loss in route capacity provided that the platforms and signalling are designed for this functionality.

Station Dwell

3.22 At regional intermediate stations it is assumed that each station stop will add a maximum of six minutes to the overall journey time including a station dwell time of two minutes. In options where trains reverse at an intermediate station, an extended dwell time of five minutes has been used for trains formed of 5 cars.

Service Balances and Turnround Allowances

3.23 In each of the options described in this section the notional rolling stock diagrams are self contained within a service group. It might be possible to further optimise the rolling stock fleet and reduce the overall terminal platform requirements by interworking sets between service groups. However, this is likely to import significant performance risk and would almost certainly require a reduction in the route planning capacity assumptions described above.

3.24 A minimum turnround time of 20 minutes is included in all notional rolling stock diagrams. However, the combination of journey time between end to end station pairs, when coupled with service frequency, ensures that most turnrounds are longer. Where some flexibility is inherent in the train set diagrams, and without prejudicing route capacity, turnround times at the London end are reduced to minimise the cost of platform provision here. This is balanced with a longer turnround at the outer end provided this itself does not add to the total platform requirement.

3.25 Actual turnround time will be a function of the station layout, the rolling stock design, train servicing arrangements and the passenger information systems. Shorter turnround times may be possible if the combination of these is optimised, although these are unlikely to fall below 15 minutes, particularly for the longer distances services with journey times in excess of 2 hours.

Route Distance

3.26 The point to point distance between any two stations pairs is based on the straight line distance +10%. In some cases up to +15% has been added to the straight line distance where obvious route geography features that the New Line must cross or circumnavigate could constrain route choice. An example of this might be a major river estuary such as the Mersey. Similarly, where the destination is served as a diverging main line, a judgement has been made on what impact this will have. Most assumed point to point distances are similar to the classic line route distance between the same two station pairs. This is illustrated in Table 3.1 using the Route 1 Option described later in this section.

TABLE 3.1 ASSUMED ROUTE 1 DISTANCE BETWEEN NEW LINE STATION PAIRS

Between	Straight line	+10%	+15%	Classic line	Assumption
London and Manchester	161	177	185	184	180
London and Birmingham	100	110	115	113	115
London and Edinburgh	331	364	380	393	375
London and Glasgow	344	378	395	401	380
London and Liverpool	177	195	204	193	200
London and Preston	188	207	217	209	205
Birmingham and Manchester	71	78	81	82	85
Birmingham and Edinburgh	246	270	283	295	280
Birmingham and Glasgow	253	278	291	296	285
Birmingham and Preston	95	104	109	104	110
Manchester and Preston	28	30	32	31	30
Preston and Edinburgh	153	168	176	191	170
Preston and Glasgow	158	174	182	192	175

Line Speed

3.27 A maximum line speed of 200mph (320kph) has been assumed in this Strategic Business Case. This was agreed as it represents the current maximum for high speed lines in Europe and that which can be achieved by trains currently available on the market.

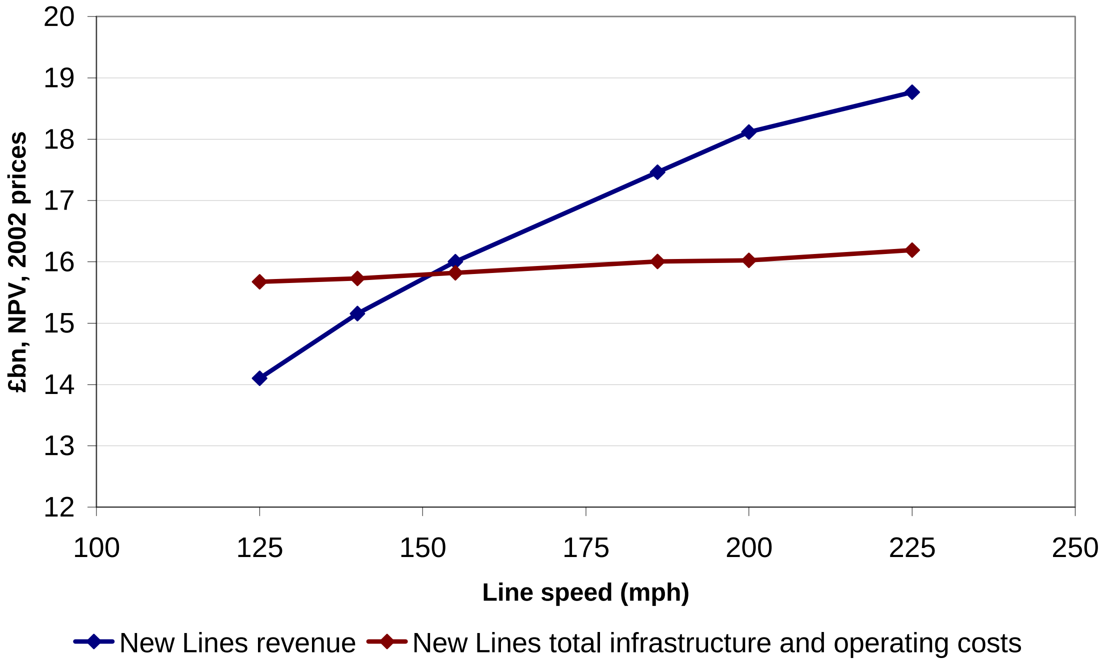
3.28 The impact of alternative maximum line speeds has been assessed to show the change to journey times, train hours and rolling stock fleet requirements. A standalone analysis has also been undertaken examining the impact of different speed assumptions. This analysis demonstrated that the performance of the scheme, in terms of the BCR, improves as speed increases. This will be a consideration if any existing (Class 373, 390, 395 or IEP) trains were to be redeployed on the New Line or if faster line speeds were a serious option at the time of project delivery. This is illustrated in Option MB1.0A, described later in this section, in Table 3.2 below.

TABLE 3.2 IMPACT OF ALTERNATIVE LINE SPEEDS ON OPTION MB1.0A

Between	125mph	140mph	155mph	186mph	200mph	225mph
London Manchester	92mins	85mins	79mins	69mins	66mins	61mins
London Birmingham	60mins	56mins	53mins	47mins	46mins	44mins
Total Fleet requirement	32 sets	30 sets	29 sets	26 sets	24 sets	22 sets
Annual train hours	138,446	128,583	122,738	113,425	103,562	98,935

3.29 These assumptions have been run through the New Lines modelling suite to estimate the impact on the value of the scheme under differing speeds of operation. Figure 3.2 below shows the relationship between speed and the NPV of the key components of the appraisal of the scheme. As speed increases operating cost increases, due to the cost of increased energy consumption outweighing service efficiencies. However revenue rises at an even faster rate than costs.

FIGURE 3.2 NET PRESENT VALUE OF COMPONENTS ASSUMING DIFFERENT SPEEDS OF OPERATION



3.30 Table 3.3 below shows the BCRs estimated for Option MB1.0a at different speeds of operation. This analysis indicates that the faster the service, the better the case for a New Line. However, 200mph operation has been assumed for the New Line services. This is the speed of the fastest rail passenger services currently in operation.

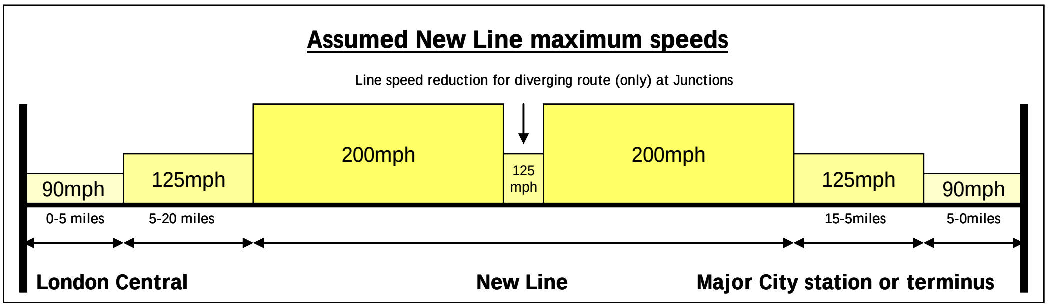
TABLE 3.3 SPEED OF OPERATION AND BCR OF OPTION MB1.0A

SPEED	BCR
125MPH	0.4
140MPH	0.5
155MPH	0.6
186MPH	0.8
200MPH	0.9
225MPH	1.0

3.31 As part of this project AEA Technology was commissioned by the New Lines Programme to fully consider the environmental impact of a new line. As part of this piece of work AEA considered the energy consumption of different rolling stock, and different speeds of operation. The work demonstrated a significant net benefit of high-speed rail services over equivalent conventional services in terms of energy consumption and emissions per passenger-km. This is more fully documented in the paper “Comparing the Environmental Impact of Conventional and High Speed Rail” which is available on the Network Rail website. It should be noted that due to the timescales in which the Strategic Business Case was required it was not possible for the full findings of the AEA work to be taken into account in the appraisal presented in this document.

3.32 Figure 3.3 shows the New Line speed profile used to calculate journey times between any two stations pairs. Using this profile journey times between all the station pairs has been calculated using RailSys. A notional 2.5% performance allowance has been added to all calculated times.

FIGURE 3.3 ASSUMED NEW LINE SPEED PROFILE



Route Planning Assumptions

London Terminus

3.33 Throughout this Strategic Business Case the London terminus is referred to as London Central. An assumption was developed that for the purpose of this Strategic Business Case, the New Line London terminus would be assumed to be located somewhere on the Circle Line.

3.34 In preliminary analysis, a multi-criteria assessment was undertaken to narrow down location choice for planning purposes and to consider the relative impact that location would have in terms of construction (cost, feasibility) and accessibility and connectivity.

3.35 This assessment considered the ease of access to markets, destinations, development areas and transport links. The construction feasibility and cost impacts for the possible station location choices were also considered, together with the impact on existing services that might be displaced. The output from this work has formed a key input to the infrastructure cost model.

Major City Termini

3.36 At each of the major city destinations it was assumed that the New Line terminus would be located at, or within walking distance, of one or more of the classic line principal stations. For example in Manchester the terminus was assumed to be at, or near, Piccadilly, Oxford Road or Victoria. In Birmingham the terminus was assumed to be at, or near, New Street, Snow Hill or Moor Street.

Regional Station location

3.37 For regional stations, the assumed station location was less precise, reflecting the uncertainty of route alignment, but each was assumed to have connections to an existing classic line and have good accessibility.

Route approach to London

3.38 A major cost driver in the Strategic Business Case is the cost of penetrating central London at least as far as the Circle Line. Without extensive tunnelling from the London boundary there are relatively few obvious approach routes into London. Those that do exist would all use existing rail corridors in some way, and with varying impacts on existing services during and post construction. A number of route choices have been considered at a high level and these are briefly described below.

Great Western and Great Central Joint (GW&GC Joint)

3.39 This approach reaches the London boundary via the existing Chiltern Main Line from High Wycombe to Northolt Junction. For most London terminus options the route would then use the very lightly used corridor from Northolt Junction towards North Acton and Old Oak Common where it joins the Great Western Main Line (GWML). The corridor is shared with LUL's Central Line. South of Northolt Junction a double track route would reach the North Acton area where the forward approach to Central London would vary by choice of London terminus. This approach provides potential access to HS1 and Heathrow can be reached from the GW & GC Joint route via the Greenford branch and the GWML.

West Coast Main Line (WCML)

3.40 This approach uses the WCML route corridor and could be achieved by displacement of existing services to enable the creation of two tracks suitable for a New Line. This might be achieved through displacing the London Overground DC and Bakerloo line services and much of the DC lines route between Euston to Watford Junction but it would also require significant change to other lines and services. This would be highly disruptive during construction and almost certainly require closure of most, if not all, existing DC line stations in London and Hertfordshire. This approach provides potential access to HS1. Access to Heathrow could be achieved via the West London Line, Windsor Lines and Airtrack or a new route connection.

Midland Main Line (MML)

3.41 This approach uses the existing MML corridor from the Greater London boundary near Elstree tunnel. From Elstree tunnel the New Line route shares the corridor with the M1 motorway. At Silkstream Junction the existing route becomes a six track corridor to West Hampstead junction. South of West Hampstead a new tunnel would take the line to a new terminus. This approach provides potential access to HS1 with a new link to HS1 or via reversal at St Pancras. Access to Heathrow could be achieved via an upgraded Dudding Hill line and the GWML from Acton.

Lea Valley (West Anglia Main Line)

3.42 This approach arrives at the London boundary via the existing West Anglia Main Line. From Cheshunt to Tottenham Hale it follows the Lea Valley corridor and then to Stratford and via the HS1 corridor to London Central. Heathrow could be accessed via St Pancras and the MML to West Hampstead and then via the Dudding Hill line and GWML from Acton.

Impact of Route Choice

3.43 Table 3.4 shows the impact on route distance to Manchester of the four approach corridors.

TABLE 3.4 IMPACT ON ROUTE DISTANCE (TO MANCHESTER) OF LONDON APPROACH CORRIDOR

Corridor and first station beyond GLA boundary	Rail distance from London Central (St Pancras/King's Cross) to GLA boundary stn	Straight line distance GLA boundary station to Manchester	Total distance
GW and GC Joint Denham (Bucks)	20 miles (estimated)	150 miles	170 miles
WCML Carpenders Park (Herts)	15 miles (estimated)	150 miles	165 miles
MML Elstree & Borehamwood (Herts)	12 miles (estimated)	150 miles	162 miles
Lea Valley Waltham Cross (Herts)	22 miles (estimated)	155 miles	177 miles

3.44 In assessing the four route approaches it is clear that the relatively small difference in distance between London Central and Manchester is unlikely to have a significant impact on overall journey times.

3.45 In conclusion it is clear that the final route approach choice into London could have a significant infrastructure and disruption cost impact on the Strategic Business Case but that it has relatively little impact on revenue or operating costs of the New Line services. It is also clear that the route approach choice has to be considered carefully with the London terminus choice.

Stage 1: Conceptual Route Strategy

3.46 The initial option development identified the core route of London to Manchester and Birmingham as the key building blocks on top of which other services and calling patterns are tested.

3.47 Before developing the Train Service Specification further it was necessary to understand the difference in cost and benefits of the strategic route choice for the core option. The two basic choices for the core route are:

- Route 1 - London and Manchester with a diverging main line to Birmingham; or
- Route 2 - London and Manchester via Birmingham.

3.48 A secondary consideration in making the strategic route choice is the impact on regional services between Birmingham and Manchester to establish if these enhance the overall case once the additional costs and benefits were added. This has been considered for each route together with a hybrid option (MB2.0c) that combines links between all three station pairs in one service.

3.49 A further New Line option is a route that serves Heathrow as an intermediate station stop and this, Route 3, is considered in section 7 together with other Heathrow options.

3.50 For each core route choice the following services has been compared:

- London and Manchester 4tph + London and Birmingham 4tph; and
- London and Manchester 4tph + London and Birmingham 4tph + Birmingham and Manchester 2tph.

3.51 In addition a London and Manchester service with an intermediate station stop in Birmingham has also been tested. In order to provide a direct comparison between this option and Options MB1.0b and MB2.0b, the same capacity has been provided for the combined Manchester and Birmingham markets. This has been achieved by forming trains with 15-car sets and increasing the frequency to 6tph

3.52 Figures 3.4 and 3.5 show the route plan and Train Service Specification (TSS) for the route options and the core service variants for each. In these two routes choices, and for all subsequent New Line route extensions associated with other service options, the junctions have been named as shown in route plans. This is to assist their identification and ease inputs to the Infrastructure Cost Model. These names have no other meaning.

FIGURE 3.4 ROUTE 1 PLAN AND TRAIN SERVICE SPECIFICATION FOR OPTIONS MB1.0A AND MB1.0B

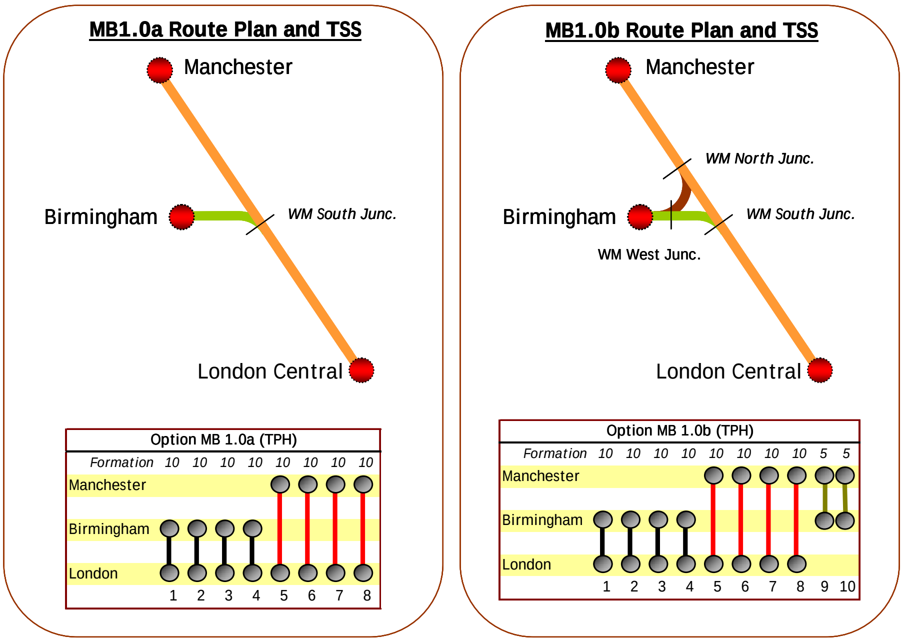
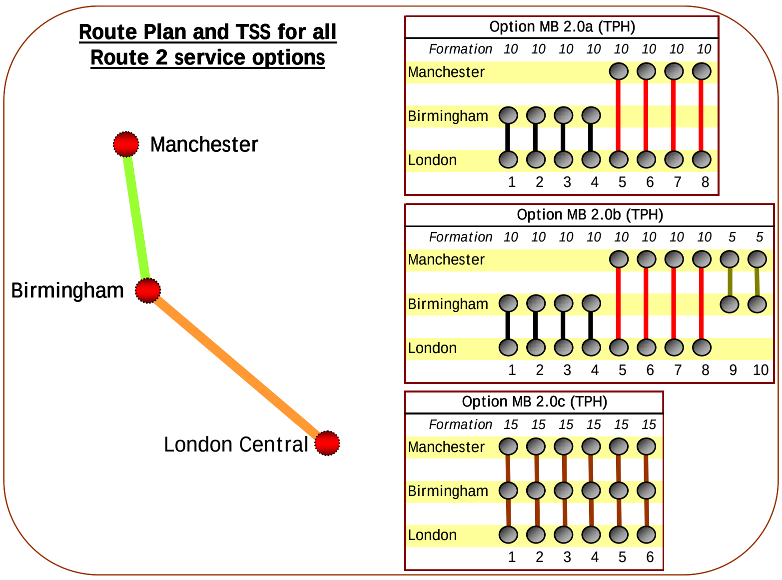


FIGURE 3.5 ROUTE 2 PLAN AND TRAIN SERVICE SPECIFICATION FOR OPTIONS MB2.0A, MB2.0B AND MB2.0C



3.53 A summary of the inputs made to the Infrastructure Cost Model, the Operating Cost Model and the Demand and Revenue modelling suite for these and subsequently described options are shown separately.

3.54 Table 3.5 below compares the same service operated on the two routes (Options MB1.0b and MB2.0b). This confirms that whilst Route 2 offers slightly faster journey times between both London and Birmingham and Birmingham and Manchester, the journey time increase to Manchester is 11 minutes for a non stop train. Annual train hours are also significantly higher in the Route 2 option, although the annual vehicle miles are the same for both route options.

TABLE 3.5 COMPARISON OF ROUTES 1 AND 2 JOURNEY TIMES AND COST DRIVERS

Between	Route	Journey time	Fleet (sets)	Train hours	Vehicle miles
London and Manchester	1	66 minutes	14	59,178	66m
	2	77 minutes	16	69,041	69m
London and Birmingham	1	46 minutes	10	44,384	42m
	2	44 minutes	10	44,384	40m
Birmingham and Manchester	1	38 minutes	5	22,534	9m
	2	34 minutes	5	22,534	8m

Confirming Route Choice and Base Train Service

3.55 The economic appraisal, shown in Section 6, confirms that the Route 1 options perform better than the Route 2 options and that Option MB1.0b, which includes the service between Birmingham and Manchester, is best overall. This has therefore formed the start point for developing other options that explore the cost and benefits of serving additional destinations and the impact on the Strategic Business Case.

3.56 Route distance and journey time to all target destinations north of Birmingham are determined to be shorter via Route 1 and therefore this route choice will optimise the cost benefit of adding further destination to the chosen core route choice.

Stage 2: Developing the best performing Route Option

3.57 Once the core route had been selected, further options were developed by adding additional targets to the line. They were built up incrementally to assess the value of each market.

Widening target destinations to the East Midlands and Yorkshire

3.58 At this development stage consideration was given to looking at options with a diverging route to the East Midlands and forward to Sheffield and Leeds. As a core objective of the study was to release capacity on the West Coast Main Line (WCML), this was parked pending the results from Options MB1.1 onwards and also to establish the results from serving Heathrow. As these options added further trains to the New Line and transferred passengers to its services from the existing WCML classic line it gave potentially a better opportunity to develop a more substantial recast of the WCML with enhanced revenue and cost benefits.

3.59 As the results from each subsequent option that added additional services, also improved overall business case performance, it was unnecessary to look to the East Midlands and Yorkshire catchments for more benefits to support the case for a New Line.

3.60 Furthermore, until a route alignment is chosen, it is difficult to calculate accurate journey times and costs to relatively short distance secondary destinations off the core route like the East Midlands. A diverging main line to Yorkshire would also require significant additional New Line mileage for the route north of the East Midlands. The business case for this, even at four trains an hour between London and Leeds, is unlikely to as strong as that achieved by serving destinations on the West Coast Main line.

3.61 Section 11 paragraph 11.34 considers the opportunity of adding additional routes to create a New Line network that would consider the East Midlands and West Yorkshire as potential target destinations.

Further Option Development

3.62 The following options have been developed to test the impact of adding further destinations to the chosen core route and train service specification. The New Line options are divided into those assumed to be self contained and serve all destinations directly and those that run on to the classic network.

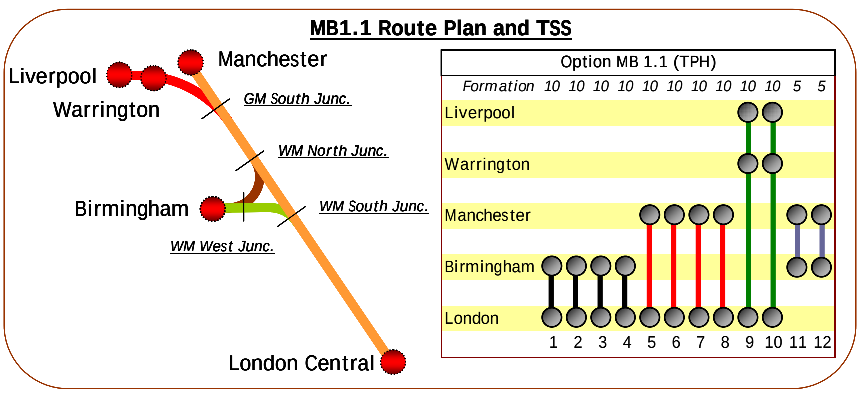
- **Self-contained options:**
- Warrington and Liverpool – Option MB1.1;
- Preston, Edinburgh and Glasgow – Option MB1.2; and
- Warrington, Liverpool, Preston, Edinburgh and Glasgow – Option MB1.4.
- **New Line with classic line running options:**
- Options MB1.3: New Line to Preston with through services to and from stations between Preston and Edinburgh Waverley/ Glasgow Central; and
- Option MB1.6: New Line to Preston and with through New Line services to and from stations between Preston and Edinburgh/ Glasgow and with a further Classic Line connection to Warrington and Liverpool Lime Street.

3.63 These options are described below and a summary of the inputs made to the Infrastructure Cost Model, the Operating Cost Model and the Demand and Revenue modelling suite for each of these options are shown separately.

Option MB1.1: Route 1 London to Manchester, Birmingham and Liverpool

3.64 Option MB1.1 as shown in Figure 3.6 below adds a diverging main line to Liverpool with a new intermediate station at Warrington to the chosen core Option MB1.0b.

FIGURE 3.6 OPTION MB1.1 ROUTE PLAN AND TRAIN SERVICE SPECIFICATION (TSS)



Option MB1.2: Route 1 London to Manchester, Birmingham and Scotland

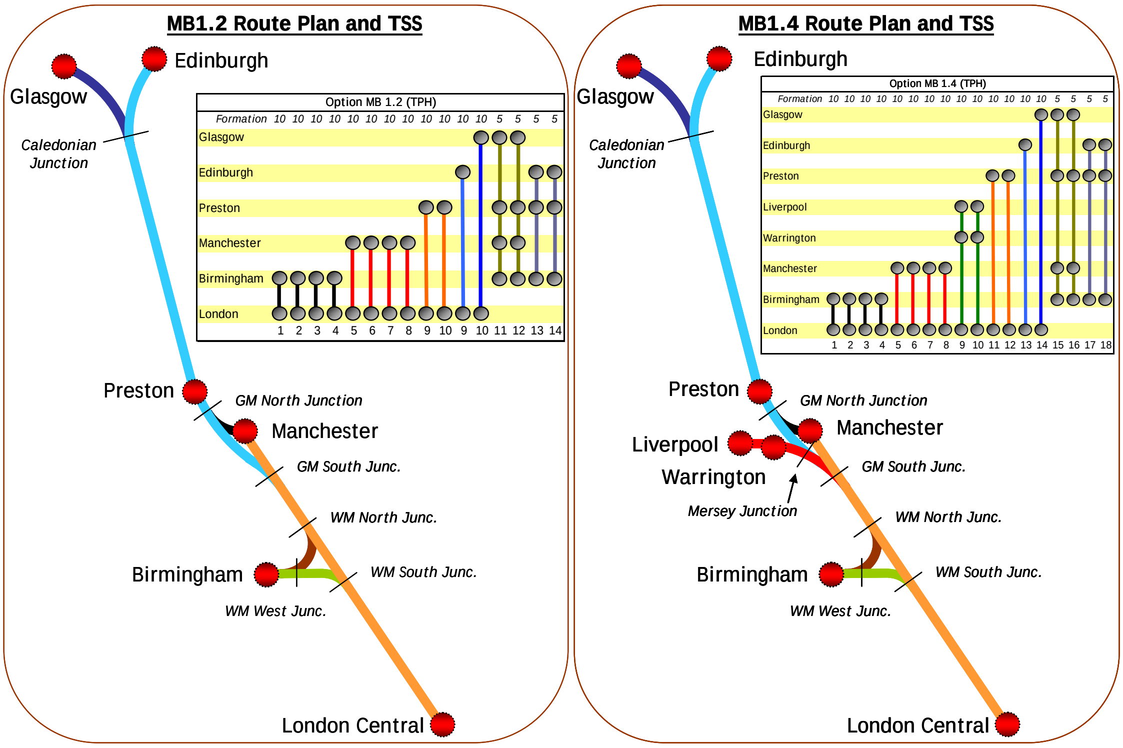
3.65 In Option MB1.2 the New Line is extended to serve both Edinburgh and Glasgow with an intermediate station at Preston. On the core route section between London and WM South Junction a total of 10tph are proposed to be operated in each direction. In addition a connection is made from the New Line terminus at Manchester to join the

New Line at GM North Junction to enable trains to operate between Manchester, Preston and Scotland. The route plan and train service specification are shown in Figure 3.7 left.

Option MB1.4: Route 1 London to Manchester, Birmingham Scotland and Liverpool

3.66 In Option MB1.4 a diverging main line to Warrington and Liverpool is added to the service in Option MB1.2 to give 14tph on the core route section between London and WM South Junction. The route plan and train service specification are shown in Figure 3.7 right.

FIGURE 3.7 OPTIONS MB1.2 AND MB1.4 ROUTE PLANS AND TRAIN SERVICE SPECIFICATION (TSS)



Options MB1.2.1 and MB1.4.1: Enhanced services to Scotland

3.67 Early demand and revenue results indicated that crowding levels on the services between London and Scotland for Options MB1.2 and MB1.4 were giving significant disbenefits. Therefore a further refinement of the TSS was tested that extended the 2tph service between London and Preston to Glasgow and diverted the existing London and Glasgow service to run non stop to and from Edinburgh. The service between London and Scotland is revised to become:

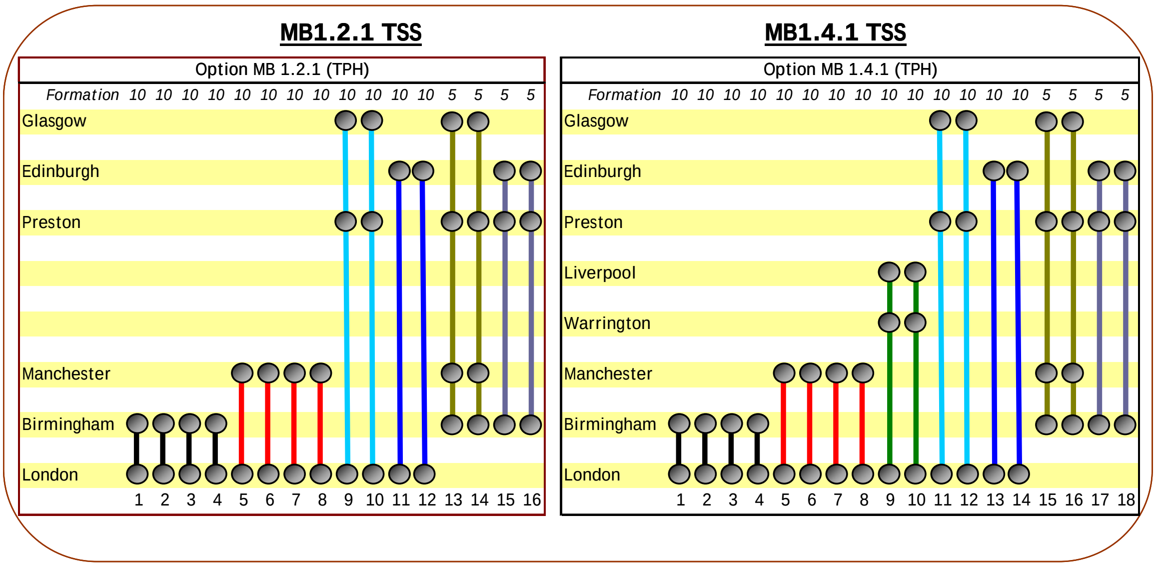
- London-Preston-Glasgow 2tph (with slightly extended journey time to and from Glasgow because of the Preston stop); and
- London-Edinburgh 2tph non-stop.

3.68 This has enabled an assumption to be made that there is a modest reduction in ECML services between Scotland and London King’s Cross. It is also assumed that cross Edinburgh services between London and Inverness/ Aberdeen are withdrawn throughout on the classic network.

3.69 These option variants overcome the crowding disbenefits and generate additional net revenue to more than offset the net additional operating costs. They also have the same infrastructure requirements as MB1.2 and MB1.4 from which the revised TSS was derived.

3.70 The revised TSS for these Options is shown in Figure 3.8.

FIGURE 3.8 OPTIONS MB1.2.1 AND MB1.4.1 TRAIN SERVICE SPECIFICATION (TSS)



Option MB1.3 Classic Connections to Scotland

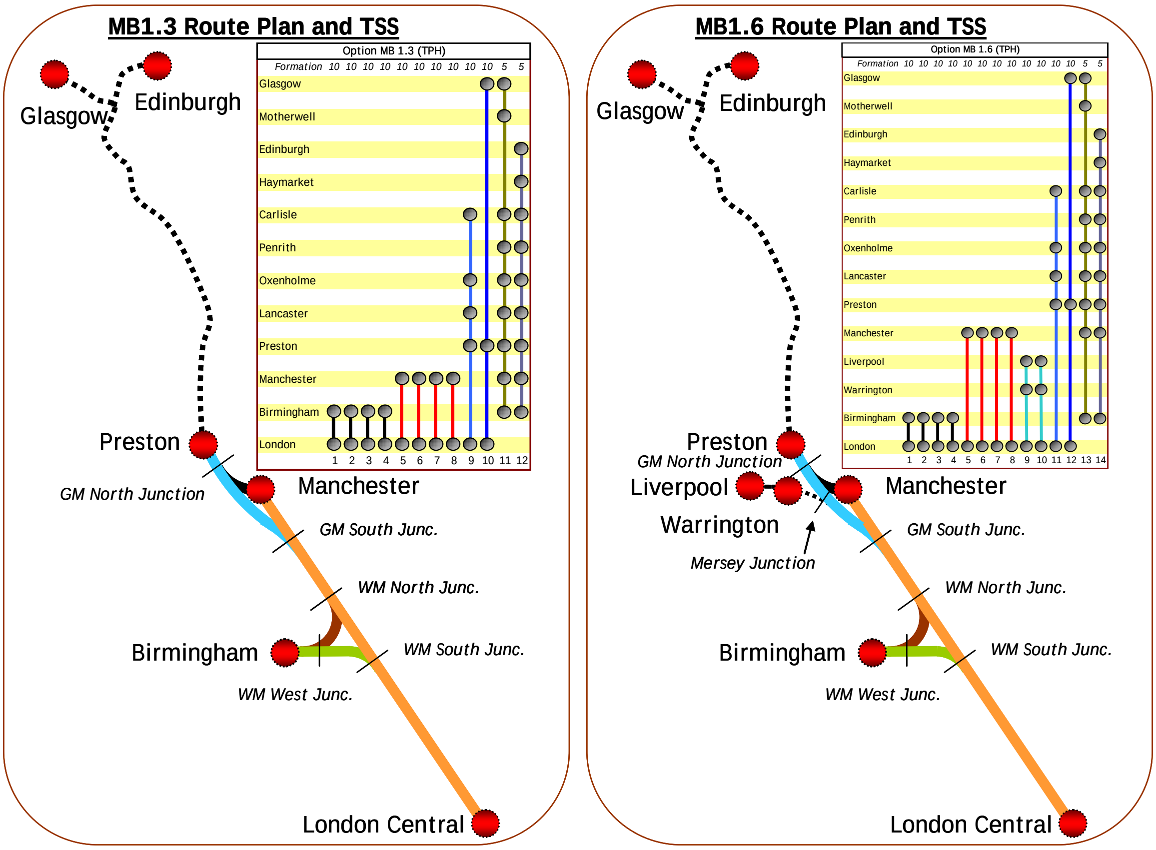
3.71 In this option the New Line services are assumed to displace all existing long distance Intercity passenger train services north of Preston on the WCML. How this would be achieved in practice has not been considered in detail, but what is known is that no further capacity is available for additional fast passenger trains on this route section beyond that achieved in the current WCML timetable. Therefore in this option there are no services proposed between London and Edinburgh via the New Line.

Option MB1.6 Classic Connections to Scotland and Liverpool

3.72 In this option, in addition to the New Line services operating on the classic line north of Preston, it is proposed to operate 2tph between London, Warrington and Liverpool via a classic line connection at a point where the New Line can form a grade separated junction with a suitable classic route. The point at which the New Line would actually connect with one or other of the existing route(s) to Warrington and Liverpool is unknown. In this option the service to Warrington and Liverpool is assumed to operate via Warrington Central and the Cheshire Lines. In practice it might be more practical to run via the Chat Moss route with a 'Warrington' station somewhere else in the target catchment area, or via Warrington Bank Quay and Earlestown.

3.73 Whether paths could be found for these trains, without significant change to other services is untested and would undoubtedly be difficult without a full recast of other local and inter-regional services. An alternative option might be to serve Liverpool with a connection via Runcorn. However, the distance from the New Line route alignment to the existing branch between Weaver Junction and Runcorn could be significantly longer than a route via Warrington. If this were the case the benefits might be lower and the costs significantly higher. It is possible that any variant of this option is undeliverable without significant further enhancement to one of the classic line routes to Liverpool and/ or slower journey times to the target destinations.

FIGURE 3.9 OPTIONS MB1.3 AND MB1.6 ROUTE PLANS AND TRAIN SERVICE SPECIFICATION (TSS)



Creating the New Line Notional Timetables

3.74 Creating timetables for each New Line option has enabled inputs to the various modelling suites to be both precise and based on a firm foundation. With the Rules of the Plan (RotP) assumption that the New Line headway is three minutes; that trains have identical performance characteristics; and that service intervals and calling patterns are standardised, it is relatively easy to generate simple notional timetables for the options with only two or three service groups. These include Options MB1.0; 1.0b; 2.0a; 2.0b; and 2.0c. As more complex options are developed, that include multiple destinations served, more care is required to ensure that the notional timetables are operationally robust and designed to use the assumed assets efficiently.

Core Timetable Option MB1.0b

3.75 The timetable for the core Route 1 option is shown in Figure 3.10. In this timetable the 4tph even interval services between London and Manchester/ Birmingham and the 2tph service between Birmingham and Manchester are both easy to path, and optimise rolling stock balances and terminal station infrastructure requirements.

FIGURE 3.10 OPTION MB1.0B OUTLINE TIMETABLE

MB1.0b Outline Timetable

DOWN	London Central	dep.	10:00		10:05	10:15	10:20	10:30		11:35	10:45	10:50
	Birmingham	arr.			10:51		11:06			12:21		11:36
		dep.		10:35					11:05			
	Manchester	arr.	11:06	11:13		11:21		11:36	11:43		11:51	
UP	Manchester	dep.	09:00	09:05		09:15		09:30	09:35		09:45	
	Birmingham	arr.		09:43					10:13			
		dep.			09:28		09:43			09:58		10:13
	London Central	arr.	10:06		10:14	10:21	10:29	10:36		10:44	10:51	10:59

Option MB1.4.1 Timetable

3.76 Options MB1.4.1 and MB3.4.1 have the highest proposed New Line utilisation. The best performing of these two MB1.4.1 is shown to illustrate a fully developed timetable plan.

3.77 In Option MB1.4.1 the New Line service comprises 14tph in each direction on the core route from London Central to the diverging junction for Birmingham (WM South Junction). Between WM North Junction and GM South Junction, where the diverging route to Preston leaves the core main line to Manchester, there are also 14tph comprising of 10tph to and from London and 4tph services between Birmingham and Scotland.

3.78 With utilisation of the New Line approaching full capacity it becomes increasingly challenging to optimise all elements of the plan. This optimisation includes ensuring that connecting services and service intervals are most effective placed in the timetable at intermediate stations such as Preston. In this example the timetable also requires stopping services to be overtaken by a following non-stopping trains. This demonstrates why it is necessary to include four platform faces remote from the fast running lines a shown in Figure 3.1 at this intermediate station.

3.79 The timetable for the core Route 1 option is shown in Figure 3.11.

FIGURE 3.11 OPTION MB1.4.1 OUTLINE TIMETABLE

Option MB1.4.1 Outline Timetable

DOWN	London Central	dep.	10:00	10:03	10:06	10:12	10:15	10:18	10:21			10:30	10:33	10:36	10:42	10:45	10:48	10:51		
	Birmingham	arr.		10:49				11:04					11:19				11:34			
		dep.								10:45	11:00								11:15	11:30
	Manchester	arr.	11:06				11:21			11:23		11:36				11:51			11:53	
		dep.								11:28									11:58	
	Warrington	arr.			11:12									11:42						
		dep.			11:14									11:44						
	Liverpool	arr.			11:29									11:59						
	Preston	arr.				11:25				11:43	11:46				11:55				12:13	12:16
		dep.				11:27				11:45	11:48				11:57				12:15	12:18
	Edinburgh	arr.							12:30		12:47							13:00		13:17
	Glasgow	arr.				12:28				12:46					12:58				13:16	
UP	Glasgow	dep.					07:59				08:16					08:29				08:46
	Edinburgh	dep.	07:51							08:15		08:21							08:45	
	Preston	arr.					09:00			09:14	09:17					09:30			09:44	09:47
		dep.					09:02			09:16	09:19					09:32			09:46	09:49
	Liverpool	dep.				08:49									09:19					
	Warrington	arr.				09:04									09:34					
		dep.				09:06									09:36					
	Manchester	arr.									09:34									10:04
		dep.		09:00				09:15			09:39		09:30				09:45			10:09
	Birmingham	arr.								10:02	10:17								10:32	10:47
		dep.			09:23				09:38					09:53				10:08		
	London Central	arr.	10:00	10:06	10:09	10:12	10:15	10:21	10:24			10:30	10:36	10:39	10:42	10:45	10:51	10:54		

Potential Service Additions to the Chosen New Line Scheme

3.80 Each of the destinations evaluated so far will be relatively indifferent to the route alignment, in cost and benefit terms, provided the route distance does not exceed the relatively conservative assumptions made in Table 3.1.

3.81 As described in paragraph 3.19 it is possible to add two further trains per hour in each direction to Option MB1.4.1 to fully utilise the New Line capacity. However, until the final route alignment is chosen, it is more difficult to accurately assess the costs and benefits of other destinations that may or may not be close to the New Line route alignment. This is because the input assumptions, including journey time, rolling stock requirements and infrastructure costs could be very different.

3.82 Paragraph 3.58 explains why options that included services to the East Midlands were not considered in detail during this work. Whilst it was not the only consideration in the decision to stop developing the option further, the uncertainty over route alignment and therefore costs was one aspect of this decision. In this example, if the New Line route alignment broadly followed the existing WCML, then the cost of a diverging main line would be relatively high if were to serve the principal city markets of Leicester and Nottingham. However, if the New Line followed the straight line or broadly the existing MML alignment, then it will pass the outskirts of Leicester and require a relatively short diverging route to serve the two cities.

3.83 To further illustrate this, a diverging main line to Crewe and Chester could be considered as attractive target destinations, in demand and benefits terms, for the final two train paths. However, if the New Line route alignment approached Manchester from the south east, as the former Midland route did until 1968, then a diverging main line to Crewe and Chester would probably be too long to add value to the overall case. If the New Line were to more closely follow the existing WCML alignment then the diverging main line would be relatively short and may add value to the case.

3.84 The next stage of the programme development could look at the options further when there is more certainty over the chosen route alignment.

Overview of Classic Lines Recast

Impact of the New Line on the WCML and other Classic Line services

3.85 As the geography and scope of the additional New Line services expand, then the impact of the change on the classic line(s) grows. First and foremost, this impact is felt through the transfer of passengers from the existing services to the New Line services. Even in the best performing core Option MB1.0b the effect is dramatic, as almost the entire existing passengers flow volume between the three cities of London, Birmingham and Manchester moves to the New Line. In Option MB1.0b the classic line response is assumed to be a reduction in WCML services between London and Birmingham of 1tph; London and Manchester of 1tph; and Birmingham and Manchester of 1tph. Each service withdrawn enables a corresponding reduction in classic line rolling stock and operating costs.

3.86 However, this is not the whole story. In order to minimise the disbenefit to passengers travelling between WCML intermediate stations and London, Birmingham and Manchester it is necessary to redistribute the stations stops of the withdrawn trains to the remaining services. It also assumed that at least the London and Birmingham service is re-timetabled to provide a 30 minute even interval service between London, Coventry, Birmingham International and Birmingham New Street. This is required to minimise, what could be, significant disbenefits to passengers using these services and who have received no benefit from the New Line service. This study has not considered the timetabling implications of any of these changes apart from making a judgement that this can be achieved with only a minimal impact on other classic line services.

3.87 At this stage of option development no rolling stock type or train length changes are assumed as this would probably create other inefficiencies if these trains were not operated as part of a common fleet with other WCML and Cross Country services.

Classic Line Opportunities

3.88 The development of a New Line not only provides the opportunity to improve services to cities on the New Line, it also frees up capacity on the classic network. This provides a substantial opportunity to improve services and provide more capacity for a significant number of markets.

3.89 In options where there is a more substantial transfer of existing long distance passengers to the New Line is becomes increasingly plausible that the appropriate response for the classic lines is a radial rethink of service provision.

3.90 The objectives of a rethink would be to:

- Provide additional capacity for growth in commuter demand to London, Birmingham and Manchester;
- Reduce the operating cost of serving the much smaller, but still substantial, passenger demand that does not and/or cannot transfer to the New Line e.g. retaining frequency but with shorter and more suitable trains;
- Develop opportunities to expand existing markets not particularly well served because of capacity constraints and the opportunity cost to the existing major flows e.g. Milton Keynes Central to the West Midlands;
- Develop new markets with through services to destinations not currently served with direct trains e.g. Shrewsbury and Blackpool North, and in doing so, taking advantage of the more flexible and suitable train types to avoid unnecessary additional operating costs; and
- Provide capacity for freight train growth.

3.91 The development of a fully optimised classic line timetable is outside of the scope of this project. There are just too many uncertainties and unknowns within the modelling suite of tools to effectively consider, develop, iterate and select from the very many possible options available in the time available.

3.92 However it is necessary to create a plausible train service specification to help understand what a rethink of classic line service might do to the costs and benefits to be included in the New Line Strategic Business Case.

3.93 To avoid the risk of understating the cost and overstating the benefits of change to the classic lines, this study has taken a cautious approach. Therefore, the changes proposed to the classic line services and the underlying assumptions made veer towards the conservative position where the cost and benefit trade off is not fully refined and iterated. This is true both for the simple options, where there is a modest reduction in service, to the more extensive changes proposed in association with Option MB1.4.1.

Reference Case

3.94 In order to provide a comparator to the New Line options a reference case has been developed. This is intended to reflect the timetable and rolling stock configuration likely to be in place on the West Coast Main Line in 2020 if no major intervention is undertaken. Given that WCML timetable was completely recast in December 2008 this is based upon the current West Coast timetable with train lengthening assumed where it is judged to be easily achievable.

3.95 The following timetable assumptions are included in the reference case:

- Full West Coast December 2008 Timetable;
- Pendolino sets lengthened to 11-car for services to Birmingham and Manchester;
- Partial lengthening of the 350 fleet to 12-car;
- Class 378s extended to 5-car; and
- 10 car IEP rolling stock on Northampton services.

4 Cost Modelling

Infrastructure Costs

4.1 This section describes the process undertaken to develop the high level infrastructure cost estimate that is utilised in the Strategic Business Case.

Summary of Methodology

4.2 At this stage of project development only a very high level indication of the potential route of a new line can be assumed. Therefore a bespoke approach to estimating the likely cost of constructing a new line has been developed to enable the estimation of costs for a generic alignment. To reflect the inherent risk and uncertainty that applies at this stage of project development a 66% allowance for optimism bias has been applied to the final estimate of infrastructure costs within the scheme appraisal. This is in line with DfT appraisal guidance.

4.3 The key inputs to the infrastructure cost modelling process are provided by the:

- **High Level Technical Specification -** which defines the key engineering requirements for the new routes. This defines items such as the signalling system, linespeed, line gradients and platform lengths; and the
- **Train Service Specification** – which defines the key operating requirements to deliver the assumed service level. For example the origin and designation, requirements for intermediate stations, route length, connections with classic lines, quantity of rolling stock and the number of platforms required at stations.

4.4 The High Level Technical Specification enables appropriate unit costs to be defined for each main asset required for a new line. A Train Service Specification is required for each potential route and service option.

4.5 Estimates of the capital cost of building a new line are derived by multiplying agreed unit costs by the volume of each asset required (the bill of quantities) to deliver each option. This provides an estimate of the construction cost of a new line, i.e. the cost estimate of contracts awarded to physically build the required works. On top of this non-construction (or indirect) costs must be added to cover client costs for Project Management, Sponsorship and Procurement as well as other services required to support the construction such as Design, Consultation, Consents and Approvals and Compensation.

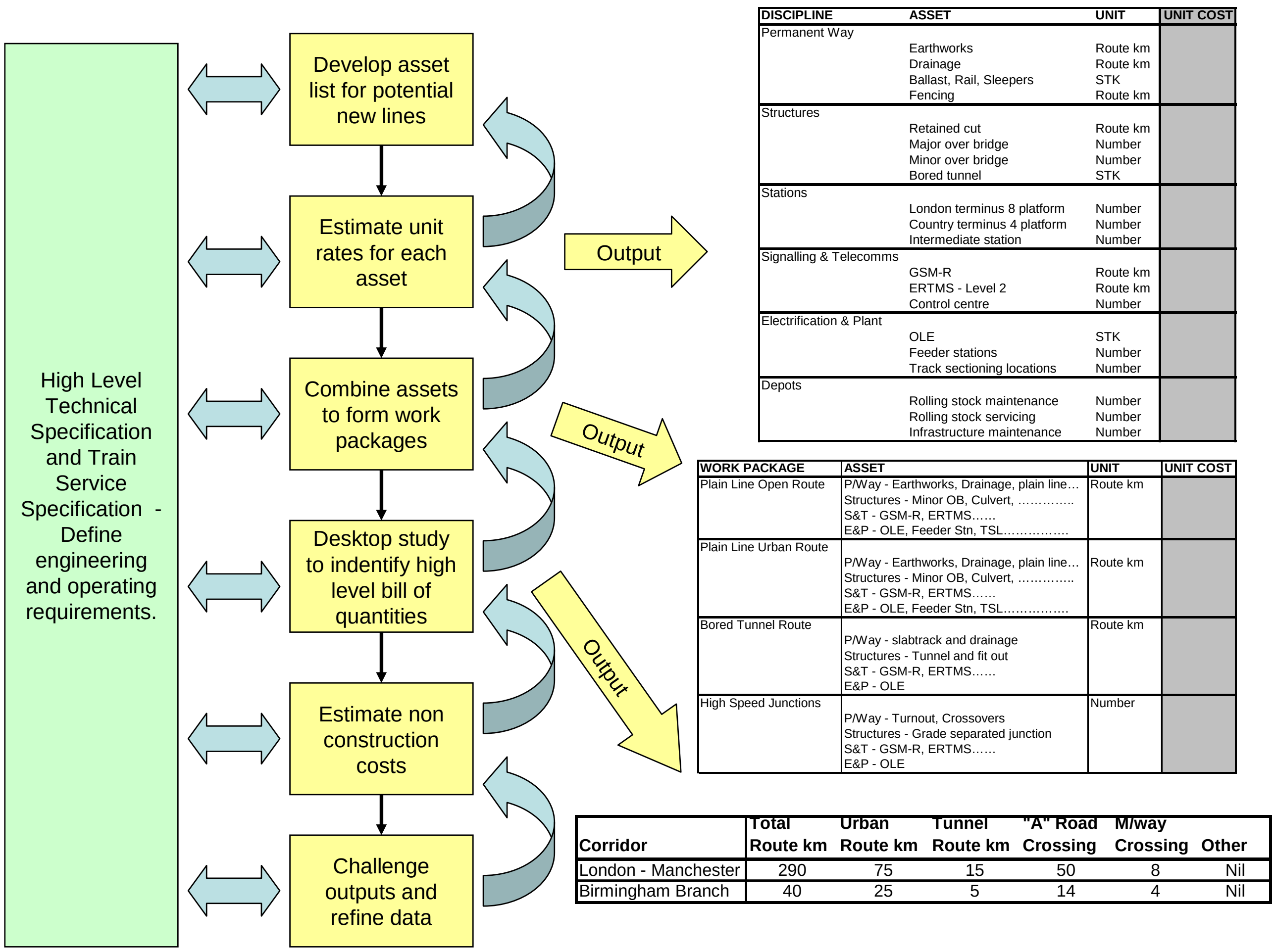
4.6 The High Level Technical Specification is common between all of the options considered. However the Train Service Specification varies for each option. The infrastructure cost model contains unit rates based on the technical specification and estimates the total cost of each option given the proposed route and train service specification. The process is shown pictorially in Figure 4.1 with summaries of example outputs from the key stages shown on the right of the diagram.

4.7 Unit rates for each asset and apportionment of non construction costs were developed in conjunction with the estimating team from the Infrastructure Investment department of Network Rail.

4.8 The key items identified which have a significant impact on the capital cost of the scheme are:

- Overall length of route, number and size of stations;
- Quantity of major structures – tunnels, viaducts, motorway crossings, river / trunk road / railway crossings;
- Length of route through or adjacent to urban areas; and
- Number of junctions – both new line to new line and new line to classic lines.

FIGURE 4.1 METHODOLOGY FOR DEVELOPING CAPITAL COST ESTIMATES



4.9 The estimated cost of the schemes per km were compared to outturn costs for High Speed 1 and other recent European high speed rail projects. Comparisons were also made to other new line cost estimates that have been previously developed. The assumptions used in the model were challenged by both the project team and Network Rail Infrastructure Investment and Enhancement Engineering and refinements made until all parties were satisfied with the base content.

4.10 The cost model was peer reviewed to ensure all calculations were providing the expected outputs.

Key Assumptions

4.11 The key assumptions contained in the cost model are:

Unit Rates

4.12 Information from Network Rail's cost database has been used to derive unit rates where applicable. It is assumed 90%+ of works on the new line will take place away from the classic line railway and therefore the standard rates have been reduced slightly to reflect this. Structure costs are assumed to be more expensive than the costs normally accrued by Network Rail. This is due to two factors. Firstly increased spans are required for new lines, this leads to an increase in costs. Secondly it is assumed that where new lines will cross existing infrastructure (roads or rail lines) the existing infrastructure at these locations will have made best use of the existing topography and therefore more earthworks will be required for the new lines crossing.

4.13 OLE feeder station connections to the national grid are assumed as 1 every 30km rather than 1 every 60-70km as per classic lines. In the absence of accurate installed cost data for ERTMS level 2 systems the cost model uses 70% of the standard 4 aspect SSI signalling cost per route km and interlocking. Station costs for new lines include for 400m length platforms. No other significant variances between classic lines and new lines equipment costs were identified.

Work Packages

Plain line open route

4.14 This is a twin track route with standard earthworks cost for 98% and uplift for retained cut for 2%. The rate includes for track formation, permanent way, drainage and a post & wire boundary fence. Overhead line equipment includes provision for a feeder station and national grid connection every 30km and switching station every 10km. A sum of £500k per km is included for diversion of existing utilities. The land purchase corridor is assumed as 50m wide at a cost of £225k per route km. A crossing of one B class road is assumed every 2km and one major culvert is assumed every km. Signalling and telecoms equipment are included. The total rate equates to £9.5m per route km including prelims and OH&P but excluding project management, design and risk.

Plain line urban route

4.15 As open route assumptions with the following exceptions. Standard earthworks are applied for 50% and uplift for retained cut for 50%. Acoustic barriers are costed rather than post and wire fence. The sum for diversion of utilities is increased to £1,500k per km and the land purchase corridor is reduced to 25m wide but at an increased cost of £1,500k per route km. A crossing of one A class road and one major culvert is assumed every km. The total rate equates to £19.7m per route km including prelims and OH&P but excluding project management, design and risk.

New Lines to New Lines Junctions

4.16 This cost element assumes 1 route km earthworks, a grade separated structure, two pairs of crossovers, one pair of turnouts, one route km of additional land and a signalling interlocking. The total rate equates to £29.5m per junction including prelims and OH&P but excluding project management, design and risk.

Classic Lines Upgrade Costs

4.17 Junctions for normal operations are specified as above but with costs added for modification of classic lines infrastructure – signalling interlocking, OLE and telecoms equipment at the tie in location. Junctions with classic lines for emergency / maintenance operation are as above but at grade. The total rate equates to £34.6m per operational junction and £14.4m for emergency junctions including prelims and OH&P but excluding project management, design and risk.

4.18 An allowance of £300k per track km has also been made to cover required upgrades to the classic lines in options where there is through running of New Line services.

Identification of Bill of Quantities

4.19 City centre locations are assumed for all terminus stations. A tunnelled approach to each station is assumed. The length of tunnelling was estimated from a desktop review of large scale maps. A specific alignment for each route options was not developed – this is not appropriate for this stage of the project lifecycle. Wide corridors for each route were examined.

Results

4.20 The high level bills of quantity for each test scenario are listed in Table 4.1 below.

TABLE 4.1 NEW LINES OPTIONS – BILLS OF QUANTITY

Option	Route Distance (km)	Urban Distance (km)	Tunnel Distance (km)	Motorway Crossings (Number)	Trunk Road / Rail Crossing (Number)	Other
MB1.0a	314	85	25	11	60	1 junction
MB1.0b	330	95	25	12	64	3 junctions
MB1.1	386	130	25	14	79	4 junctions 2km viaduct
MB1.2.1	733	215	55	31	129	7 junctions 6km viaduct
MB1.3	419	140	35	17	91	7 junctions 2km viaduct
MB1.4.1	773	240	55	32	138	8 junctions 8km viaduct
MB1.6	419	140	35	17	91	8 junctions 2km viaduct
MB2.0	320	81	39	9	58	Underground station at Birmingham with passing loops

4.21 The capital cost estimate output for each test option is listed in Table 4.2 below.

TABLE 4.2 NEW LINES OPTIONS - CAPITAL COST ESTIMATES

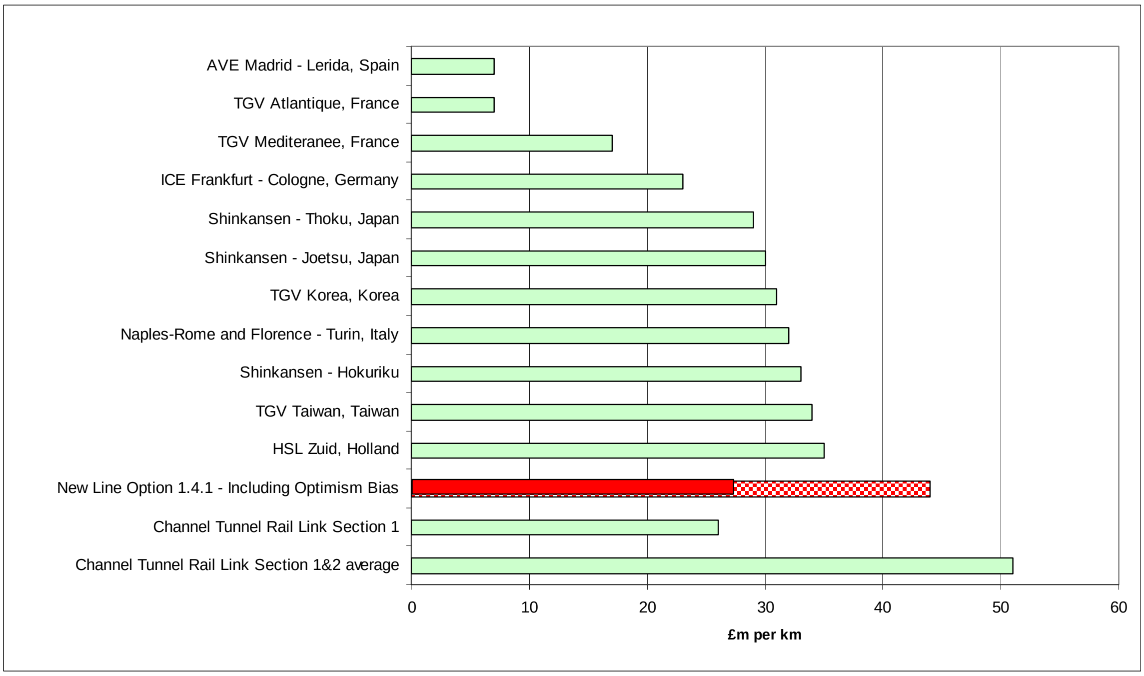
Option	Construction Cost (£m)	Non Construction Cost (£m)	Optimism Bias @ 66% (£m)	Total (£m)	£m per route km
MB1.0a	6,690	2,358	5,972	15,020	47.8
MB1.0b	7,036	2,484	6,284	15,807	47.9
MB1.1	8,221	2,904	11,125	18,468	47.8
MB1.2.1	14,236	5,104	12,765	32,105	43.8
MB1.3	9,279	3,298	8,301	20,878	49.9
MB1.4.1	15,086	5,403	13,523	34,012	44.0
MB1.6	9,353	3,327	8,369	21,049	50.3
MB2.0	7,325	2,553	6,520	16,398	51.3

Benchmarking of Costs

4.22 An examination of available data regarding the cost of building high speed lines worldwide shows that the most expensive high speed line ever constructed was High Speed 1 (HS1) in the UK which had an out-turn cost equivalent to £26m/route km for section 1 and £85m/route km for section 2. When considered on a per km basis the New Line cost estimates including full optimism bias are in line with the average outturn costs for HS1. It is considered unlikely that costs would be this high, as lessons have been learnt from the construction of HS1, and it is unlikely a New Line north from London would face the same geographical constraints as HS1. These geographical constraints meant that 25% of the line had to be in tunnel. However it is appropriate that the infrastructure cost estimate including optimism bias is at this level.

4.23 Excluding optimism bias the base cost estimate for all New Line options considered in this paper is in the range of £26-30m/route km, this is in line with the cost of other high speed rail projects which have averaged £20-30m per route km, although at the upper end of the range. It should be noted that a number of the estimates of outturn infrastructure costs for worldwide projects are believed it exclude non-construction programme costs which are included in the New Line costs. Figure 4.2 below shows the range of costs. The solid part of the red bar shows the cost of Option MB1.4.1 without optimism bias, the addition of optimism bias is reflected by the patterned part of the red bar.

FIGURE 4.2 BENCHMARK INFRASTRUCTURE COSTS



Infrastructure Operating, Maintenance and Renewals Costs

Operating and Maintenance

4.24 During Control Period 4 for the UK rail network, Network Rail will expend:

- £4,794m for 5 years of maintenance activities; and
- £4,397m for 5 years of operating and support activities.

4.25 For an infrastructure asset base of 30,800 single track km, this equates to approximately £60k per annum per single track kilometre. However the actual effort deployed on operating and maintaining each part of the network is proportional to the level of usage. Therefore the average operating and maintenance cost per single track km is higher on the East and West Coast Main Lines, compared with the national average, and significantly higher than on rural branch lines.

4.26 It is understood the annual operating and maintenance costs for HS1 equate to circa £20m. For a route of 109km this equates to approximately £90k per single track kilometre per annum. Due to the independent nature of HS1, overheads form a significant portion of the annual infrastructure O&M cost (circa 25%).

4.27 O&M costs for European high speed routes average €70k per single track kilometre. Due to differing regulatory and operating regimes on European rail networks, there is not always a direct correlation to be drawn with costs incurred on the UK rail network.

4.28 An annual O&M rate of £80k per single track kilometre or £160k per route kilometre is therefore assumed. This is 30% above the average rate of the current classic network and comparable with costs incurred on the East and West Coast Main Lines. It is also comparable with the costs being incurred on HS1 when account is taken of the smaller proportion of overhead which would be incurred on the proposed new lines route.

Renewals

4.29 All assets comprising the new infrastructure have a planned life after which they must be renewed. The cost of renewal is not always the cost of installing the asset in the first place. For example rail, sleepers and top ballast all have defined lifespans depending upon both levels of use and preventative maintenance. However, the base formation will not typically require renewal, providing the supporting infrastructure such as drainage continues to operate.

4.30 An asset life has been estimated for each asset. A percentage of the original construction cost which would be deemed to apply to a renewal has also been assumed. These are summarised in Table 4.3 below.

4.31 No residual value has been included for those assets with lives greater than 60 years as once the line is built these assets do not have any alternative uses other than as part of the line.

TABLE 4.3 ASSET LIFE ESTIMATES

Asset	Estimated Life (yrs)	Renewal %	Comment
Track formation	120	0	No renewal within appraisal period.
Track drainage	60	0	No renewal within appraisal period.
Rail, sleeper & ballast	30	100%	Full renewal included in appraisal period.
Switches and crossings	30	100%	Full renewal included in appraisal period.
Lineside fencing	30	100%	Full renewal included in appraisal period.
Maintenance depots	30	50%	Assume buildings refitted out during appraisal period.
Retained cuttings	120	0	No renewal within appraisal period.
Over & under bridges, tunnels and viaducts	120	0	No renewal within appraisal period.
Culverts	60	0	No renewal within appraisal period.
Signalling & telecoms	30	100%	Full renewal included in appraisal period.
OLE including switchgear	30	65%	Contact wire renewed but not necessarily masts, foundations, switchgear and buildings.
Stations	40	30%	Partial renewal included in appraisal period. Building fit out renewed – not structural works.

4.32 All rail infrastructure requires regular maintenance inspections to provide assurance that it is safe for operational use. Replacement of components only forms a relatively small part of the maintenance activity with the majority of costs being incurred by staff and plant required to undertake inspections. Undertaking pre-planned maintenance is particularly important in the early years of new infrastructure in order to:

- Identify and correct inherent quality defects on individual components as the system beds in;
- Provide operational data on the reliability of the rail system as a whole in order that a risk based maintenance approach can be developed from operational experience to complement the requirements specified by component manufacturers;
- Allow staff to become familiar with the infrastructure prior to works to change life expired components and consumables commencing; and
- Keeping the infrastructure reliability and availability as high as possible to build operator and public confidence in the system as encourage demand growth.

4.33 Therefore it is assumed full maintenance resources will be required from the commencement of operational services and no ‘maintenance holiday’ for the early years of operation has been accounted for in the appraisal.

Classic Line Maintenance Costs

4.34 No change in the cost of maintaining the WCML is assumed to apply in the New Lines Strategic Business Case. The operation of slower and lighter trains on the West Coast Main Line might lead to a reduction in the cost of maintaining it. However the frequency of track maintenance is determined by the track category assigned to each track, based on the gross tonnes per annum operated over it. It is not expected that the rating of the WCML would be changed following the introduction of a new line given the high frequency of services that would still operate upon it, the continued use of the line by freight and the potential increase in the number of freight services.

Operating Costs

Summary of Methodology

4.35 In order to calculate the cost of operating services on a New Line both the cost of providing the infrastructure and the cost of operating services over it must be taken into account. Therefore an operating cost model has been developed to estimate the cost of operating New Line services. The following costs are included in the operating cost estimate:

- Staff wage costs including drivers, guards, cleaners, general station staff and ticket sales staff;
- Pension and National Insurance costs;
- Station maintenance and running costs;
- Headquarters staffing and overhead costs;
- Rolling stock lease or purchase costs;
- Rolling stock maintenance costs; and

- Traction power costs.

4.36 Although in some respects the cost of operating services on the New Line will be more efficient than the cost of operating the current West Coast Main Line services, for example reduced journey times will reduce rolling stock requirements and enable more efficient turnround times to be achieved. In other respects a New Line service will cost more to operate. High speed services utilise more traction energy and as such the cost of electricity will be significantly higher than for classic line services.

4.37 The cost of operating a New Line option has been estimated using a bottom up approach. Unit rates for each cost item, such as driver costs, station maintenance costs and platform staffing costs have been estimated and then have been multiplied by the appropriate cost driver. Train miles and train hours were calculated following the assumptions laid out in section 3 above. An estimate of the units required has been made based on the assumed journey times and turnround times. As an example the calculation of the relationship between train hours and driver costs is set out below:

TABLE 4.4 CALCULATION OF DRIVER COST PER TRAIN HOUR – INPUT DATA

Item	Assumption
Cost per Driver	£45k
Uplift for General Relief Requirements (e.g. sickness, leave, training)	23%
Effective National Insurance rate	11.5%
Pension Contribution	10%
Productive Driving Hours per Week per Driver	20
Weeks per Year	52

1) Cost per Driver = £45k

2) Uplift for pension and National Insurance and (add 4.5k and 5.175k) = £54.68k

3) Productive driver hours per annum = 20 * 52 = 1040

Adjust annual hours by 23% to allow for general relief = 801

4) Divide cost per Driver by Driver hours per annum = £54.68 /800

= £68 = Driver cost per train hour

4.38 This rate has been checked against expected rates based on existing Intercity experience. In addition one trainee driver has been assumed for every ten drivers at a rate of £30k per annum.

4.39 Following Webtag guidance an allowance for optimism bias of 41% has been added to the projected operating costs.

Key Assumptions

4.40 The key assumptions underpinning the cost estimates of running a new line service are outlined below (these rates exclude optimism bias):

TABLE 4.5 KEY OPERATING COST ASSUMPTIONS

Item	Value (£ 2008 prices)	Cost Driver	Source
Purchase cost per 10-car New Line train sets	£24m	Number of train sets	Network Rail
Cost of electricity per train mile for New Line services	£5.6	Train miles	Network Rail analysis of HS1 traction costs
Headquarters cost	£3.4m per annum	New companies	Bottom up estimate
Driver cost per train hour	£68	Train hours	Bottom up estimate using input data provided by ATOC and general assumptions
Total operational staff cost per train hour (drivers, trainee drivers and guards)	£114	Train hours	Bottom up estimate using input data provided by ATOC
Station staffing cost per station (for a station with 4 platforms)	£3.6m per annum	Number of platforms	Bottom up estimate using input data provided by ATOC
Station maintenance and other station operational costs	£474k per annum	Number of platforms	Based on Qualifying Expenditure and Long Term Charge data for a typical Intercity station

4.41 These unit rates were multiplied by the appropriate driver. The train service features that drive operating costs are:

- Total train hours;
- Total train miles;
- Number of train sets;
- Number of stations; and
- Number of platforms.

4.42 Table 4.6 below shows the key train service characteristics that drive the costs of each option.

TABLE 4.6 TRAIN SERVICE ASSUMPTIONS

Option	Total New Line Train Hours (thousands)	Total New Line Train Miles (thousands)	Number of sets required
MB1.0a	104	10,779	24x10-car
MB1.0b	126	12,571	24x10-car, 5x5-car
MB2.0a	113	10,962	26x10-car
MB2.0b	136	12,648	26x10-car, 5x5-car
MB2.0c	72	6,943	25x15-car
MB1.1	167	16,925	31x10-car, 5x5-car
MB1.2.1	319	36,975	46x10-car, 20x5-car
MB1.3	268	24,123	39x10-car, 18x5-car
MB1.4.1	360	41,329	53x10-car, 20x5-car
MB1.6	315	28,477	48x10-car, 18x5-car

Classic Line Operating Cost Changes

4.43 As outlined in section 3 above, services on the classic lines have also been modified in response the new line service pattern. In some cases this has involved a net reduction in services offered on the classic line (e.g. 1 tph to Birmingham and Manchester has been removed in options MB1.0a, MB1.0b, MB2.0a, MB2.0b and MB2.0c) and in some cases this has involved an increase in train miles (e.g. the recast of services under option MB1.1). However even where the service has not been reduced cost savings will still be realised. Following the classic line recast enabled by the New Line, services can be operated using shorter trains, at a lower cost. A similar approach to that used to calculate New Line cost has been used to estimate changes in the cost of classic line services, the resultant change in train miles, train hours and train set requirements have been calculated and multiplied by the appropriate cost. The key classic line changes which impact on operating cost are as follows:

TABLE 4.7 CLASSIC LINE SERVICE CHANGES THAT IMPACT UPON OPERATING COSTS

Option	Key Classic Line Service Changes
MB1.0a MB2.0a	Removal of one train an hour between London and Birmingham Removal of one train an hour between London and Manchester
MB1.0b MB2.0b MB2.0c	Removal of one train an hour between London and Birmingham Removal of one train an hour between London and Manchester Removal of one train an hour between Manchester and Birmingham
MB1.1	West Coast Main Line recast, with remaining service operated by 5-car units in the off peak (10-car in the peak). WCML services to and from Scotland remain on the Classic Line
MB1.2.1	West Coast Main Line recast, with remaining service operated by 5-car units in the off peak. Services to Liverpool remain on classic line
MB1.3	West Coast Main Line recast, with remaining service operated by 5-car units in the off peak. Services to and from Liverpool remain on classic line
MB1.4.1	Full West Coast Main Line recast
MB1.6	Full West Coast Main Line recast

Results

4.44 Applying the methodology and values outlined above the following estimates of the operating cost of the new line are calculated. The value shown below includes optimism bias, which is applied at a rate of 41%.

TABLE 4.8 OPERATING COST ESTIMATES BY OPTION

Option	60 Year NPV of Operating Cost of New Line (£bn)	60 Year NPV of Change of Operating Cost of Classic Line Services (£bn)	Total (£bn)
MB1.0a	3.3	-0.9	2.4
MB1.0b	3.8	-1.2	2.5
MB2.0a	3.5	-0.9	2.6
MB2.0b	3.9	-1.2	2.7
MB2.0c	3.4	-1.2	2.1
MB1.1	5.0	1.1	6.1
MB1.2.1	9.3	-0.6	8.6
MB1.3	6.7	-0.7	6.0
MB1.4.1	10.4	-0.7	9.7
MB1.6	8.0	-1.4	6.6

Other Income

4.45 The costs and revenues of providing an onboard service have not been included. At this stage of development it would be inappropriate to determine the exact nature of the onboard product offer. It is reasonable to assume that the service offer will be developed along commercial lines ensuring that the costs of providing the offer are covered by the revenues accruing from it (a combination of on board revenue and revenue from additional ticket sales).

4.46 There are also significant potential income streams that could arise from the New Line stations. Main line stations generally feature retail unit which yield rental income to the station owner. Station car parks can also provide significant income streams. As the exact value of such revenues is commercially confidential it has not been possible to resource reliable information on the potential value of this item and as such this has been excluded, although it is believed that up to £2m per station per annum could be accrued. The inclusion of any such income would improve the case for a new line. However the full cost of renting office for the headquarters functions has been included in the appraisal. It is assumed that this space is provided at one of the station locations. If the stations are to be fully exploited for their rental value the cost of housing these functions elsewhere will need to be included.

5 Demand, Revenue and Benefit Forecasting

Overview of Approach

5.1 The demand forecasting framework has been designed to consider the impacts on a range of markets that could be affected by New Lines:

- Long distance Intercity markets served by any New Line;
- The impact on commuter and regional markets as the classic network is commensurately recast and improved as the New Line removes the Intercity services;
- The improvement in the attractiveness of using rail to access Heathrow, especially if direct services are provided; and
- The improvement in the attractiveness of using rail to access the near continent (notably Paris and Brussels), through interchange onto HS1.

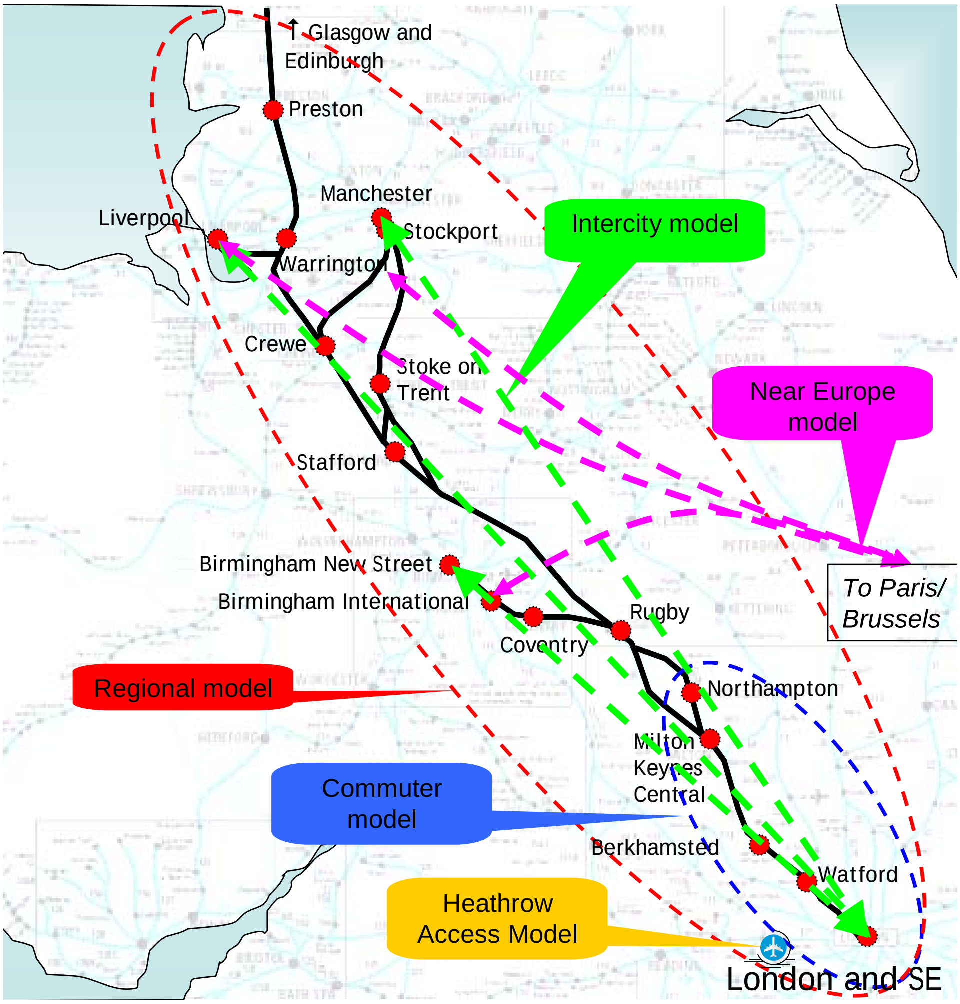
5.2 The framework comprises a suite of five, spreadsheet based, models (or decision support tools), designed to capture the impact of New Lines on each of the aforementioned markets:

- An **Intercity model**, designed to forecast the demand impacts of New Lines on the demand for inter city travel, considering how demand may switch from other modes (classic rail, air and car) and how the New Line may 'generate' new demand on the New Line corridor (either through changes in destination or through changes in trip frequency). This model has been based on the PLANET Strategic model (PSM) developed for the SRA's High Speed Line Study in 2002, with rebased demand and model parameters.
- A **Commuter model**, focusing on the London commuter market and how a recast network would benefit travellers through improvements in journey time, frequency and crowding.
- A **Regional model**, which focuses on the remaining parts of the network not captured in the Intercity and Commuter models and considers how changes in journeys times and frequencies afforded by a classic rail network recast would improve the rail offer for regional flows (including to and from London for flows other than the major cities).
- A **Heathrow Access model**, which considers how indirect or direct New Lines services improving accessibility to Heathrow may affect the choices between surface access modes and between air interlining and surface access.
- A **Near Europe model**, a simple mode choice model considering how the improved connections to London from the regional cities would affect demand to Paris and Brussels via HS1 through modal shift from air.

5.3 The decision support tools are exactly that; at this stage, the key requirement is that the tools enable relative differences between options to be estimated and assessed with confidence. The tools are not designed, at this stage, to provide precise absolute forecasts. The programme team has applied best practice techniques to all of the modelling analysis and has used experience and judgement to ensure that the forecast estimates produced are as robust as possible. However, the model outputs are designed to support the Strategic Business Case and inform the development of train service specifications – the tools are not designed, nor would be appropriate at this stage, to provide inputs to a detailed timetabling exercise.

5.4 The scope of the models as applied to an illustrative New Lines option centred on the West Midlands and North West corridor is illustrated in Figure 5.1.

FIGURE 5.1 MODELLING SUITE



5.5 No primary research has been undertaken for demand data, rather full use has been made of datasets of existing and forecast demand. Of note, use has been made of the demand data originally collected for the SRA study into high speed lines undertaken in 2002, CAA air demand data and RIFF/LENNON rail ticket sales data. These have been used to derive estimates of Base 2007 demand by mode.

5.6 Forecasts of (Do-Minimum) demand in 2030 before any New Lines are introduced are based on DfT forecasts of changes in rail, air and road demand and are therefore consistent with national policy. These forecasts reflect expected changes in transport infrastructure, pricing policies by the respective market players and changes in the socio-economic drivers of demand (such as the spatial distribution and level of population and employment, car ownership and GDP growth).

5.7 The modelling framework has been developed to a level commensurate with the overall study, namely that of establishing if a case for New Lines exists. Further development of the modelling suite, including enhanced data, would be required should the case be considered in more detail. Such modelling refinements are set out later in this section.

Current Rail Demand

5.8 The starting point for the forecasting process is a picture of demand in 2007, the modelling base year. Focusing on the key markets within the chosen London to north-west and Scotland corridor, Table 5.1 sets out the overall demand on the respective rail markets (noting that these relate to total flows between London/South-east to the Birmingham area, Manchester area etc, not just the point to point flows).

TABLE 5.1 2007 RAIL DEMAND BY KEY MARKET TO LONDON

City	Journeys (million)
Birmingham	4.4
Manchester	3.5
Liverpool	1.3
Glasgow	0.6
Edinburgh	1.1
Total	10.9

5.9 Birmingham has the largest volume, with Manchester a close second. Liverpool is relatively low, with the Scottish markets of Edinburgh and Glasgow totalling 1.7 million trips per year.

Looking to the Future

5.10 In July 2007 the DfT published their rail White Paper 'Delivering a Sustainable Railway', which set out a strategic direction for the railway. The White Paper looked at the potential future challenges for the railway over a 30-year horizon and identified three long-term agendas for Government and the rail industry working in partnership: increasing the capacity of the railway, delivering a quality service for passengers, and fulfilling rail's environmental potential.

5.11 As part of the analysis leading up to the publication of the White Paper, DfT undertook a wide ranging demand forecasting process to understand how socio-economic and economic drivers, along with committed and proposed developments to the rail network would impact on rail demand. It is these forecasts that have been used to derive rail demand data for 2030 as part of this study.

5.12 The impact on rail demand in the potential New Lines corridor is a broad doubling of demand to all the key markets (as shown in Table 5.1) from London. This is a slackening of the demand growth rates seen in recent years and does not reflect the current economic downtown, but provides the most current forecast in the context of this study[1].

5.13 Given the sometimes high level of demand and crowding on services between London and Birmingham/Manchester currently experienced, these forecasts may seems at first sight unrealistic. However, the forecasts include and reflect the enhanced capacity provided by the new WCML timetable introduced in December 2008 which increased Birmingham and Manchester services to 3tph from 2 thp. Furthermore, these services will benefit from the addition of two Standard class carriages to the Pendolino fleet of trains operating on the WCML.

The Impact of New Lines

Modal preference

5.14 The Intercity model has been used to forecast the impact of New Lines on Intercity rail demand and the potential for transfer from other modes and for the generation of rail demand. As part of this modelling process, a stated preference survey was undertaken to determine the value travellers place on differing elements of journeys, and to test whether people have an innate preference for high speed rail over other modes, including classic rail.

5.15 The survey interviewed 453 rail users, 353 car users and 251 air travellers, asking them to trade off mode, journey time and frequency under a number of different choice scenarios. The responses from these travellers were then analysed, using a number of differing functional forms and theories of behaviour.

5.16 The key consideration was how travellers value time spent on high speed rail compared to that on classic rail (in the same way that most travellers prefer riding in a vehicle than walking or waiting). The PSM model parameters feature a higher value of time for high speed rail compared to classic rail and a high speed rail mode specific constant which leads to a preference for New Rail. At certain distances (e.g. Manchester to London) these impacts approximately equal each other out. However at shorter distances, such as between London and Birmingham the mode specific constant (which does not vary with distance travelled) will outweigh the impact of the higher value of time on New Rail services, leading to a higher forecast than would be the case otherwise. It is perhaps surprising that time spent on high speed rail is valued at a higher rate than time spent on classic rail. New high speed rail services are likely to have a better quality interior and ambience that classic rail, which could lead to passengers valuing time spent on New Rail services at a lower rate.

[1] DfT are currently updating the NMF model to reflect current economic and planning forecasts and the latest view on network and timetable developments to 2020.

5.17 The key findings from the SP were that:

- A mode specific constant for high speed rail was found to be statistically significant, but the value achieved was lower than that found in the PSM model. A value of 19 to 20 minutes per leisure passenger and 38 or 39 minutes per business passenger was estimated and assumed a constant value of time across all modes; and
- Conversely, a model was developed that had modal based values of time which therefore better reflects preferences varying with journey length. This found evidence that the value of time on high speed rail should be lower than that on classic rail. Given that the PSM model has calibrated values of times for all modes with the exception of New Lines, the SP was used to only inform the relative value of New Line values of time compared to classic rail value of time. For business users this was 75% lower and for leisure users 8% lower.

5.18 The values of time derived from the SP survey undertaken were compared with those in the PSM model and in particular the values attributable to high speed rail reviewed. Given the use of differing values of time for different journey elements, both in PSM and in modelling practice more widely, and the ‘lumpy’ nature of mode constants, it was decided to dispense with the use of any mode constant and simply employ a lower value of time relative to classic rail for New Lines. As noted above, the value employed was informed by the SP; for business users this was 75% lower and for leisure users 8% lower.

Fares Assumptions

5.19 A premium fare of 30% is assumed for any New Lines route. This is the same premium that applies to HS1 commuter services in Kent.

Stage 1

5.20 Table 5.2 sets out the aggregate demand forecasts for the New Line options considered under Stage 1. Overall demand on New Lines is forecast at around 20-22 million trips per annum. The demand is dominated by the London to Birmingham and London to Manchester demand, with the (non-London flow) Birmingham to Manchester demand around 6% of the total. Birmingham demand is relatively constant at around 9 – 9.5 million, this constancy reflecting the minimal change to run times across the options. Conversely, Manchester demand does vary reflecting changes in run times between option MB1.0, which has direct services to Manchester (with a run time of 66 minutes), and Option MB2.0, which runs via Birmingham with an attendant increase in run time to 77 minutes (a and b), or 80 minutes (c).

5.21 The impact on the classic network is proportional to the New Lines demand, with typically a reduction of around 14 - 15 million trips across all the options. The net change on the overall rail network is some 6-7 million additional passengers.

5.22 The impact on car journeys is a reduction of some 1.5 – 1.6 million journeys when only London-Birmingham and London-Manchester is served by New Lines. Adding a Birmingham-Manchester New Line service further reduces car journeys by some 0.5 million, a significant proportion of the 1.2-1.4 million trips this New Lines service attracts. Air journeys reduce by around 0.2 million across all options.

TABLE 5.2 STAGE 1 NEW LINE DEMAND (MILLION JOURNEYS P.A. IN 2030)

Route	MB1.0a	MB1.0b	MB2.0a	MB2.0b	MB2.0c
Birmingham	9.2	9.2	9.4	9.4	9.6
Manchester	11.9	11.9	10.5	10.5	10.6
Non-London flows	0.0	1.2	0.0	1.3	1.4
Total	21.0	22.2	19.9	21.1	21.6
Abstraction from classic rail	*-14.6*	*-15.0*	*-14.0*	*-14.4*	*-14.5*
Overall rail network demand	*6.4*	*7.2*	*5.9*	*6.7*	*7.1*
Change in car journeys	*-1.6*	*-2.0*	*-1.5*	*-2.0*	*-2.1*
Change in air journeys	*-0.2*	*-0.2*	*-0.2*	*-0.2*	*-0.2*

5.23 Apart from Option MB2.0c, all options have services between London and Birmingham and London and Manchester operating at 4tph. Resultant load factors for option MB1.0 on these services are at an average of 39% across the day for Birmingham services and 48% for Manchester services.

5.24 Figures 5.2 and 5.3 show how the demand changes from the current (2007) levels for the Birmingham and Manchester markets respectively. The changes have been disaggregated to show the contribution made by:

- Demand growth to 2030;
- Catchment area – where New Lines will widen the catchment relative to classic rail;
- Modal shift – from air (where applicable) and from car; and
- ‘Generated’ demand – to reflect changes in trip patterns and wholly new trips.

FIGURE 5.2 SOURCE OF LONDON - BIRMINGHAM DEMAND

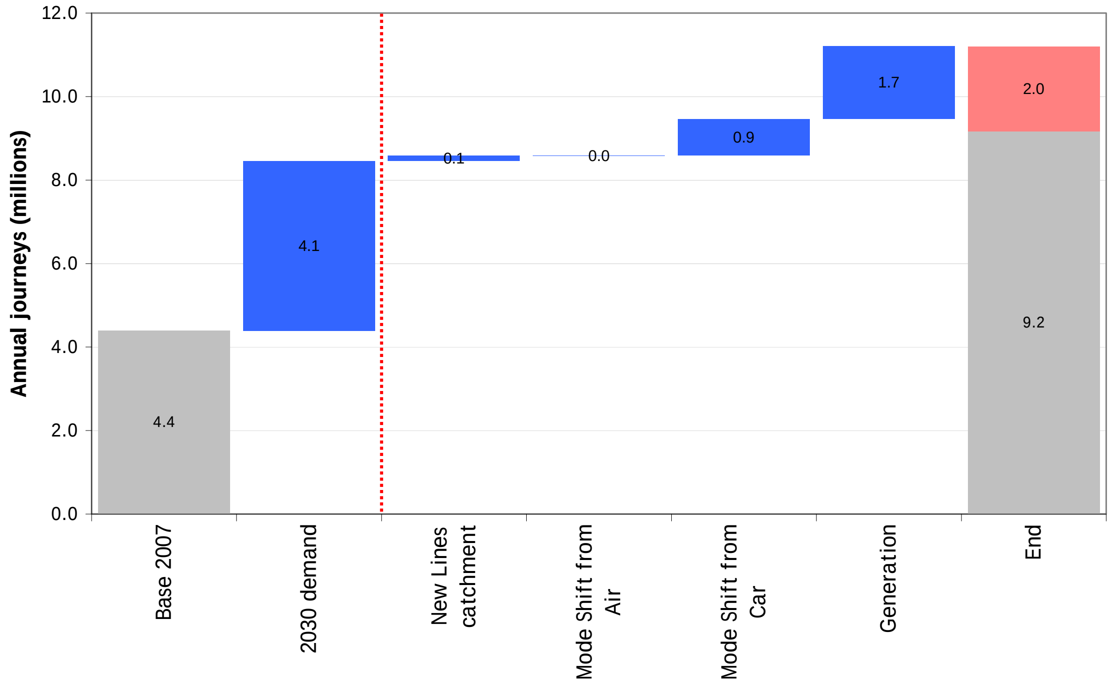
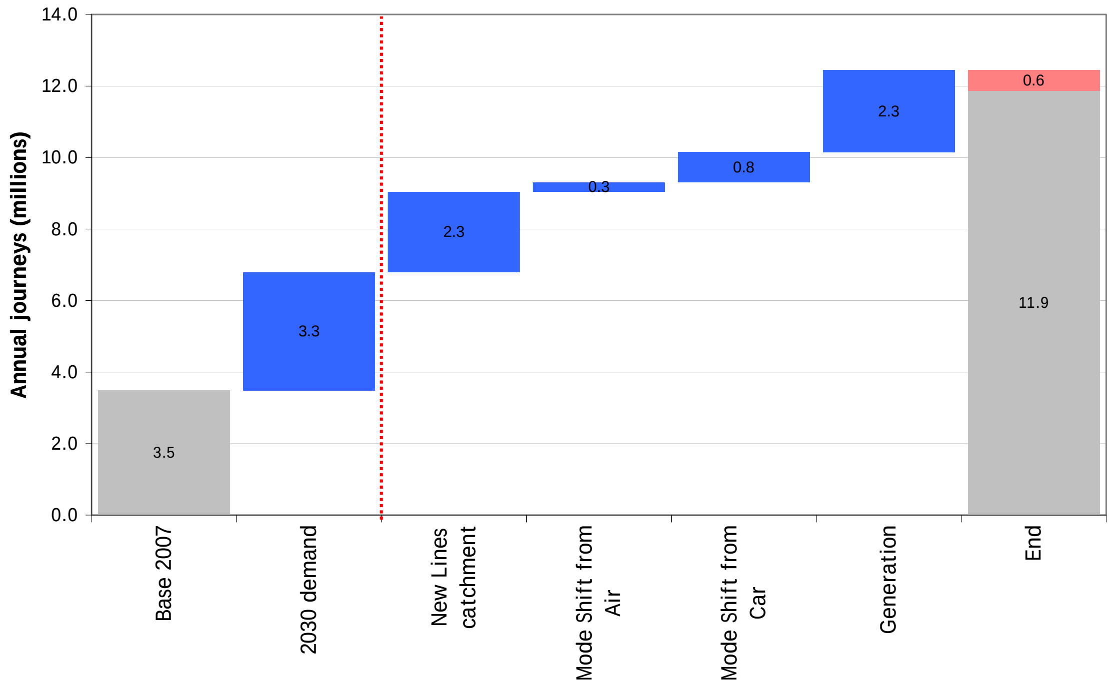


FIGURE 5.3 SOURCE OF LONDON - MANCHESTER DEMAND



5.25 For London - Birmingham, current demand is around 4.4 million trips and this will increase to some 8.5 million by 2030. New Lines do not materially change the catchment, but encourages some 0.9 million trips to transfer to rail from car. The biggest additional demand comes from new rail demand generated on this route, adding another 1.7 million. Overall, there are 9.2 million on New Lines, with 2.0

million remaining on the classic network, as shown by the pink block on the upper right hand side of the chart.

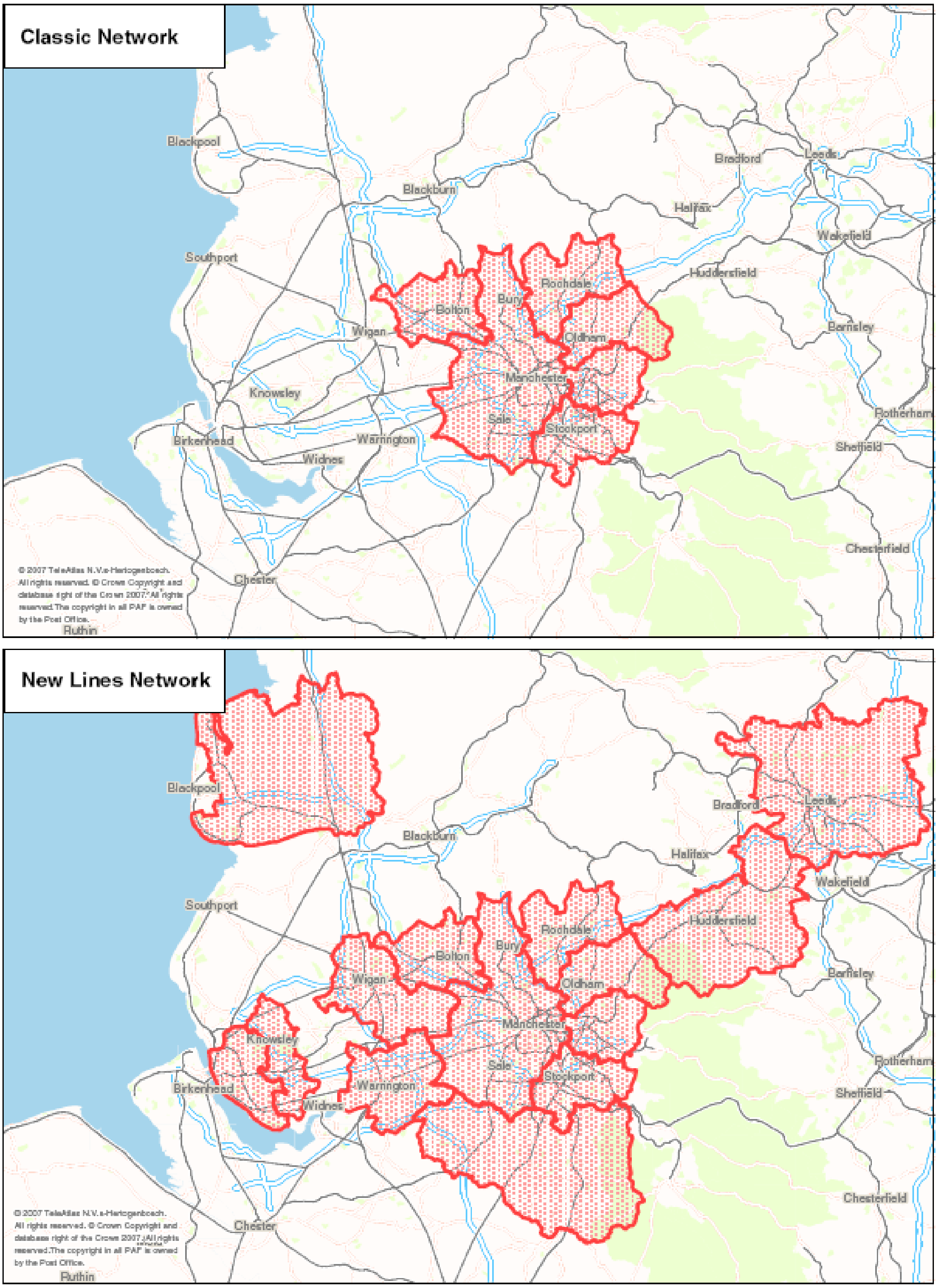
5.26 A similar pattern exists for the London – Manchester corridor, but with more demand coming from a wider catchment at this location (such as Liverpool, Warrington and Leeds). Transfer from air is 0.3 million, with that from car 0.8 million, giving 1.1 million overall. Generation is some 2.3 million. Demand remaining on the classic network is much lower reflecting the greater advantage New Lines brings to this route.

5.27 In both cases, the travel market is relatively mature with a credible rail offer; consequently, the scope for large modal transfer is limited. On that basis, much of the additional demand will be new to the corridor and hence 'generated' demand accounts for around 18% of demand.

5.28 The average time saving per New Lines user is around 40 minutes. The actual time saving for Birmingham is 38 minutes and Manchester is around 62 minutes. However, this will be reduced by flows which will have a longer access time to New Lines than the local classic rail station (for example demand from Stockport). Also, where the choice between New Lines and classic rail is more marginal, New Lines users will not benefit from the full reduction in journey time.

5.29 This is best illustrated through comparison of the Manchester catchments and the example of Liverpool (see Figure 5.4). The classic rail catchment is essentially the greater Manchester area. For New Lines, the reduction in travel time to London means that travellers from a wider area will benefit from using the line; essentially, the additional access time to New Lines is outweighed by the time saving on the New Line. On that basis, much of the Manchester, Liverpool and Preston triangle falls in scope to use New Lines. (Note that the catchment area is defined by access times to the New Lines station and hence for some zones in this area where access is poor, they have not been selected. However, demand from these zones is low and hence their omission will not materially affect the case for New Lines. Any inaccuracy will be an upside to the case).

FIGURE 5.4 MANCHESTER CATCHMENTS



5.30 The key facet to note is that not all the demand will use New Lines from these additional areas, rather they have a choice to do so and only a proportion of the demand will chose to do so. For example, around 18% of Liverpool – London demand uses New Lines via Manchester. Whilst Liverpool continues to have a direct service to London, it is only operates hourly taking around 130 minutes. With New Lines serving Manchester, the journey time is 114 minutes via Manchester. However there is an interchange required and as both legs have 4tph the overall perceived time is somewhat longer than the classic rail direct service.

Stage 2

5.31 The Stage 2 tests consider the value of increments on the core London to Birmingham/Manchester scheme. Whilst Birmingham and Manchester are discrete mutually exclusive markets, some of the route variants tested in Stage 2 do have overlapping markets with Manchester and this is reflected in the catchment areas of the increments. The Stage 2 tests also employ enhanced recasts of the classic rail network, which will affect the choice between New Lines and classic rail.

5.32 Where New Line services run onto the classic network, notably when running to Scotland in options MB1.3 and MB1.6, the modal preference for that portion of the journey is removed. Fare premia for the journey are also reduced from the 30% assumed for New Line to 15% for London/Birmingham to Scotland journeys and to 0% for Manchester/Preston to Scotland journeys

5.33 The demand impacts are set out in Table 5.3. Overall New Lines demand is commensurate with the extent of the network, with option MB1.4.1 having the highest demand, at 43.7 million, the highest reduction on the classic network (23.1 million) and the highest net increase on rail demand (20.6 million).

TABLE 5.3 2030 NEW LINE DEMAND FOR STAGE 2 TESTS (MILLION JOURNEYS P.A.)

City	MB1.0b	MB1.1	MB1.2.1	MB1.3	MB1.4.1	MB1.6
Birmingham	9.2	8.1	8.1	8.1	8.1	8.1
Manchester	11.9	10.9	11.3	11.3	10.5	10.5
Warrington	-	2.3	-	-	2.4	2.3
Liverpool	-	3.6	-	-	3.6	3.4
Preston	-	-	3.0	3.1	2.9	3.0
Glasgow	-	-	4.2	2.7	4.2	2.7
Edinburgh	-	-	6.5	1.4	6.5	1.4
Non-London flows	1.2	1.3	5.6	4.2	5.6	4.2
Total	22.2	26.3	38.7	30.8	43.7	35.6
Abstraction from classic rail	*-15.0*	*-16.9*	*-20.1*	*-18.7*	*-23.1*	*-21.9*
Overall rail network demand	*7.2*	*9.4*	*18.6*	*12.1*	*20.6*	*13.8*
Change in car journeys	*-2.0*	*-2.3*	*-3.5*	*-3.0*	*-3.8*	*-3.3*
Change in air journeys	*-0.2*	*-0.3*	*-2.7*	*-1.4*	*-2.8*	*-1.5*

Note: may not sum due to rounding

5.34 In the stage 2 options both Birmingham and Manchester dip slightly in terms of New Lines demand as the classic network is improved relative to that in option MB1.0b. The Warrington/Liverpool New Line adds around 6 million passengers a year, with Preston a further 3 million. New Lines to Glasgow and Edinburgh are major demand generators, adding some 10-11 million trips to the New Lines network (Option MB1.2). However, using the classic network north of Preston severely reduces the advantage of New Lines and reduces the demand by 62% to just 4.1 million.

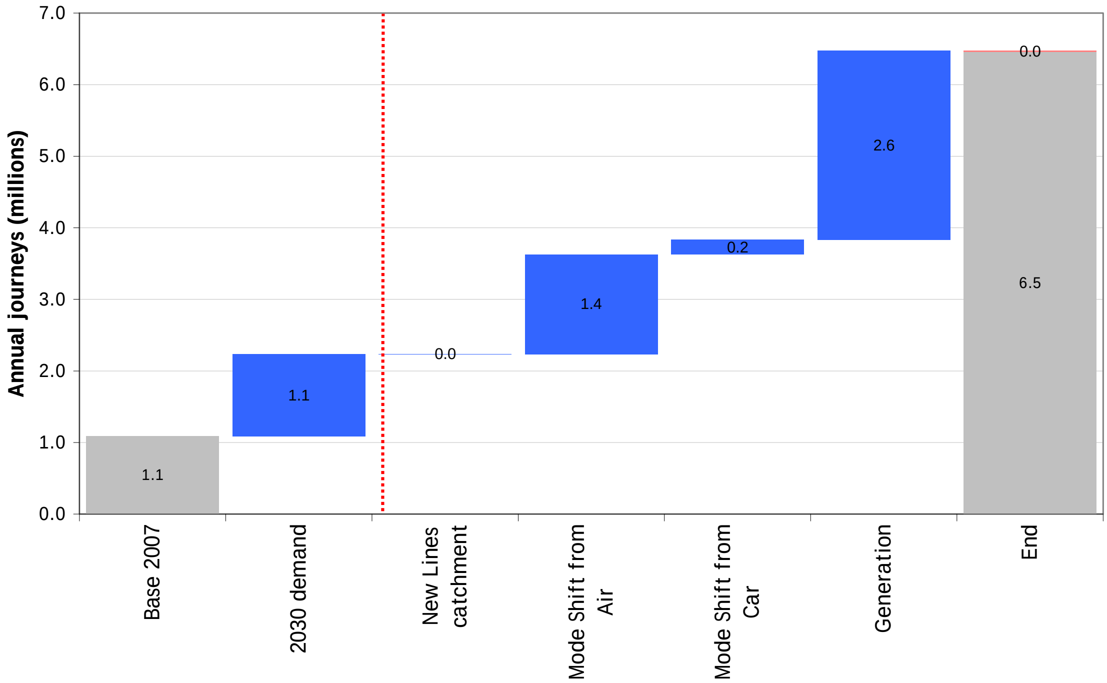
5.35 Comparison of Liverpool and Warrington demand shows that running onto the classic network does not materially affect demand, with demand for this line in Option MB1.6 being 6% lower than the New Line option in MB1.1. This final section of New Line only saves an additional 5 minutes to Warrington and 12 minutes to Liverpool, the latter being 25% of the overall time saving.

5.36 The impact on car and air demand is also shown in Table 5.3. New Lines to Birmingham and Manchester (option MB1.0b) reduce car demand by 2.0 million, with a small reduction in air demand. Adding Liverpool and Warrington reduce car demand by a further 0.3 million. Adding New Lines to Scotland removes further car demand and significantly increases the reduction in air demand to around 2.7 million. This is an 18% capture of air demand, the total South East[2] to the North West and Scotland air market being around 15.1 million in 2030. Using the classic network north of Preston to reach Scotland (Option MB1.3 and MB1.6, reduction with Glasgow only seeing an hour off existing rail times and Edinburgh having only a marginal reduction in run time) severely reduces the air demand.

5.37 Edinburgh has higher demand than Glasgow, at 6.5 million, when New Lines is implemented the entire way; the breakdown of this demand is set out in Figure 5.5. By 2030, demand on this route is expected to be around 2.2 million, a doubling of the current demand of 1.1 million. Additional demand from a wider catchment is negligible, with modal transfer adding 1.6 million, the vast majority of which is from air. Generation is the biggest single source of additional demand, adding 2.6 million trips, forming some 41% of New Line demand. Whilst significant, the Scottish markets benefit from a halving of rail journey times to London to a journey time equivalent to that from Manchester or Leeds today. Their demand is forecast to reach 6.8 million and 5.6 million respectively by 2030, so the demand forecasts for Edinburgh are commensurate.

[2] Defined as the Government Office Regions of London, South East and East of England

FIGURE 5.5 SOURCE OF LONDON - EDINBURGH DEMAND



Impact on Air Demand

5.38 Table 5.4 summarises the impact on air demand across the modelled markets. The core option serving Birmingham and Manchester only has a negligible impact on reducing air demand, with the majority of this coming from reducing air demand to Near Europe (Paris and Brussels), the forecast with the most uncertainty. Building New Lines to serve Scotland is the only option that significantly reduces air demand, mostly from domestic trips. Routing the New Line via Heathrow does further reduce air demand (as outlined in section 7) but not materially.

TABLE 5.4 IMPACT OF NEW LINES ON (IN-SCOPE) AIR DEMAND (2030 MILLION TRIPS)

	2030 demand	**MB1.0b**	**MB1.4.1**	**MB1.7.1**	**MB3.4.1**
Domestic	15.1	-0.2	-2.8	-2.8	-2.8
Heathrow Interlining	4.0	-0.1	-0.3	-0.6	-0.9
Near Europe (Paris / Brussels)	2.9	-0.5 (mid-range impact of Scenario 1)			
Total	22.0	-0.8	-3.6	-3.9	-4.2

5.39 The forecasting process has assumed no changes to the air market supply (frequency and fares). Airlines would likely react to New Lines competitively, through pricing policy, although it is likely some reduction in service levels would take place on some routes[3].

Results Benchmarking

5.40 A review of the results has been undertaken to understand how the forecasts for New Lines compare with:

- the Passenger Demand Forecasting Handbook (PDFH) forecasting framework;
- experience of High Speed Rail elsewhere where significant air markets existed; and
- benchmarking against UK demand flows.

PDFH

5.41 The PDFH is designed to provide guidance for forecasting the impact of incremental changes to rail services on demand. Whilst it is not typically used to forecast the impact of changes of this magnitude, the recommended values can provide a benchmark for comparison.

5.42 PDFH methodologies have been employed to derive an overall growth factor for a combination of the following New Lines benefits:

- Journey time and frequency (GJT);
- Fares (to reflect the New Lines 30% premia);
- Quality (where the New Lines system will likely provide some improvement); and
- Reliability (where a closed New Lines system is expected to have a significant benefit).

5.43 Table 5.5 shows the growth factors from the Intercity model and the corresponding PDFH values, split by purpose and overall. Analysis has been carried out for Birmingham, Manchester and Edinburgh, these representing the range of destinations served by New Lines (short, medium and long distance) and with a mix of demand characteristics (notably modal competition).

[3] Modelled frequencies have assumed to increase in line with demand to 2030, so for the key routes service frequencies would still remain comparable or better to today even if airlines reduced flights in the light of New Lines.

TABLE 5.5 INTERCITY MODEL VS PDFH GROWTH FACTORS

		Business	Commuting	Other	Overall
Birmingham	Intercity model	1.60	1.20	1.25	1.29
	PDFH	1.49	1.37	1.29	1.36
Manchester (only)	Intercity model	2.07	n/a	1.60	1.84
	PDFH	1.60	n/a	1.39	1.50
Manchester (network)	Intercity model	1.80	n/a	1.41	1.61
	PDFH	1.60	n/a	1.39	1.50
Edinburgh	Intercity model	3.51	n/a	2.43	2.90
	PDFH	1.64	n/a	1.43	1.52

5.44 Birmingham and to a large degree Manchester are typical of the markets PDFH was designed to consider, where journey time and fare change, with minimal air competition. The results for Birmingham are comparable to PDFH, with slight differentials by purpose; overall, the Intercity model is lower than PDFH. For Manchester, the Intercity model produces higher demand growth than PDFH would suggest; however, this is when Manchester is the sole New Lines station in the north west. In this instance, New Lines does abstract rail demand from other corridors, from Leeds in the east to Liverpool in the west, giving rise to a high growth factor. When a network of New Lines is modelled (as in option MB1.4.1), demand from places such as Warrington, Liverpool and Wigan use other stations besides Manchester, although Leeds demand is still abstracted. This is more closely related to the PDFH forecasting parameters and does result in a closer match between the Intercity model and PDFH growth factors, with the Intercity model slightly higher.

5.45 The Intercity model forecasts for Edinburgh are considerably in excess of those from PDFH, in large part because of the large air market between the South East and Scotland. The impact of New Lines on the Scottish market has been considered below.

5.46 Overall, the Intercity model provides forecasts consistent with PDFH.

Experience of High Speed Rail

5.47 A review has been undertaken of the available literature on international experience of the introduction of high speed rail. This indicates that the introduction of high speed rail can lead to significant increases in rail demand. For example when air passengers transferring to other flights are excluded Eurostar services are estimated to carry 80% of the London to Paris market.

5.48 Journey time elasticities implied by observed changes in behaviour have been utilised to benchmark the New Line forecasts. The best available data existing relates to the initial stage of the Paris to Lyon line; this reduced train journey times by around 30% and had an implied JT elasticity of around -1.6. The second southern section stage reduced JTs by 25% but only saw a JT elasticity of -1.1 (Nash, 2008). This is lower since significant transfer from air had been largely completed in stage one.

5.49 These values have been compared to the journey time elasticities implied by the New Line forecasts of circa -0.4 for Birmingham to London, -0.8 between Manchester and London and -1.5[4] for Edinburgh to London where there is the most to be gained from air competition. Of note, the Edinburgh elasticity is very comparable to the Paris-Lyon experience and again provides comfort that the New Lines forecasts are credible and robust.

UK demand flows

5.50 Forecast New Line demand for particular flows have also been compared to that achieved by existing and forecast UK flows. In particular, in option MB1.4.1 the market between Edinburgh and London is forecast to grow to 6.5m passengers per annum. The New Line journey time between Scotland and London is broadly equivalent to that from Manchester and Leeds to London today; service frequencies are comparable at 2tph or 3tph. Their Do-Minimum demand is forecast to reach 6.8 million and 5.6 million respectively by 2030, so the demand forecasts for Edinburgh are commensurate given the rail journey times.

5.51 This is set against the relative sizes of the population. Manchester is forecast[5] by 2030 to have a population some 75% greater than SE Scotland (the area served by a New Lines service to Edinburgh), with West Yorkshire (the Leeds area conurbation) some 55% greater. However, these areas are much more accessible, with road and rail offering reasonable accessibility. Conversely, only air arguably offers the same for Scotland (where rail is well over 4 hours and car has journey times of 7 hours or more).

5.52 Were accessibility levels comparable, then it can be argued that the demand for travel would be comparable, after accounting for the relative attractiveness of the markets. This is illustrated in Table 5.6 for the South East to North West and South East to Scotland markets. The attractiveness is measured by the relative level of population and employment in the two markets (the South East is common to both and hence does not affect the relative attractiveness); overall, the North West has 40% higher population and employment than Scotland in 2030.

5.53 In 2030, the Do-Minimum demand to the North West is 40 million trips per annum. Whilst the attractiveness of Scotland is some 30% lower, the demand to Scotland is nearly 50% lower, reflecting the relatively poor accessibility to Scotland from the South East. New Lines improves rail accessibility to Scotland to a level equivalent to that currently experienced for the North West; the forecasts indicate that the Scottish market grows to a size commensurate with the North West accounting for the differences in population and employment (i.e. 40/28 = 1.4).

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[4] This is the average with and without any fare premia, the elasticity values being 1.46 and 1.62 respectively. This reflects the uncertainty around fare changes on the Paris-Lyon route on which the elasticity is being compared.

[5] TEMPRO 5.4.

TABLE 5.6 RELATIVE MARKET SIZE FOR THE NORTH WEST AND SCOTLAND IN 2030

South East[6] to:	2030 attractiveness index (population and employment)	2030 Do-Minimum (million journeys p.a.)	2030 Do-Something (million journeys p.a.)
North West	1.4	40	n/a
Scotland	1	21	28

Summary

5.54 The preceding discussion has set out a set of benchmarking analysis to demonstrate the credibility and robustness of the New Lines forecasts. The forecasts are consistent with PDFH, the industry standard rail demand forecasting tool, commensurate with experience elsewhere and accord with comparison of demand on other key rail flows.

5.55 However, it must be emphasised that any forecasting is prone to uncertainty and that should the case for New Lines be considered further, the forecasting process should be developed in more detail, notably with regard the preference for New Lines over other modes and the propensity for New Lines to generate demand. Other refinements for consideration are set out in paragraphs 5.92 to 5.95.

The Impact of the Classic Rail Recast

5.56 This section sets out the impact on commuter and regional markets as the classic network is commensurately recast and improved as the New Line removes the Intercity services. For the Regional services, a recast has been developed for each Stage 2 option; for the Commuter market, the recast has focused on Option 1.4.1, where the opportunities exist for a comprehensive recast of the London WCML commuter services.

Stage 1

5.57 The first stage options, MB1.0a to MB2.0c, entail an overall decrease in service levels between West Coast stations not served by the new line. As both Birmingham and Manchester currently have three trains per hour, it was judged that it would be possible to remove one of these trains when a new line was in operation, in order to reduce operating costs.

5.58 Two services per hour are retained so that a service can be provided from intermediate stations, with intermediate calls on the removed services being redistributed between the remaining services. Therefore, no one station suffers a significant decrement in services, but some stations have an overall decrease in service frequency.

5.59 Summary results for options MB1.0a to MB2.0c are shown in Table 5.7 (the outputs for all these options are identical). These options result in a net decrease in both

6 Government Office Regions of London, South East and East of England.

demand and revenue since, as mentioned above, the timetable recast for these options was designed to minimise operating costs rather than maximise demand and / or revenue.

TABLE 5.7 CLASSIC LINE MODEL RESULTS FOR OPTION MB1.0A-MB2.0C (MILLIONS 2030)

	Commuter market	Regional market	Total
Change in demand	-	0.0	0.0
Change in revenue (£ 2007 prices)	-	-2.6	-2.6
Passenger benefits (hrs)	-	-0.5	-0.5
Value of crowding relief (hrs)	-	-	-

5.60 However, some flows beginning or ending at Milton Keynes Central do see an increase in demand and revenue, as there is an increase in direct services between Milton Keynes and other West Cost stations due to the redistribution of calls.

5.61 The main flows with a reduction in demand and revenue are those featuring intermediate stations on the West Coast Main Line, such as the flows between London and Coventry, between London and Stoke on Trent and between Birmingham International and Wolverhampton.

5.62 Given the geographical scope of the Commuter model, only a few of the classic line service spec changes being considered are relevant to it. The services removed in the classic line specifications for options MB1.0a- MB2.0c do not call at stations within the scope of the Commuter Model and therefore no results from this model are presented.

Stage 2

5.63 As described earlier, as well as impacting on demand between the cities served by the new line, the new line services also enable a recast of the classic lines timetable to provide benefits to passengers travelling between a large number of destinations. The second stage options therefore entail an overall increase in service levels between West Coast stations not served by the new line.

5.64 Summary results for option MB1.1 are shown in Table 5.8. In total there is a demand increase of 4.0 million per year, and an increase in revenue of £54m a year on classic line services. It should be noted that the abstraction of classic line demand for flows served by the New Line is modelled within the Intercity model and as such is excluded from this revenue increase.

TABLE 5.8 CLASSIC LINE MODEL RESULTS FOR OPTION MB1.1 (MILLIONS 2030)

	Commuter market	Regional market	Total
Change in demand	2.3	1.7	4.0
Change in revenue (£ 2007 prices)	20.1	33.8	53.9
Passenger benefits (hrs)	2.2	3.8	6.0
Value of crowding relief (hrs)	1.2	-	1.2

5.65 The main flows which see an increase in revenue are Milton Keynes to London, Northampton to London and Nuneaton to London. Milton Keynes to London and Northampton to London both see an increase in service frequency and London to Nuneaton has an improvement in both journey time and frequency.

5.66 In general, the flows with the largest increases in demand and revenue are those which have improvements in both frequency *and* journey times, such as the flow between London Euston and Nuneaton, as opposed to flows with improvements in frequency only, such the flow between London Euston and Stafford.

5.67 Leighton Buzzard to London and Lancaster to London see decreases in revenue, although these revenue decreases are much smaller than the gains to the improved flows. These decreases are due to increased journey times between Lancaster to London due to the inclusion of intermediate stops, and the removal Leighton Buzzard stops in fast services. In the revised service specification Leighton Buzzard is served by stopping services.

5.68 The revised service specification leads to an increase of the total number of peak trains into London Euston which call at stations within the scope of the commuter model. This rises from twelve in the Do Minimum to eighteen in the Do Something timetable. The key beneficiaries of this are Northampton, Milton Keynes Central and Watford Junction. By 2030 this increase in capacity leads to a benefit of 1.2m passenger hours per year.

5.69 No crowding benefit accrues from the regional model as the services covered within the scope of the model are unlikely to be heavily capacity constrained.

5.70 Summary results for option MB1.2.1 are shown in Table 5.9. The classic line service specifications for options MB1.1, MB1.2.1, MB1.3, MB1.4.1 and MB1.6 are relatively similar, and only differ in their treatment of services to and from destinations that might be served by the New Line. Therefore as expected this option shows similar increases in both demand and revenue as option MB1.1.

TABLE 5.9 CLASSIC LINE MODEL RESULTS FOR OPTION MB1.2.1 (MILLIONS 2030)

	Commuter Model Results	Regional Model Results	Total
Change in demand	2.3	1.8	4.1
Change in revenue (£ 2007 prices)	20.1	33.8	53.9
Passenger benefits (hrs)	2.2	3.8	6.0
Value of crowding relief (hrs)	1.2	-	1.2

5.71 The flows with the largest gains in revenue are Milton Keynes, Northampton and Nuneaton to London followed by Stafford and Rugby to London. Again there are small losses between Leighton Buzzard and London, there are also small losses between London and Warrington and London and Stoke on Trent due to extended journey times, from the inclusion of intermediate stops in these services.

5.72 The service specifications for the Commuter Model are consistent across all of options MB1.1 to MB1.4.1. As such the same Commuter Model results apply for options MB1.1 to MB1.4.1.

5.73 Summary results for option MB1.3 are shown in Table 5.10. Overall, this option results in smaller proportional and absolute increases in demand and revenue than options MB1.1, MB1.2.1 and MB1.4.1.

TABLE 5.10 CLASSIC LINE MODEL RESULTS FOR OPTION MB1.3 (MILLIONS 2030)

	Commuter Model Results	Regional Model Results	Total
Change in demand	2.3	1.6	3.9
Change in revenue (£ 2007 prices)	20.1	30.2	50.3
Passenger benefits (hrs)	2.2	3.3	5.5
Value of crowding relief (hrs)	1.2	-	1.2

5.74 Summary results for option MB1.4.1 are shown in Table 5.11. This option shows the highest proportional increase in both total demand and total revenue of all the options tested, as it provides the most scope for recasting the classic lines timetable.

TABLE 5.11 CLASSIC LINE MODEL RESULTS FOR OPTION MB1.4.1 (MILLIONS 2030)

	Commuter Model Results	Regional Model Results	Total
Change in demand	2.3	1.9	4.2
Change in revenue (£ 2007 prices)	20.1	33.5	53.6
Passenger benefits (hrs)	2.2	4.1	6.3
Value of crowding relief (hrs)	1.2	-	1.2

5.75 Summary results for option MB1.6 are shown in Table 5.12. This option performs worse overall in terms of proportional increases in demand and revenue than option MB1.4.1 as there is less scope to recast the classic timetable.

TABLE 5.12 CLASSIC LINE MODEL RESULTS FOR OPTION MB1.6 (MILLIONS 2030)

	Commuter Model Results	Regional Model Results	Total
Change in demand	2.5	1.5	4.0
Change in revenue (£ 2007 prices)	23.5	27.7	51.2
Passenger benefits (hrs)	2.8	2.9	5.7
Value of crowding relief (hrs)	0.8	-	0.8

5.76 Table 5.13 provides a summary of the results of the forecasting of the classic lines recast. Broadly, all of the Stage 2 options provide comparable benefits, with around 4.0 million additional journeys and an additional £50-54 million revenue. Passenger benefits are around 6 million hours.

TABLE 5.13 SUMMARY OF CLASSIC LINE IMPACTS (MILLIONS 2030)

	Stage 1 (MB1.0a/b)	MB1.1	MB1.2	MB1.3	MB1.4.1	MB1.6
Change in demand	0.0	4.0	4.1	3.9	4.2	4.0
Change in revenue (£ 2007 prices)	-2.6	53.9	53.9	50.3	53.6	51.2
Passenger benefits (hrs)	-0.5	6.0	6.0	5.5	6.3	5.7
Value of crowding relief (hrs)	-	1.2	1.2	1.2	1.2	0.8

Tests of Robustness

5.77 To examine the robustness of the scheme and in accordance with the HM Treasury Green Book and WebTAG guidance, a number of tests of robustness have been conducted to reflect the risks related to the scheme. These address variations to the demand and benefits, and operating and capital costs in light of changes to the scheme definition and model parameters.

5.78 This section sets out the demand impacts of this analysis. The resultant impact on the economic case for New Lines and tests to address variations to the operating and capital costs are set out in Section 4.

5.79 The demand forecasting sensitivity tests have been undertaken in the Intercity model only. The tests focus around the following assumptions and parameters:

- Adoption of Network Rail's view on demand growth across rail, car and air;
- Lower air growth;
- New Line fare premia;
- Lower generation factor; and
- Reduced preference for New Lines compared to classic rail.

5.80 The results of the sensitivity analysis are presented in Table 5.14.

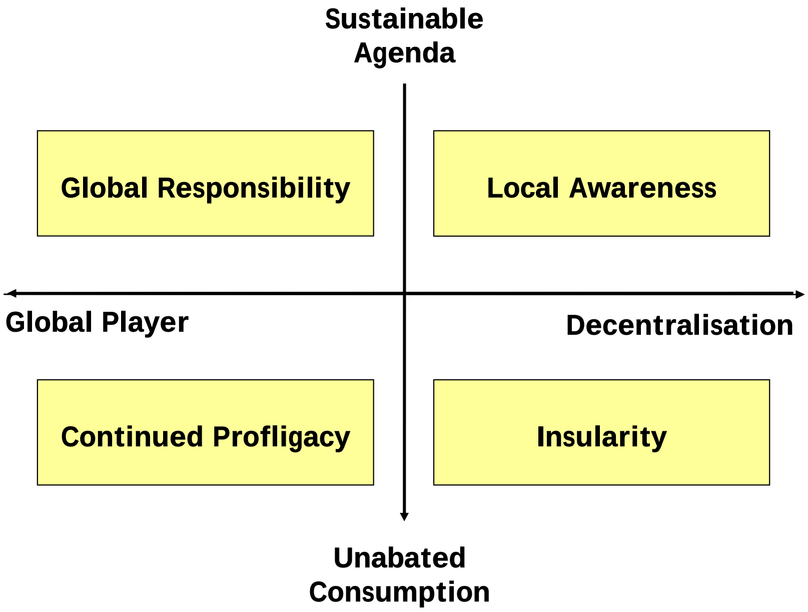
Network Rail Economic Scenarios

5.81 As part of the nationwide route utilisation strategy process (the Network RUS) Network Rail has developed four scenarios of potential economic development in Britain. These scenarios consider how the economy might develop given different trends in the approach to sustainability and the centralisation of the economy. Differing levels of drivers such as economic growth, population growth, regional distribution of growth, urbanisation and the pricing of externalities have been modelled and the impact on the demand for travel by different modes has been estimated.

5.82 The four scenarios developed as part of this work, shown diagrammatically in Figure 5.6, can be summarised as follows:

- Continued Profligacy (Unabated Consumption, Global Player);
- Insularity (Unabated Consumption, Decentralisation);
- Global Responsibility (Sustainable Agenda, Global Player); and
- Local Awareness (Sustainable Agenda, Decentralisation).

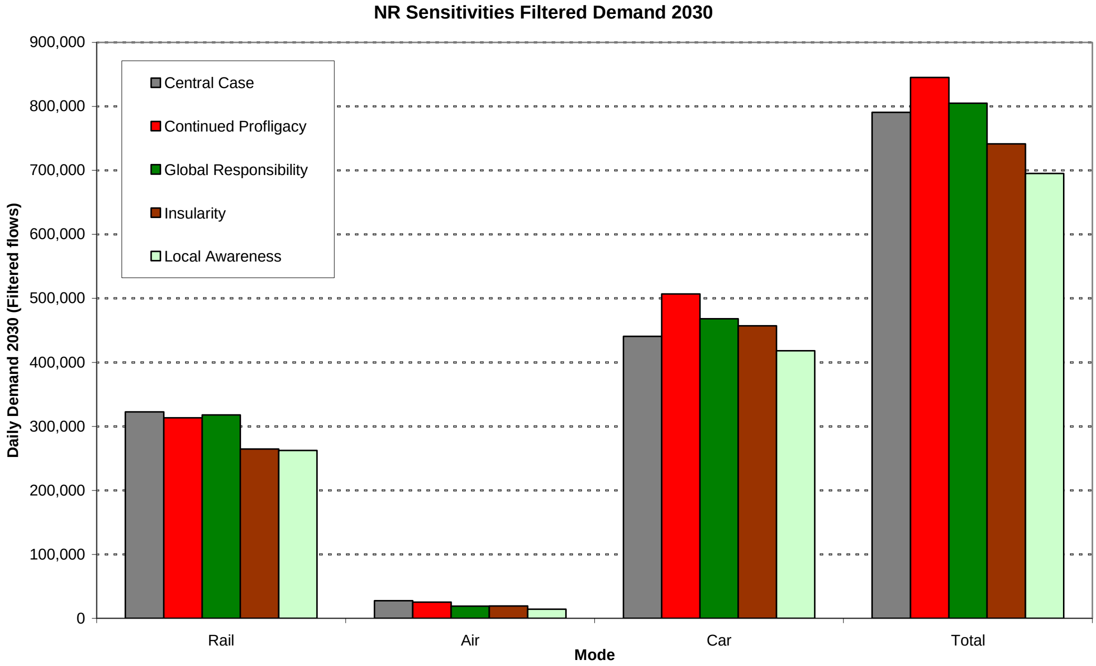
FIGURE 5.6 NETWORK RUS ECONOMIC SCENARIOS



5.83 These four scenarios lead to significantly different predictions of demand for travel by mode. These growth rates have been compared to the New Lines central case forecast. The analysis has been undertaken for the flows included within the New Lines Intercity model (those over fifty miles).

5.84 As can be seen in Figure 5.7 in terms of the do minimum total demand for travel the New Lines model predicts lower growth in the market for travel than that indicated by the Continued Profligacy scenario. However the rate of growth in the Central Case is slightly higher than that suggested by the Global Responsibility scenario, and is significantly higher than the level forecast by the Local Awareness and Insularity scenarios.

FIGURE 5.7 COMPARISON OF THE CENTRAL CASE DEMAND FORECAST AND THE NETWORK RUS SCENARIO DEMAND FORECASTS



5.85 All of the NR growth scenarios give lower New Line demand than the comparable MB1.4.1 test which has been used as the comparator. This lower demand is across all the London centric markets, with only the non-London flows being higher under the Global Responsibility and Continued Profligacy scenarios. The changes in the classic rail network and overall change in rail network demand are also consistently lower as are air demand reductions (with the exception of the Continued Profligacy scenario, where overall rail network demand and air reductions are comparable to MB1.4.1). Conversely, the reduction in car journeys is higher across the NR scenarios, with the exception of the Local Awareness test. These results reflect the overall forecasts shown in Figure 5.7 which shows rail and air demand lower than the central case, with car demand higher in all but the Local Awareness test.

Lower Air Growth

5.86 The DfTs forecast of air demand growth are based on 2005 observed figures. The significant growth seen between 2000 and 2005 was expected to continue into the future. However since 2005 there has actually been a fall in demand for air travel, suggesting that the forecasts may overestimate air passenger demand growth. This test, based on air growth to 2030 being 50% of that forecast, gives a lower New Rail demand, by around a million, with the key reductions occurring on the Glasgow and Edinburgh markets, with a slight reduction on the Manchester market. Non-London flows also fall slightly. The reduction in air demand is lower by some 26%, consistent with the assumed reduction in air growth (i.e. air demand is forecast to broadly double and hence a reduction in growth of 50% leads to an overall reduction of 25%).

Fare Premia

5.87 Halving the fare premium on New Lines from 30% to 15% has a significant impact on demand. New Lines demand increases by around 12%; some of this comes at the expense of a further reduction in classic rail demand. Overall there is a demand increase of 17% on the rail network. Transfer from both car and air also increases.

Generation

5.88 All of the markets served by New Lines benefit from a significant amount of demand generation over and above simple transfer from other modes. The highest generation occurs in those markets where the benefits of New Lines in journey time reduction is greatest, namely Scotland. Edinburgh is forecast to have 40% of the New Line demand generated.

5.89 A test was undertaken reducing the model parameter controlling generation by half. This had a material effect, reducing New Line demand by 15%. The impact is spread disproportionately to those markets with the largest New Line benefit. The demand to Scotland falls 25%, with demand to the north west falling an average of 12%. Demand to Birmingham is the least affected, falling just 9%. The abstraction from the classic network and from air and car actually all marginally increase; this is due to the slightly lower crowding brought about from the lower overall demand levels from reduced generation attracting slightly more demand from the other modes.

New Lines Preference

5.90 The forecasting has assumed that passengers prefer time spend on New Lines to that on classic rail, with the relative values of time on New Line being 25% lower for Business passengers and 8% lower for Leisure passengers. Valuing such preferences is prone to some degree of uncertainty and hence a sensitivity test has been undertaken where the relative preference is halved: Business passengers have a New Line value of time 12.5% lower and leisure passengers 4% lower than time spent on classic rail.

5.91 The impact is to reduce the attractiveness of New Lines and this is reflected in the demand forecasts, which show a 5% reduction in demand. The impact is broadly spread across all markets, with Birmingham and Manchester experiencing the largest absolute fall. This is due to these markets having a credible classic rail alternative, whereas the Scottish market in particular is essentially 100% New Line, with the demand reduction being through reduced demand generation. Transfer from car and air is also slightly depressed.

TABLE 5.14 2030 NEW LINE DEMAND SENSITIVITY ANALYSIS (MILLION JOURNEYS P.A.)

City	MB1.4.1	NR Growth: Global Responsibility	NR Growth: Local Awareness	NR Growth: Insularity	NR Growth: Continued Profligacy	50% lower air growth	15% fare premia	50% generation	50% New Lines preference
Birmingham	8.1	7.0	5.6	5.8	7.1	8.1	9.8	7.4	7.7
Manchester	10.5	10.2	7.7	8.3	10.7	10.4	11.6	9.4	9.8
Warrington	2.36	2.0	1.5	1.7	2.2	2.3	2.7	1.9	2.2
Liverpool	3.64	3.3	2.5	2.7	3.5	3.6	3.9	3.2	3.5
Preston	2.9	2.5	1.9	2.0	2.7	2.9	3.2	2.5	2.8
Glasgow	4.2	2.9	2.2	2.3	3.1	3.9	4.4	3.0	4.0
Edinburgh	6.5	5.8	4.4	4.6	6.0	6.1	7.0	5.0	6.1
Non-London flows	5.6	6.8	5.5	5.4	6.3	5.5	6.0	4.7	5.4
Total	43.7	40.5	31.3	32.8	41.7	42.8	48.8	37.1	41.5
Abstraction from classic rail	-23.1	-21.2	-16.7	-16.9	-21.0	-23.2	-24.8	-23.7	-22.6
Overall rail network demand	20.6	19.3	14.6	16.0	20.7	19.6	24.0	13.4	18.9
Change in car journeys	-3.8	-4.7	-3.5	-4.1	-5.3	-3.8	-4.2	-4.2	-3.5
Change in air journeys	-2.8	-2.0	-1.5	-2.1	-2.8	-2.1	-2.9	-2.9	-2.7

Note: may not sum due to rounding

Potential Model Refinements

5.92 The key model refinement would be to update the demand data from the original 2000 base data. Although this was undertaken here to a new 2007 base, a more thorough update could be done using observed data, in particular for the air and rail data where good data sources exist (the CAA passenger survey and ticket sales data respectively). Updating road data should also be considered, although the source for such data is not clear and would need to be investigated.

5.93 Associated with any updates to base demand data, forecast 2030 demand could also be refined by obtaining more detailed data from the DfT forecasts. Use of the NMF data for rail is robust, but the air and highway forecasts could be done at a more disaggregate level.

5.94 The analysis would also benefit from greater spatial disaggregation and network based analysis, particularly in London and the South East, where access to the respective modal networks (classic rail and New Lines stations, and airports) can have a material influence on mode and route choice.

5.95 Model structures and functionality could also be refined, to better capture the impacts of New Lines on trip patterns and land use impacts. This should also include updated model calibration to ensure current behavioural patterns are captured in the modelling process (for example to reflect extended air travel security arrangements and any impacts environmental concerns have had on decision making). Finally, the use of incremental models should be reviewed where the existing market is dominated by a single mode. An option would be to have an incremental model for those flows where several modes are used, but with absolute models where rail in particular has no share currently (and hence will continue to have no share even if New Lines becomes a realistic choice).

Valuation of additional freight capacity

5.96 As well as providing additional capacity for passenger services the service specification developed for the WCML classic line recast has been designed to enable the provision of two additional freight paths per hour. The potential benefits of these additional paths are also included within the appraisal. This section outlines how these benefits have been calculated.

Utilisation of Freight Paths

5.97 The number of freight paths required within a timetable will always exceed the number of paths that are used by freight services. This is for three key reasons:

- Permanent Working Timetable paths need to be booked in advance in accordance with the standard rail industry timetabling process, therefore additional paths may need to be booked by freight operators to cover for fluctuations in the source of resources. For example power stations may source coal from a number of mines within the UK, or import coal to a port.

- The need for goods can fluctuate e.g. a construction site may have sufficient ballast for the coming week if ballast use was low in the previous week.

- As most freight trains only run loaded in one direction the cancellation of one train will lead to the non-use of two freight paths.

5.98 However the main type of freight carried on the WCML is intermodal freight. Intermodal freight achieves much higher path utilisation than other freight types as services will operate even if they are not full, in this respect intermodal freight services are similar to passenger services. It is assumed the intermodal freight will continue to be the dominant type of freight carried on the WCML, therefore the observed average path utilisation for intermodal freight has been assumed. This equates to 95% utilisation.

Access to the WCML

5.99 Freight movements often begin and end away from major conurbation e.g. from ports, power stations and mines. Therefore in order for freight trains to utilise the additional paths on the West Coast Mainline additional freight capacity would also have to be identified on feeder routes to the WCML. Given the high level of utilisation of most potential routes the lifting of this constraint could entail either the removal of some current services or additional capital expenditure. This study has not considered in detail the access routing of freight services. This should be investigated at the next stage of project development.

Approach to Calculating Freight Benefits

5.100 Network Rail and the freight industry have been working to agree future freight forecasts. Recently freight forecasts for 2030 have been agreed within the freight industry. These forecasts are by origin and destination, commodity type and tonnage. However required number of trains to carry this freight and the exact routing of theses services has not yet been determined.

5.101 Therefore it has been necessary to estimate the number of freight trains that will need access to the West Coast Mainline by 2030 given these forecasts. Forecasts of intermodal freight tonnage per day by origin and destination were considered. Any flows that could operate without utilising the WCML south of Crewe were removed from the analysis. This leads to a forecast of WCML freight tonnage for 2030. This is then converted into a required number of freight paths in each direction using the following assumptions:

- The average weight of freight carried per train is assumed to be 600 tonnes for international intermodal traffic;
- The average weight of freight carried per train is assumed to be 400 tonnes for domestic intermodal traffic; and
- These are assumed to operate for 350 days per year.

5.102 This forecast of the required number of freight paths is then compared to the number of freight paths available in the case with and without a New Line.

5.103 The additional number of freight trains that can be operated is then calculated. This is then converted back into freight tonnage using the average loads outlined above.

5.104 Approximate mileage between each origin and destination is then calculated and multiplied by the additional tonnage to be carried in order that the level of sensitive lorry miles avoided can be estimated.

5.105 It should be noted that it might be possible to utilise some paths for two freight movements. For example a London to West Midlands freight train could operate in the same path as a West Midlands to Scotland train. This has not been explicitly taken into account in the analysis of path requirements due to the inherent difficulties in coordinating such movements. However as the recast timetable does not supply all of the freight paths required by the freight forecast the result would be the same even if this was modelled.

5.106 Given the high level assumptions that have had to be made this analysis of the freight benefits is subject to a significant amount of uncertainty. The benefits have been calculated using a number of steps, and at each stage an element of judgement has been required uncertainty. In particular the following should be noted:

- The routing of freight services has been estimated using high level assumptions;
- The origin and destination of freight movements is only available at a regional level; and
- The access routing of freight services to the WCML has not been considered.

5.107 However, overall the approach taken provides a reasonable estimate of the benefit that could accrue from the additional freight paths in the recast timetable.

6 Economic Assessment

Introduction

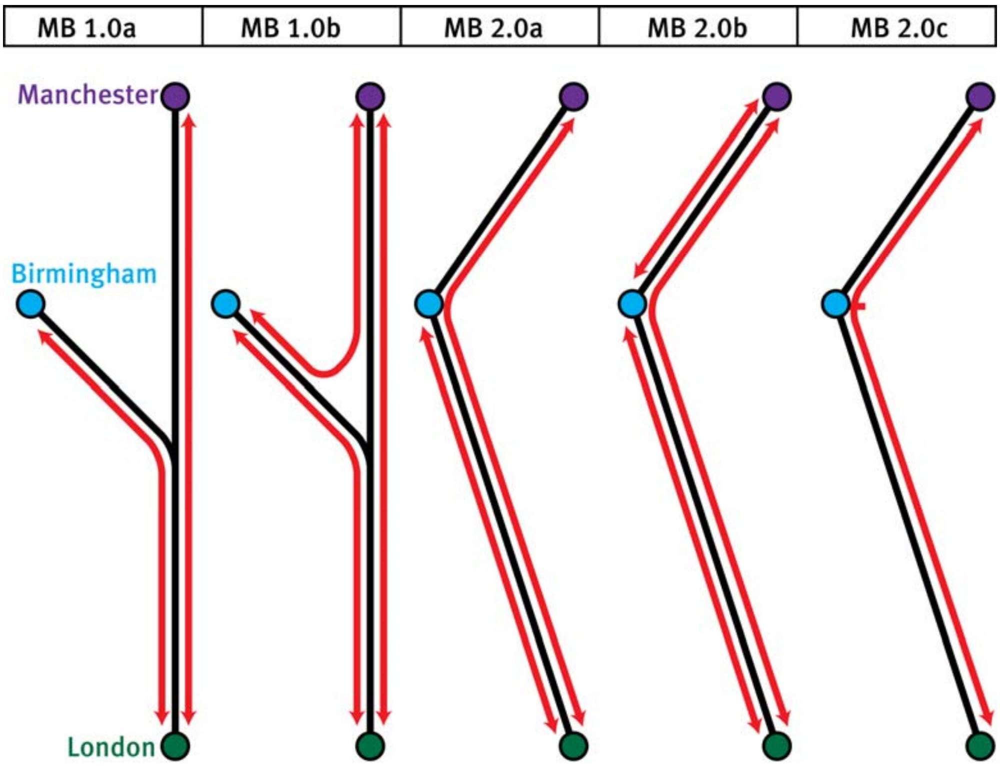
6.1 This section describes the approach to the economic appraisal and presents the results for the Stage 1 and Stage 2 assessments. This includes the impact of Network Rail's Economic Scenarios, consideration of other network impacts and selected sensitivity tests. The appraisal has been undertaken in line with the DfT Rail guidance.

Approach Overview

6.2 Consistent with the incremental approach used to develop the options that are assessed within this Strategic Business Case, the approach for the appraisal follows an incremental two stage process.

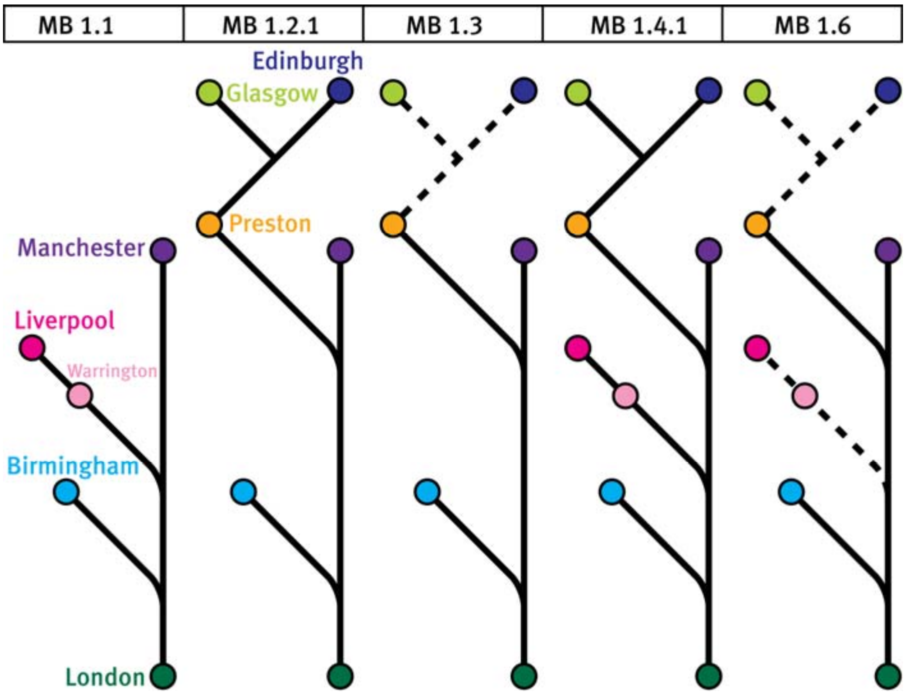
6.3 Stage 1 of the Option Assessment was based on the identification of the preferred route for the new line serving Manchester and Birmingham from London. Although no alignments have been designed for this Strategic Business Case assessment, analysis was undertaken to determine whether the route should serve Manchester via Birmingham or with a direct line to Manchester and a diverging main line to Birmingham. The impact of providing services between Birmingham and Manchester was also considered. The five options for assessment are shown in Figure 6.1.

FIGURE 6.1 STAGE 1 OPTION ASSESSMENT: LONDON TO MANCHESTER AND BIRMINGHAM



6.4 The option selected became the core route upon which all variants were developed for assessment in Stage 2 of the process. As described in Section 1 additional targets were identified and considered. Taking the core route as the base, options for assessment were developed to include additional targets and in order to investigate their incremental value. The assessment of the developed options allowed trade-offs between them to be identified and their economic performance compared. Figure 6.2 illustrates the options for assessment in Stage 2.

FIGURE 6.2 STAGE 2 OPTION ASSESSMENT: STRATEGIC BUSINESS CASE OPTIONS



6.5 The assessment of all the options has been undertaken against a consistent comparator. This Reference Case has been developed on the basis of a Do Minimum informed by the review of the existing network undertaken as part of Phase 1 of this study. It was established from existing published data, including Route Utilisation Strategies and the Strategic Business Plan from Network Rail and HLOS from the Department for Transport. In addition, and as agreed in a series of capacity baselining workshops with Network Rail planners, the baseline used for the Reference Case not only includes currently committed schemes, but also those considered likely to be delivered before 2020.

6.6 The Reference Case is set out in Section 3.

Benefits Approach

Rail Passengers

6.7 As the construction of a new line offers the opportunity to restructure the timetable on the classic network, the identification of rail passenger benefits looks at both the benefits to those passengers using the new line and those using the classic network.

6.8 These benefits arise from:

- The New Line:
  - Journey time savings for passengers using the new line;
  - Perceived journey time savings due to preference for using the New Rail as a mode of transport; and
  - Changes to levels of user charges (disbenefit).
- The Classic Line:
  - Journey time savings for passengers using the classic network due to timetable restructuring (commuter and regional impacts); and
  - Changes to crowding levels.

6.9 The approach to demand, revenue and benefit forecasting is outlined in more detail in Section 5.

Freight Benefits

6.10 As well as providing additional capacity for passenger services the service specification developed for the WCML classic line recast has been designed to enable the provision of two additional freight paths per hour. Using the DfT guidance for Sensitive Lorry Miles the highway decongestion and associated environmental and wider impacts of transferring freight from the road to rail was calculated.

6.11 The approach to calculating the additional freight capacity provided and the associated potential benefits is set out in Section 5.

Non-User and External Benefits

6.12 Improvements to the rail network will result in more people choosing to switch from car to train than would otherwise have been the case. This creates a reduction in the external costs of car travel such as road congestion, accidents and carbon emissions.

6.13 For the purposes of this Strategic Business Case the competitive response of the airlines has not been anticipated. Consequently the impact of the New Line on the aviation industry is assumed to be borne by the airlines as a financial impact, rather than by passengers in terms of service changes or fare changes. Furthermore, the same assumption means that the external costs of air travel are assumed to be unaffected.

Financial impacts

6.14 The financial impacts of the scheme are categorised as follows:

- Revenue for the new line;
- Revenue for the classic network due to abstraction to new line and service level enhancements;
- Capital cost of constructing the new line;
- Capital cost of procuring new rolling stock;
- Train operating costs for the new line;
- Train operating costs for the classic network;
- Track maintenance and renewals costs for the new line;
- Indirect tax impact on HM Treasury; and
- Maintenance and renewal costs and savings due to car and freight.

6.15 The introduction of the New Line will produce high levels of revenue for the New Line. However, some of that revenue will be abstracted from the classic lines as it would be expected that New Line would provide a more attractive option. Therefore, revenues for both the new and classic lines are considered.

6.16 The high speed nature of the New Line, along with its city centre to city centre nature would also be expected to have an impact on the air market for flights starting and ending within the UK. It was assumed for the purposes of this strategic assessment that interlining flights would not become in-scope for transfer to rail in the Stage 1 and 2 assessments. The issue of interlining has been considered separately with the Heathrow options within Section 7.

6.17 The re-casting of the classic line network will also result in a change to train operating costs, although maintenance and renewal costs are assumed to remain the same. The removal of cars and lorries from the highway network leads to a savings in maintenance and renewals.

6.18 The approach to determining revenue forecasts can be found in Section 5 and the approach to calculating operating, maintenance, renewal and capital costs can be found in Section 4.

Economic Results

6.19 The treatment of the forecast economic and financial impacts for the appraisal of the options was undertaken in accordance with DfT Rail guidance. The following assumptions have therefore been applied:

- 60 year appraisal period for benefits;
- Costs and benefits rebased and discounted to 2002;
- Economic benefits are grown with the value of time;
- Real construction cost inflation;
- Real growth in operating costs;
- Optimism bias;

- Market price unit of account; and
- Revenue transfer to government.

6.20 The opening year for the New Line assumed for this Strategic Business Case is 2019/20. Construction is assumed to commence in 2016.

Stage 1 Results

6.21 The results for the Stage 1 options as shown in Figure 6.1, can be seen in Tables 6.1, 6.2 & 6.3 below.

Forecast benefits

6.22 The benefits to rail passengers result from journey time savings and crowding benefits. The benefits to non-users result from reductions in the external costs of car travel such as road congestion, accidents, and carbon emissions due to modal shift from road to rail. A summary of the benefits is presented in Table 6.1.

TABLE 6.1 STAGE 1 SUMMARY OF BENEFITS

	£bn PV				
Element	**MB1.0a**	**MB1.0b**	**MB2.0a**	**MB2.0b**	**MB2.0c**
New Line Benefits	5.9	6.4	4.6	5.2	5.5
Classic Line Benefits	0.3	0.3	0.3	0.3	0.3
Private Sector Impacts	0.1	0.2	0.2	0.2	0.2
Car externalities	1.4	1.5	1.3	1.4	1.5
Freight Benefits	0.0	0.0	0.0	0.0	0.0
Total PVB	**7.7**	**8.3**	**6.4**	**7.1**	**7.5**

Total may not sum due to rounding

6.23 The New Line generates large benefits across all the options, with the majority coming from the considerable journey time savings achieved by the New Line. These are greatest in the MB1.0 options due to faster journey times to Manchester than in the MB2.0 options. Additional benefits from journeys between Birmingham and Manchester mean that MB1.0b performs most strongly in this indicator and results in the highest benefits.

6.24 In all the options, no significant recast of the classic line can occur as insufficient services are removed by the New Line. There is a 1 train per hour reduction between the each station pair served in the option from the classic line service, which while leading to a reduction in costs also leads to a journey time disbenefit.

6.25 As no significant classic line recast is possible in the options, no additional freight paths are achieved. Therefore there are no freight benefits for the Stage 1 options.

Financial Impacts

6.26 The financial impacts of the Stage 1 option assessment are set out in Table 6.2.

TABLE 6.2 STAGE 1 SUMMARY OF FINANCIAL IMPACTS

	£bn PV				
Element	**MB1.0a**	**MB1.0b**	**MB2.0a**	**MB2.0b**	**MB2.0c**
New Line Revenue	18.1	18.6	16.9	17.4	17.7
Change in Classic Line Revenue	-10.6	-10.9	-10.1	-10.3	-10.4
Subtotal PVR (Revenue transfer)	**7.5**	**7.7**	**6.8**	**7.0**	**7.2**
Capital cost (infrastructure)	10.6	11.2	11.6	11.6	11.6
Renewals (infrastructure)	0.6	0.7	0.7	0.7	0.7
Maintenance (infrastructure)	1.4	1.5	1.4	1.4	1.4
Train services (New lines)	3.3	3.8	3.5	3.9	3.4
Train services (Classic rail)	-0.9	-1.2	-0.9	-1.2	-1.2
Indirect tax	0.7	0.7	0.6	0.6	0.6
Car and freight externalities	Negligible				
Subtotal PVC	**15.7**	**16.5**	**16.9**	**17.1**	**16.5**

Total may not sum due to rounding

6.27 Table 6.2 demonstrates that significant additional revenue is received by the New Line for all options. MB1.0b generates the highest revenue (£18.6bn PV) which is a combined result of the faster journey times achieved by the MB1.0 options and the additional revenue gained through the Birmingham and Manchester flows.

6.28 In fact, in Present Value (PV) terms, the revenue generated by the New Line exceeds the costs of building, operating and maintaining the New Line in the MB1.0 options and MB2.0c. However, a significant amount of the revenue is abstracted from the classic line, so the net revenue for the New Line is also shown.

6.29 The MB2.0 options all have higher capital costs as the routeing requires construction through Birmingham. MB1.0b has a higher cost than MB1.0a due to additional connectivity between Birmingham and Manchester. The capital cost of purchasing new rolling stock is contained within the train operating costs.

6.30 There is also a reduction in operating costs associated with the classic line. This is due to fewer trains running on the classic line.

6.31 It has been assumed that the costs of maintaining and renewing the classic line will not change as there will be no change to the classification of the railway.

Transport Economic Efficiency (TEE) Results

6.32 Table 6.3 presents the economic performance of the Stage 1 options, through quantifying scheme costs and benefits over a 60-year appraisal period.

TABLE 6.3 STAGE 1 SUMMARY OF ECONOMIC RESULTS

	£bn PV				
	MB1.0a	**MB1.0b**	**MB2.0a**	**MB2.0b**	**MB2.0c**
Present Value of Benefits	7.7	8.3	6.4	7.1	7.5
Present Value of Costs	15.7	16.5	16.9	17.1	16.5
Present Value of Revenue Transfer	7.5	7.7	6.8	7.0	7.2
Net Present Value	-0.6	-0.5	-3.8	-2.9	-1.8
Benefit to Cost ratio	0.9	0.9	0.6	0.7	0.8

6.33 It should be noted that the Stage 1 results are not intended to and do not present the best case for each option as a standalone proposal.

6.34 As can be seen from the table, none of the Stage 1 options achieve a positive Benefit to Cost Ratio (BCR), although both the MB1.0 options perform better than the MB2.0 options with a BCR of 0.9:1. MB1.0b performs slightly better in Net Present Value terms.

6.35 The costs have not been optimised for the core route and the options do not utilise the capacity of the line. However the associated infrastructure in these options is consistent with a fully utilised line.

6.36 From the above analysis, it was concluded that MB1.0b will be taken forward to form the basis of the stage 2 option assessment.

Stage 2 Results

6.37 The results for the Stage 2 options, as shown in Figure 6.2, can be seen in Tables 6.4, 6.5 & 6.6 below.

Forecast Benefits

6.38 The benefits to rail passengers result from journey time savings and crowding benefits. The benefits to non-users result from reductions in the external costs of car travel such as road congestion, accidents, and carbon emissions due to modal shift from road to rail. A summary of the benefits are presented in Table 6.4.

6.39 As additional targets are added to the core route the benefits increase significantly. As would be expected the further the line goes, the larger those benefits become. The options that run to Scotland on wholly new line (MB1.2 and MB1.4.1) produce very large benefits due to the dramatic reduction in journey time between Scotland and London. The benefits are significantly lower in options that run on to the classic line (MB1.3 and MB1.6).

6.40 Running more services on the New Line offers greater opportunity to recast the services on the classic line, enabling additional connectivity and reducing crowding.

6.41 The additional freight capacity available after the classic line recast generated freight benefits. As the additional freight capacity is consistent across the Stage 2 options, the freight benefits are also constant.

6.42 The options also offer considerable non-user benefits due to the modal shift to road achievable with a New Line. New Line options to Scotland also have a large impact on the air market due to the journey time reductions.

TABLE 6.4 STAGE 2 SUMMARY OF BENEFITS

Element	£bn PV					
	MB1.0b	MB1.1	MB1.2.1	MB1.3	MB1.4.1	MB1.6
New Line Benefits	6.4	10.2	21.3	10.2	25.1	13.3
Classic Line Benefits	0.3	2.3	2.3	2.0	2.4	1.9
Private Sector Impacts	0.2	0.3	-0.9	-0.4	-0.8	-0.4
Car externalities	1.5	2.6	3.8	3.0	4.1	3.2
Freight Benefits	0.0	0.7	0.7	0.7	0.7	0.7
Total PVB	**8.3**	**16.1**	**27.2**	**15.5**	**31.4**	**18.7**

Total may not sum due to rounding

Financial Impacts

6.43 The financial impacts of the Stage 2 option assessment are set out in Table 6.5 demonstrates that significant additional revenue is received by the New Line for all options. As expected revenue increases as additional targets are added to the line and the greater the extent of the new line.

6.44 In Present Value (PV) terms the revenue generated by the New Line options exceed the costs of building, operating and maintaining the New Line in all options except MB1.2.1. However, a significant amount of the revenue is abstracted from the classic line, so the net revenue for the New Line is also shown.

6.45 The reduction in classic line operating costs in MB1.0 is due to fewer trains running on the classic line. In MB1.1 not enough services have been removed from the classic line in order to recast efficiently so costs increase. Options MB1.3, MB1.4.1 and MB1.6 allow a recast of the New Line, removing some of the long distance services and the running of more suitable trains. Both of these are large cost drivers so the classic line operating costs decrease as a result.

6.46 It has been assumed that the costs of maintaining and renewing the classic line will not change as there will be no change to the classification of the railway.

TABLE 6.5 STAGE 2 SUMMARY OF FINANCIAL IMPACTS

Element	**£bn PV**					
	MB1.0b	**MB1.1**	**MB1.2.1**	**MB1.3**	**MB1.4.1**	**MB1.6**
New Line Revenue	18.6	23.6	33.7	25.8	39.4	31.3
Change in Classic Line Revenue	-10.9	-11.7	-13.6	-12.7	-16.0	-15.2
Subtotal PVR (Revenue transfer)	7.7	11.9	20.1	13.1	23.4	16.1
Capital cost (infrastructure)	11.2	13.1	22.8	14.8	24.1	14.9
Renewals (infrastructure)	0.7	0.8	1.3	0.8	1.4	0.8
Maintenance (infrastructure)	1.5	1.7	3.3	1.9	3.5	1.9
Train services (New lines)	3.8	5.0	9.3	6.7	10.4	8.0
Train services (Classic rail)	-1.2	1.2	-0.5	-0.7	-0.6	-1.3
Indirect tax	0.7	1.3	2.4	1.6	2.6	1.8
Car externalities	Negligible	-0.1	-0.1	-0.1	-0.1	-0.1
Subtotal PVC	16.5	23.1	38.4	25.2	41.3	26.1
Total may not sum due to rounding						

Transport Economic Efficiency (TEE) Results

6.47 Table 6.6 presents the economic performance of the Stage 2 options, through quantifying scheme costs and benefits over a 60-year appraisal period.

TABLE 6.6 STAGE 2 ECONOMIC RESULTS SUMMARY

Element	**MB1.0**	**MB1.1**	**MB1.2.1**	**MB1.3**	**MB1.4.1**	**MB1.6**
Present Value of Benefits	8.3	16.1	27.2	15.5	31.4	18.7
Present Value of Costs	16.5	23.1	38.4	25.2	41.3	26.1
Present Value of Revenue Transfer	7.7	11.9	20.1	13.1	23.4	16.1
Net Present Value	-0.5	4.9	8.8	3.5	13.5	8.7
Benefit to Cost ratio	0.9	1.4	1.5	1.3	1.8	1.9

6.48 As can be seen from Table 6.6 adding additional targets to the core route (MB1.0) provides additional benefits and increases the BCR above 1:1 in all options. The best performing options are the two full options (MB1.4.1 and MB1.6). These options provide the most services (14 tph) and also contain the long distance services.

6.49 The incremental value of Liverpool and Warrington is quite high, generating large benefits and revenue for the infrastructure involved.

6.50 The value of the Scottish market is very high. With the wholly new line options (MB1.2.1 and MB1.4.1), the considerable journey times savings between London and Glasgow and London and Edinburgh (and intermediate stations) mean considerable modal shift from air and also significant trip generation. In addition, the further distances mean revenue per journey will be larger. Where the New Line runs on to the classic line, the benefits and revenue generated are significantly reduced. However, the costs involved in constructing a New Line all the way to Scotland are extremely high and raise affordability issues.

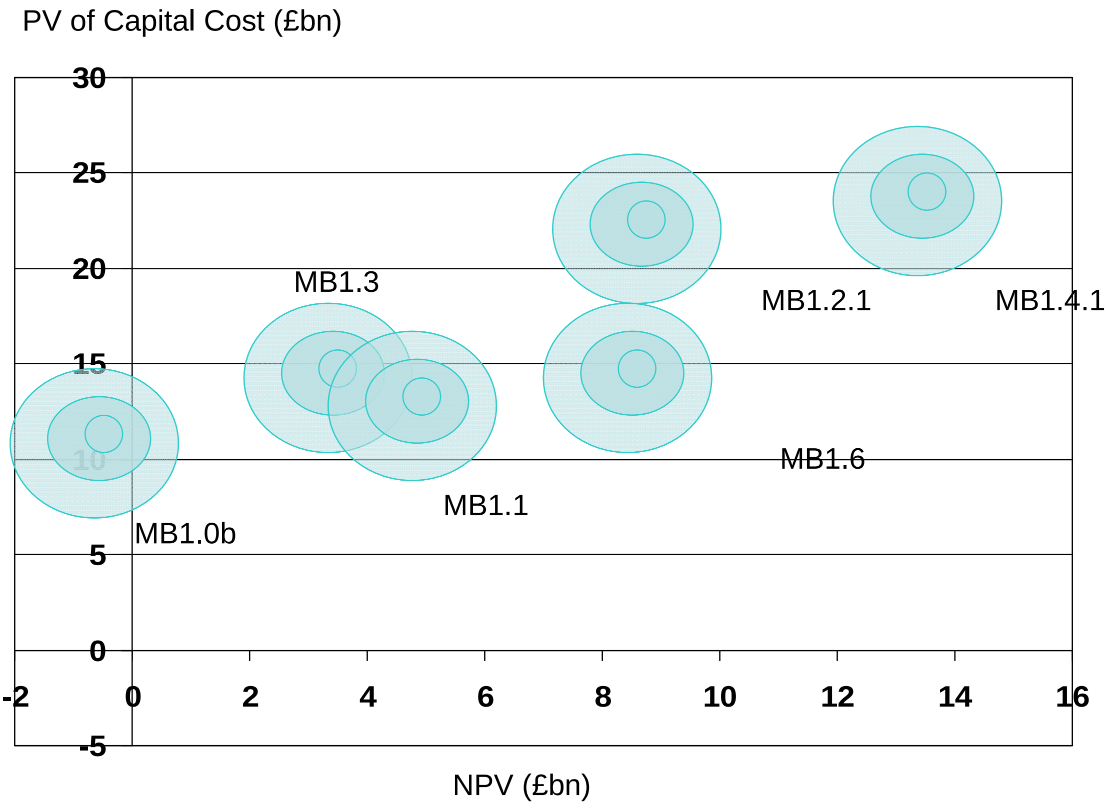
6.51 Although the BCRs of MB1.4.1 and MB1.6 are considered comparable, the costs and benefits are very different. The benefits (£31.4bn PV) and revenue (£23.4bn) generated by MB1.4.1 are much larger than any of the other options and the opportunity to recast the classic line and achieve modal shift is also greater. However, these benefits are accompanied by large costs (£41.3bn PV).

6.52 MB1.6 has a much lower Net Present Value. Both the benefits and revenue generated by this option are much lower (£18.7bn PV and £16.1bn PV respectively). The opportunity to achieve modal shift and recast the classic line network is also reduced, as the New Line services would replace current classic line services, rather than provide additional capacity. However, with less new line to construct the costs involved are much less (£26.1 PV).

6.53 Figure 6.3 below shows the relationship between the expected capital cost of the scheme and the total net present value expected to accrue. As can be seen clearly in the chart the expected net present value increases with capital cost.

6.54 Given the current level of scheme development it is not possible to estimate precisely the expected NPV of the scheme. However the tools and techniques outlined in this report allow us to determine a reasonable estimate of the likely value. The true value is likely to lie within a range of this value. Figure 6.3 indicates one potential range that these values could lie within. Given this possible range, it is clear that MB1.4.1 out performs the other options in NPV terms. However the order of options MB1.1 and MB1.3 is not clear. The range of potential outcomes for these options overlap, meaning that it is not possible to choose a clear winner from this subset of options.

FIGURE 6.3 ESTIMATED NPV VERSUS EXPECTED CAPITAL COST OF SCHEME



Wider Economic Benefits

6.55 Over recent years there has been a growing recognition that transport appraisal does not represent well the impacts schemes have on the wider economy. Firstly, concerns have been growing that the appraisal assumption of 'perfect competition' is too strict. A significant amount of literature over the last few years has addressed the potential for transport to deliver Wider Economic Benefits (WEBs) - that is, additional benefits on the wider economy beyond the direct impacts. The view is that the current approach to appraisal fails to capture these impacts.

6.56 In 2005 the DfT first published draft guidance on the topic and in the in Spring 2009 NATA refresh, the guidance was added 'for consultation'.

6.57 At this stage of the scheme development it is not considered appropriate to calculate wider economic benefits. However for illustration purposes, estimates of the potential magnitude of WEBs are presented in Table 6.7. They have been derived from benchmarking with other, similar schemes where wider economic benefits have been calculated.

6.58 As can be seen from Table 6.7, the inclusion of WEBs further strengthens the performance of MB1.4.1 and would similarly increase the other options.

TABLE 6.7 ILLUSTRATION OF IMPACT OF WEBS ON ECONOMIC RESULTS FOR MB1.4.1

	MB1.4.1	10% uprate	20% uprate
PVB (£bn)	31.4	34.6	37.8
PVC (£bn)	41.3	41.3	41.3
PVR (£bn)	23.4	23.4	23.4
NPV (£bn)	13.5	16.7	19.9
BCR	1.8	1.9	2.1

Tests of Robustness and Sensitivity Tests

6.59 This section outlines the results of the sensitivity tests and tests of robustness that have been undertaken on the New Line Results. These have been tested against Option 1.4.1. Option 1.4.1 has been chosen as it involves the largest required expenditure, level of demand growth and rate of air market capture. As such it will be most affected by changes in parameters.

Network Rail Economic Scenarios

6.60 As previously discussed in section 5 Network Rail has developed four scenarios of potential economic development in Britain as part of the nationwide route utilisation strategy process (the Network RUS). These scenarios consider how the economy might develop given different trends in the approach to sustainability and the centralisation of the economy. Differing levels of drivers such as economic growth, population growth, regional distribution of growth, urbanisation and the pricing of externalities have been modelled and the impact on the demand for travel by different modes has been estimated.

6.61 The four scenarios developed as part of this work can be summarised as follows:

- Continued Profligacy (Unabated Consumption, Global Player);
- Insularity (Unabated Consumption, Decentralisation);
- Global Responsibility (Sustainable Agenda, Global Player); and
- Local Awareness (Sustainable Agenda, Decentralisation).

6.62 The Network scenarios have been run through the New Lines modelling suite to test the robustness of the case for a New Line under differing economic conditions. Table 6.8 below shows the results of these tests:

TABLE 6.8 BCR AND NPV OF VARIANT 1.4.1 UNDER THE NETWORK RUS SCENARIOS

RUS Scenario	BCR	NPV (£bn)
Continued Profligacy	1.9:1	16.0
Insularity	1.2:1	3.8
Global Responsibility	1.7:1	13.7
Local Awareness	1.0:1	1.1

6.63 As can be seen in Table 6.8 there is an even stronger case for Option 1.4.1 under the continued Profligacy scenario and the Global Responsibility scenario only reduces the BCR slightly. However under the Insularity the BCR of the scheme drops to 1.2:1, and to 1:1 under the Local Awarenesss scenario.

Other Tests of Robustness and Sensitivity Tests

6.64 In addition to Network Rail's four economic scenarios analysis has been undertaken to test the robustness of the case for a new line. The tests fall into two main categories:

- **Break point analysis** – whereby the total value of key components of the Strategic Business Case are flexed to the point at which there is no longer a case for the new line; and
- **Specific risk analysis** – whereby specific elements of the new line case are increased or decreased to reflect the potential impact of identified risks.

6.65 Table 6.9 below shows the percentage change in the components of the Strategic Business Case that would need to occur for the BCR of Strategic Business Case to drop below 1.

TABLE 6.9 % CHANGE IN BUSINESS CASE COMPONENTS REQUIRED TO BREAK THE CASE FOR OPTION MB1.4.1

Component	% Change Required
Operating Costs	**+130%**
Infrastructure Costs	**+56%**
Revenue Forecast	**-34%**

6.66 Key risks to the Strategic Business Case for a new line have been considered and where appropriate the impact of these potential risks has been measured. Table 6.10 below shows the impact on scenarios in which they are realised.

TABLE 6.10 IMPACT OF SPECIFIC RISK SENSITIVITY TESTS

Test	Impact on BCR of Exemplar Variant	Comments
Option MB1.4.1	**1.8:1**	**Comparator**
New Lines fare premium at 15%	1.8:1	A New Line fare premium of 30% over classic line costs is assumed in the core Strategic Business Case. This tests the impact of halving this value.
Change in construction cost inflation	1.6:1	This tests an additional increase in construction cost inflation of 1% per annum.
Half the generation factor	1.2:1	Generated demand forms a significant proportion of the New Lines demand forecast. Reducing the generation factor reduces the forecast BCR to 1.2:1.
Half the mode specific value of time allowance	1.5:1	Reducing the impact of the mode specific value of time reduces the BCR from 1.8:1 to 1.5:1
Lower air demand growth	1.7:1	The DfTs forecast of air demand growth are based on 2005 observed figures. The significant growth seen between 2000 and 2005 was expected to continue into the future. However since 2005 there was actually been a fall in demand for air travel, suggesting that the forecasts may overestimate air passenger demand growth
Optimism bias on operating cost set to level appropriate for GRIP 1	2.1:1	The level of optimism bias on operating costs recommended by Webtag drops significantly between once a project is at GRIP 1. Assuming the GRIP 1 level of optimism bias improves the case significantly
No optimism bias on non-construction elements of the	2.0:1	Non-construction costs involved in project development form a

Test	Impact on BCR of Exemplar Variant	Comments
capital cost estimates		significant proportion of the capital cost of the scheme. It could be argued that optimism bias should not be applied to the non-construction elements of the capital cost estimate. If optimism bias is removed from the non-construction elements of the capital cost the BCR increases to 2:1.

6.67 None of the sensitivities shown above reduce the BCR of the New Line below 1:1.

7 Heathrow Options

Connecting the New Line with Heathrow

7.1 Amongst possible options available to serve Heathrow this study has considered three:

- Directly into the airport through the provision of a classic line connecting route from the New Line to Heathrow. Two option variants have been developed (Options MB1.5a and MB1.5b) and both are designed to test the benefit of a direct public transport surface access link between Heathrow and Birmingham/ Manchester, which available data suggests would provide the highest level of surface access demand from the route catchment;
- A diverging main line with a new route directly to Heathrow with a new station located at the airport with an assumption of easy equal accessibility to all five existing terminals (Option MB1.7.1); or
- Routing the New Line via Heathrow with a new station located at the airport with an assumption of easy equal accessibility to all five existing terminals (Option MB3.4.1).

Classic Line Connection to Heathrow

7.2 The lowest cost option, if deliverable, would be a classic line route approach to Heathrow. Exactly how such a classic line connecting route would approach Heathrow is entirely dependant on a final New Line route choice and this could have a significant impact on the cost and operability of such an option. Options MB1.5a and MB1.5b assume the services are routed via the Great Western Main Line (GWML) and BAA's Heathrow branch to the CTA and T5 stations directly. An alternative approach might be via a 'western connection' using the Colnbrook branch from West Drayton. This has not been considered and has known difficulties caused by the need for a single line section through the M4/M25 intersection and the requirement to accommodate existing freight traffic even if the rest of the branch could be enhanced.

7.3 The Demand-Capability Gaps report also prepared as part of this commission noted that utilisation of the GWML Main Lines was high in the peak and on the Relief Lines high all day. At this stage no further consideration has been given on how the additional trains planned in this option might be accommodated if at all. What is clear is that 2tph in each direction is probably the maximum that could be accommodated on any classic line route approach.

7.4 It is also assumed that capacity does exist on BAA's Heathrow branch post the introduction of Crossrail and that the trains could be accommodated on two platforms within the existing T5 station envelope. Costs have been included for platforms and station fit out at Heathrow as well as enhancement of a section of the classic line(s). As BAA's route infrastructure is unregulated no consideration has been given to how the infrastructure would be delivered or what track and station access charges might be. This would have to be addressed if this option were to be taken further.

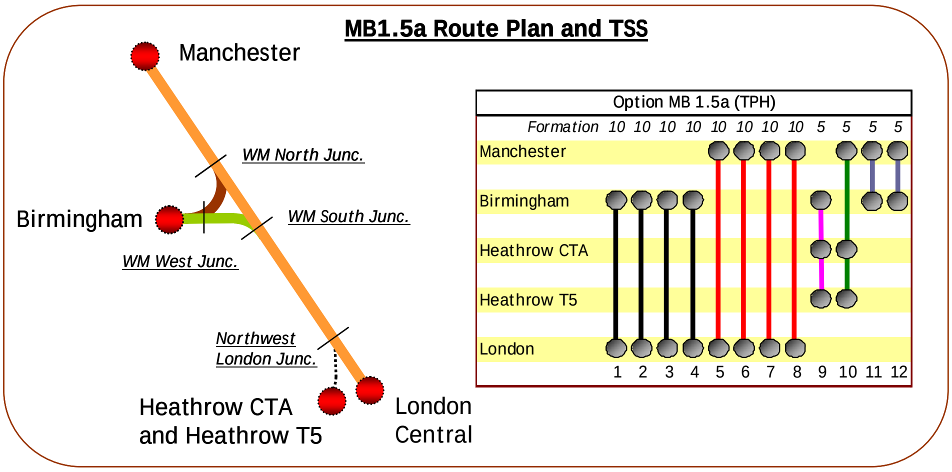
7.5 The route distance from London Northwest Junction to Heathrow T5 is assumed to be 15 miles. This together with an assumption that the New Line trains will be pathed in between all stations Crossrail trains on the GWML Relief Lines is assumed to add 30 minutes to the equivalent New Line journey time between London and Birmingham/ Manchester. Journey times to and from the Heathrow CTA station will be five minutes quicker.

Option MB1.5a

7.6 In this option (Figure 7.1) two additional services are assumed:

- 1tph (1hour 16mins) between Heathrow T5, Heathrow CTA and Birmingham; and
- 1tph (1hour 36mins) between Heathrow T5, Heathrow CTA and Manchester

FIGURE 7.1 OPTION MB1.5A ROUTE PLAN AND TRAIN SERVICE SPECIFICATION (TSS)



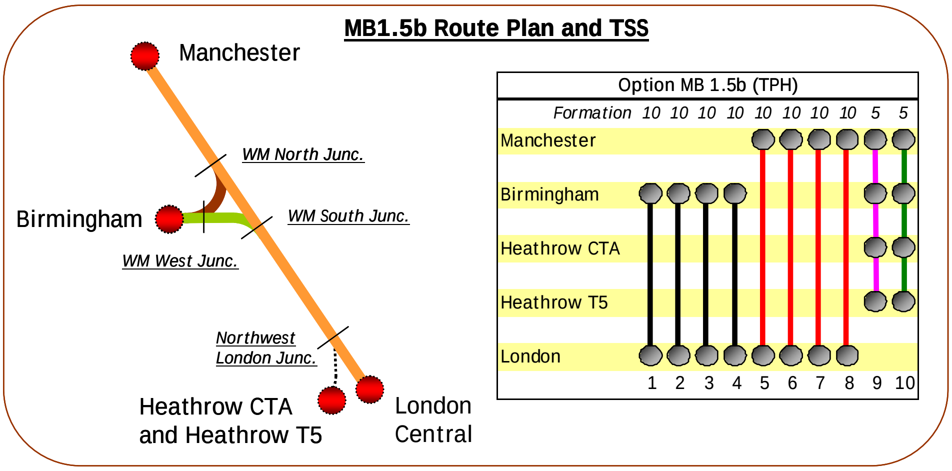
Option MB1.5b

7.7 In this option (Figure 7.2) one additional half hourly service was assumed:

- 2tph even interval between Heathrow T5, Heathrow CTA via Birmingham (1hour 16mins) and Manchester (1hour 59mins)

7.8 Birmingham, the principal catchment market for travel to and from Heathrow, is served at a higher frequency at the expense of a longer overall journey time to Manchester, although the latter is also served at the higher frequency. The incremental infrastructure and operations costs are reduced in this option when compared with Option MB1.5a, as the service between Heathrow T5 and Birmingham, is combined with the Birmingham and Manchester service to operate as a through train.

FIGURE 7.2 OPTION MB1.5B ROUTE PLAN AND TRAIN SERVICE SPECIFICATION (TSS)



7.9 The practicality of achieving either of these option variants presents a very significant delivery risk and ultimately would require a reduction in capacity utilisation on the New Line itself to mitigate even if achievable on the Classic Line connection. These issues were previously discussed in paragraph 3.20.

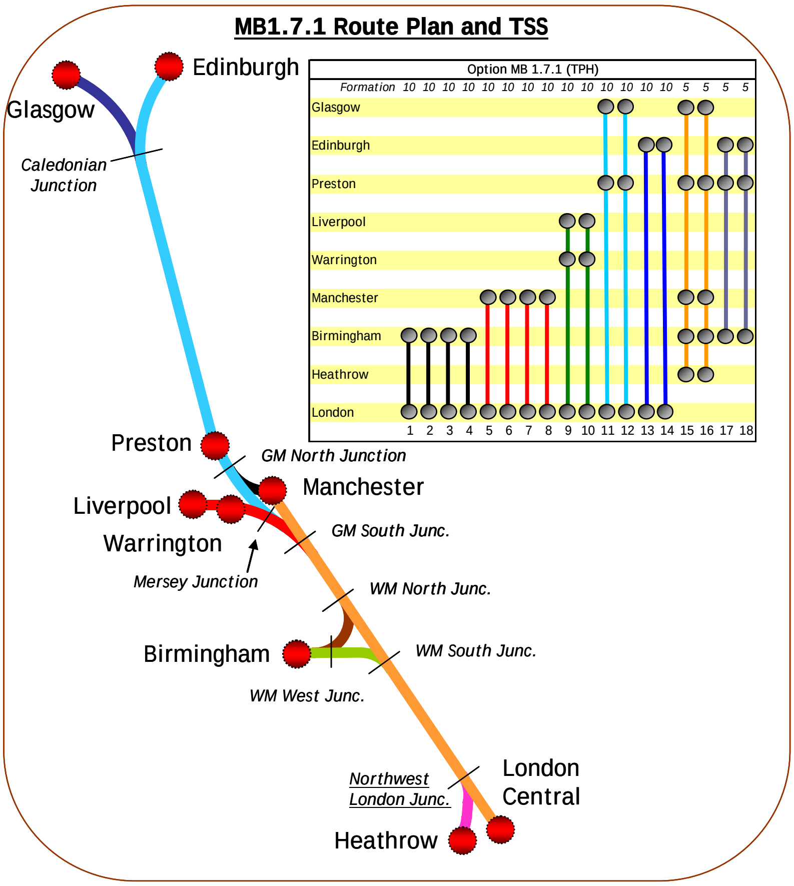
7.10 As a consequence neither of these options have been developed further and the focus has moved onto to developing an option that does not present the significant delivery risk inherent in a classic line approach.

7.11 However, the early outputs from the demand and revenue modelling indicated that Option MB1.5b performed better than Option MB1.5a and this service structure has therefore formed the basis for the development of the Heathrow service pattern in Option MB1.7.1. Option MB1.7.1 not only offers faster journey times but also overcomes the real practical delivery risk of a classic line approach.

Route 1 Diverging Main Line to and from Heathrow: Option MB1.7.1

7.12 Option MB1.7.1, shown in Figure 7.3, is achieved by adding a diverging main line to Heathrow from the core route between WM South Junction and London Central. This option provides a New Line approach to Heathrow with a new station assumed to be located in the airport with the same equal accessibility to all five existing air terminals.

FIGURE 7.3 OPTION MB1.7.1 ROUTE PLAN AND TSS



7.13 The route distance from London Northwest Junction to Heathrow T5 is assumed to be 15 miles although this could vary significantly depending on the final alignment chosen for the core New Line to and from London Central. The station at Heathrow is assumed to have two 400m platforms although where a station of this size might be sited is untested and is a major risk to the delivery of this option. Similarly, how passengers would travel between the new station and the five existing air terminals has not been examined nor has any cost been included in the business case for this element of the programme. The cost of the connecting links may be significant and the access time from the platforms to the terminals could be lengthy. An access time of 20mins to each journey to and from Heathrow has been assumed.

7.14 Option MB1.7.1, and Option MB3.4.1 shown below in paragraph 7.17, are both based on the underlying train service pattern of Option MB1.4.1 which has a New Line throughout to Glasgow and Edinburgh. These two additional Heathrow options will enable a direct comparison to be made between:

- New Line via Route 1 between London, Birmingham, Manchester, Liverpool, Glasgow and Preston with no Heathrow service - Option MB1.4.1;
- New Line via Route 1 between London, Birmingham, Manchester, Liverpool, Glasgow and Preston with a 2 tph Heathrow service between Heathrow and Glasgow - Option MB1.7.1; and
- New Line via Route 3 between London, Birmingham, Manchester, Liverpool, Glasgow and Preston via Heathrow service - Option MB3.4.1 with all services to and from London Central calling intermediately at Heathrow;

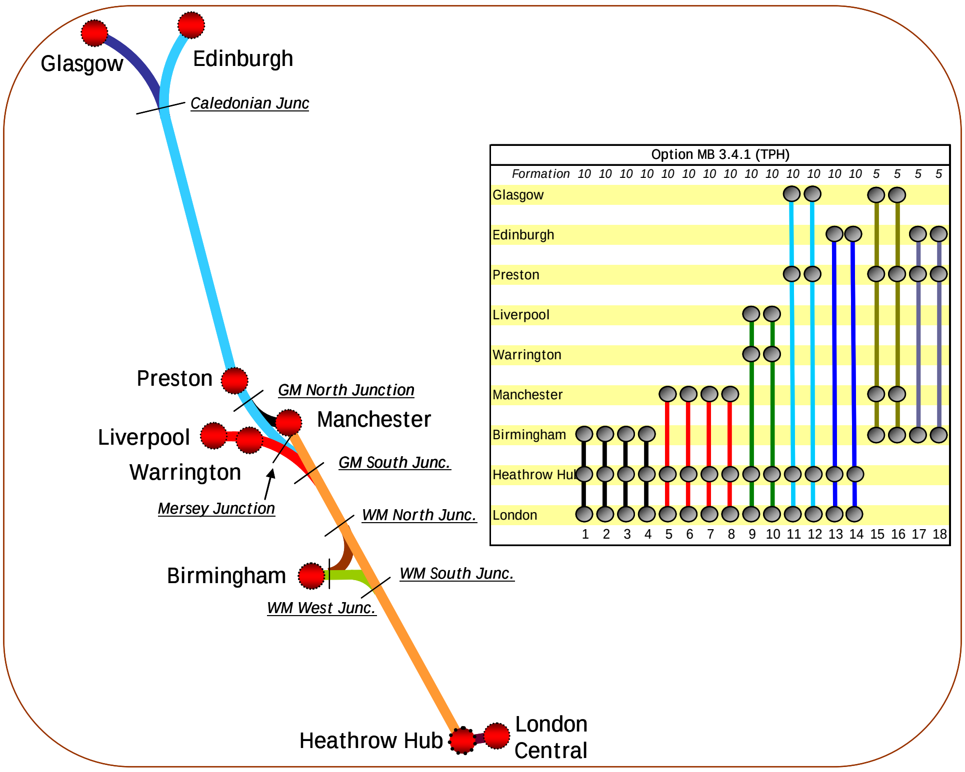
7.15 As discussed in paragraph 7.11 the initial work on Options MB1.5a/b indicated that the best business case performance would be achieved by extending an existing New Line service to and from Heathrow and in the Option MB1.7.1 this is achieved by extending the 2tph train service between Glasgow and Birmingham via Manchester to operate to and from Heathrow. This enables Birmingham, Manchester, Preston and Glasgow to be served by 2tph to and from Heathrow and has the lowest operating costs of possible alternative options considered. It should be noted that because of the likely demand profile of passenger business to and from Heathrow it is assumed that the Heathrow-Glasgow service operates at 2tph through the operating day.

7.16 Option MB1.7.1 exhausts the available capacity of 16tph in each direction on the New Line core route section between WM South Junction and Northwest London Junction. Any further services to and from Heathrow would require substitution of London services and this would also require additional platforms at Heathrow, although this might be offset with a reduction in the platform requirement at London Central.

Route 3 New Line via Heathrow: Option MB3.4.1

7.17 In this option shown in Figure 7.4 the New Line alignment runs through Heathrow which is served with a new four platform station. It is assumed that all trains will call at this station. The deliverability issues discussed in paragraph 7.13 above apply to this option also but with the added difficulty of accommodating a station and track layout of a much greater scale.

FIGURE 7.4 OPTION MB3.4.1 ROUTE PLAN AND TRAIN SERVICE SPECIFICATION (TSS)



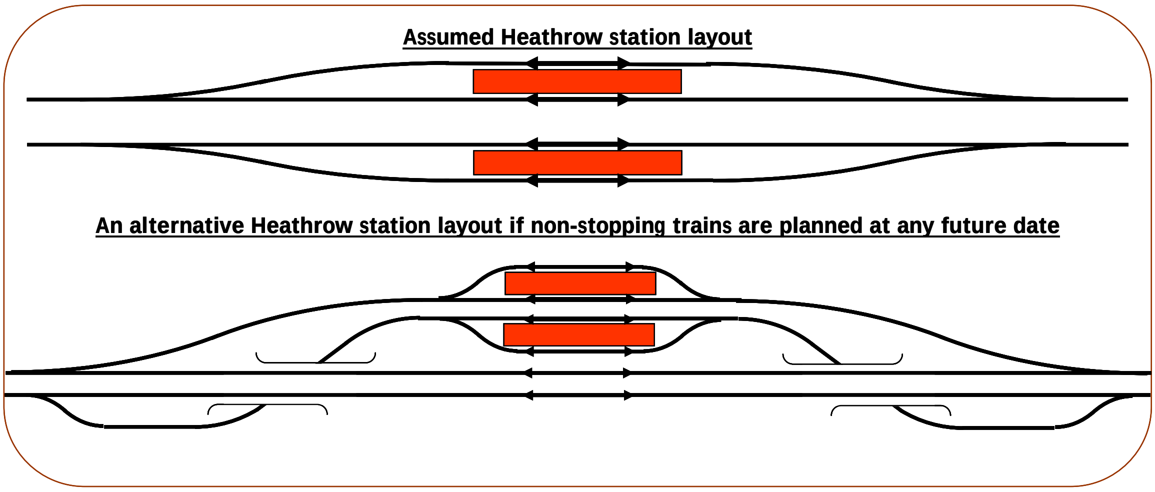
7.18 The train service pattern of Option MB1.4.1 has been taken as the base and provides a direct comparison of the cost and benefits of routing the New Line this way. Journey times to all destinations are extended by 15 minutes to reflect both the additional route distance, lower line speeds between Central London and Heathrow and the impact of the station stop itself.

7.19 All trains have been assumed to have an extended dwell time of three minutes at Heathrow to reflect the unique passenger requirements at an airport station. Trains are not assumed to carry passengers between Central London and Heathrow as doing so may further extend the station dwell time and could require additional seating and luggage capacity to be provided just for that part of the journey which would then be unused between Heathrow and the outer destinations.

7.20 Heathrow already has good direct links to and from London via the Heathrow Express and the Piccadilly line. Crossrail and the possible Airtrack service to Clapham Junction and London Waterloo would further enhance this capability.

7.21 The Heathrow station is assumed to have a simple track and platform layout with two islands enabling trains to operate consecutively in the same direction at the 3 minute planning headway. Should passive provision be required for any future option that has trains routed this way, but running non-stop through Heathrow, then the layout would have to be significant enhanced. This would increase costs significantly and has therefore not been considered further in this Strategic Business Case. The assumed option and the notional alternative are both shown in Figure 7.5.

FIGURE 7.5 ASSUMED HEATHROW STATION LAYOUT AND ALTERNATIVE OPTION



Refining Options MB1.7.1 and MB3.4.1

7.22 Each of Heathrow access options described above have varying degrees of delivery risk. There is a significant risk that none of these are deliverable even if affordable to the New Line promoter and acceptable to BAA.

7.23 For Options MB1.7.1 and MB3.4.1 locating the station to serve Heathrow on the periphery of the airport should be considered. From this station connection could be made via Heathrow Express and/or Crossrail services to all five air terminals. The cost of such a station could be lower than at Heathrow itself and without the delivery risk. It would be very important to test these issues at the next stage of the programme development.

Summary of Options Considered

7.24 An illustration of the options tested is provided below:

FIGURE 7.6 HEATHROW OPTIONS CONSIDERED

The market for Heathrow New Line services

7.25 New Lines rail services to Heathrow could play two key roles, they could:

- Provide an alternative to domestic interlining flights (i.e. the Edinburgh – Heathrow flight used to connect to a long haul flight at Heathrow); or
- Provide an alternative surface access mode in place of current access modes such as car.

7.26 This section looks at the market for Heathrow New Line services, the demand which could be abstracted onto rail from interlining and improved surface access to London and Heathrow and the impact on the case for New Lines. Even without serving Heathrow directly, any New Lines to London from the north and Scotland will encourage the use of rail for surface access and as an alternative to interlining. This is also considered below.

7.27 Note that wholly UK domestic air trips have already been considered in previous sections.

Surface access

7.28 Of the 68 million passengers passing through Heathrow in 2007, some 24 million simply changed planes (interlining). The remaining 44 million had Heathrow as their first/last airport for the journey (they were terminating passengers). Of these 82% came from London and the South East. The regions of West Midlands, North West and Scotland, those to be served by a possible New Line, accounted for just 1.5 million (3.4%) of these. Of these, around 0.6 million (37%) used public transport to reach Heathrow, with 0.9 million (63%) using private transport.

7.29 Total demand at Heathrow is forecast[7] to broadly double by 2030, reaching 136 million. The mix of this growth across the domestic, short haul and long haul markets is broadly comparable, with domestic demand growing slightly faster than long haul. Overall, therefore the terminating demand is expected to increase commensurately and on that basis the level of terminating demand originating from the West Midlands, North West and Scotland would grow to around 3.0 million (assuming that access travel costs remain unchanged).

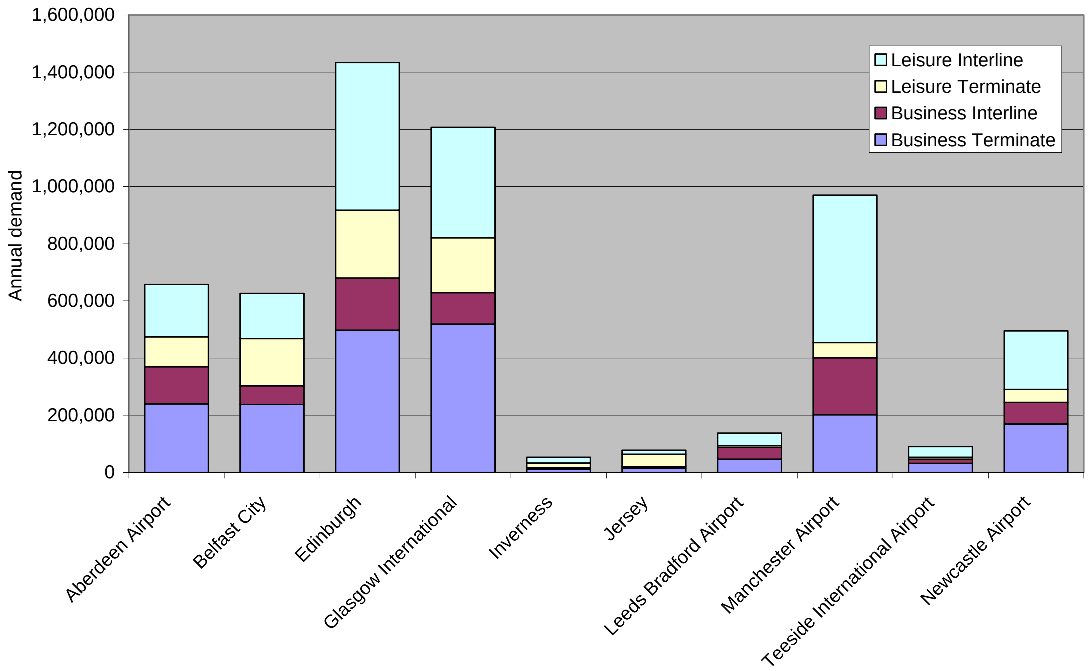
Domestic Interlining

7.30 Of the 68 million passengers who used Heathrow in 2007, around 8.5% (or 5.8 million) were on domestic flights; the key origin airports for such flows are Edinburgh (1.44m), Glasgow International (1.21m) and Manchester airport (0.97m) which between them account for 3.6m, or 63% of this domestic demand.

7.31 Interlining (where travellers change planes at Heathrow to make a long distance flight i.e. Edinburgh – Heathrow – New York) makes up a large proportion of all domestic demand from Heathrow (around 51%). Overall the percentage of demand attributable to interlining within the three key domestic origin airports is similar to the overall Heathrow figure (around 53%), though there is some variation within this – only 41% of passengers coming from Glasgow are interlining whereas 74% of those from Manchester do so. Domestic demand at Heathrow is illustrated in Figure 7.7; the three key flows are Edinburgh, Glasgow and Manchester. Aberdeen is not considered further due to the large access time to any New Line at Edinburgh making the option of transferring from air unrealistic.

[7] UK Air Passenger Demand and CO_2 Forecasts, DfT, November 2007. (Updates to these forecasts were published 15th January 2009, but programme constraints precluded their inclusion here. In any event, the forecasts are not materially different, with forecast 2030 Heathrow demand being 2% lower and the combined demand at Manchester, Edinburgh and Glasgow being just 1% lower.

FIGURE 7.7 2007 DOMESTIC DEMAND AT HEATHROW



7.32 As noted above, air demand at Heathrow is forecast to broadly double by 2030 and hence the level of interlining demand will grow commensurately (assuming that access travel costs remain unchanged).

7.33 Due to its nature, the scope for interlining demand to transfer to New Lines is lower than either surface access trips to Heathrow or the wholly domestic trips captured within the Intercity model. Domestic flights act as a feeder to more profitable long-haul services at Heathrow and those airlines operating them are likely to continue to provide them, albeit possibly at reduced levels, even if direct New Lines services were provided. They provide a competitive advantage over other airlines without a feeder network by providing a seamless feeder service to the main leg. Passengers can check-in all the way to their final destination, in particular being able to check luggage can be a major advantage.

7.34 Furthermore, the cost of the feeder leg to the typical passenger can be considerably less than the cost for that flight taken alone or, more importantly, against comparable rail fares, which further strengthens the advantage of the feeder leg. Web based research into fares indicated that the additional cost for a feeder service from Manchester or Edinburgh to Heathrow is currently typically around £60 return, with some even lower. This varied little with the booking lead time. Conversely, the cost of the same flights for wholly domestic trips started at around £80 return, with peak fares reaching between £200 and £300 return. Average rail fares between London and Manchester/Scotland are around £80-£90 return, with lower fares typically only available through advance booking, thereby restricting travel times and availability.

7.35 Finally, interlining protects the passenger against lost connections, which may not be possible where other modes are used to access Heathrow.

Market summary

7.36 Table 7.1 provides a summary of the demand that may be in-scope for transfer to New Lines. In total, by 2030, around 6.8 million trips are forecast to interline or access

Heathrow from the West Midlands, North West and Scotland, the balance switching from surface access to interlining at points further north. (As previously noted, at this stage it has been assumed that the surface access and interlining demand simply doubles in line with the overall demand forecasts for Heathrow. In practice, the mix may change over time due to changes in the level of service and pricing of the respective modes. This is explored further in the next section.)

TABLE 7.1 HEATHROW DEMAND SUMMARY (000'S)

Region or airport	Terminating		Interlining	
	2007	2030	2007	2030
West Midlands	1,200	2,400	n/a	n/a
North West / Manchester airport	236	472	715	1,430
Scotland / Edinburgh, Glasgow	82	164	1,195	2,390
Total	1,518	3,036	1,910	3,820

The demand impact of New Lines

7.37 Modelling airport accessibility is complex and as such a high level approach has been used to provide estimates of the impact of New Lines for access to Heathrow. The results should be treated as 'indicative estimates' as they have not been modelled to the same detail and rigour as in the domestic New Line models.

7.38 Note that the Intercity model looks at air demand switching to New Lines where the trip is wholly domestic i.e. for a trip between Stockport and west London where a flight from Manchester to Heathrow was used.

7.39 The modelling analysis undertaken has considered both the impact of New Lines and how the underlying mix of modal access may change through to 2030.

7.40 Table 7.2 sets out the model access to Heathrow from the West Midlands, North West and Scotland. This assumes that the 2007 mode shares are maintained through to 2030 and that the absolute demand levels are increased in line with the DfT forecasts.

TABLE 7.2 2030 HEATHROW ACCESS DEMAND ASSUMING CURRENT ACCESS MODES (000s)

	Car	Rail	Coach	Air	Total
West Midlands	1,616	281	502	0	2,400
North West	235	148	88	1,430	1,901
Scotland	53	63	47	2,390	2,553
Total	1,905	493	637	3,819	6,855

7.41 However, DfT forecasts are based on a number of evidenced and policy assumptions about how service levels (air and rail network and road congestion levels) and pricing levels change through time which will change the mode shares. Of note, air fares fall in real terms (-1% p.a. is assumed), whilst rail fares increase in real terms (+1% p.a.). Factoring this and service level changes into the Heathrow access modelling changes the 2030 mode shares; this is demonstrated in Table 7.3. Whilst car is broadly unchanged, air access (interlining) increases marginally (5%), with compensating reductions in rail and coach. This forecast forms the basis for understanding the impact of New Lines on access to Heathrow.

TABLE 7.3 2030 HEATHROW ACCESS DEMAND WITH FORECAST MODE SHARES (000s)

	Car	Rail	Coach	Air	Total
West Midlands	1,714	233	453	0	2,400
North West	168	94	44	1,595	1,901
Scotland	33	58	19	2,445	2,553
Total	1,915	384	516	4,040	6,855

7.42 Even in the case of MB1.4.1 where no direct service is provided to Heathrow, there will still be a small increase in demand to and from Heathrow as the journey time to London will be reduced. This will lead to a faster journey time between regional cities and Heathrow when this trip is undertaken by rail via London. The impact of option MB1.4.1 on Heathrow access is shown in Table 7.4. Comparison with Table 7.3 shows that rail increases substantially (117%), albeit from a low base, with an additional 450,000 rail trips. Around 63% of this comes from air (mostly Scotland), with the remainder mostly from car; however in percentage terms the impact on the other modes is marginal (5-7%) reflecting their relative sizes. This impact is not included in our core assessment, but for the purposes of comparison it has been included in the MB1.4.1 results presented here. This comparator is referred to as MB1.4.1 with HA.

TABLE 7.4 2030 HEATHROW ACCESS WITH OPTION MB1.4.1 (000s)

	Car	Rail	Coach	Air	Total
West Midlands	1,587	383	430	0	2,400
North West	158	197	42	1,504	1,901
Scotland	30	254	18	2,252	2,553
Total	1,775	834	489	3,756	6,855
Change	*-140*	*450*	*-27*	*-283*	

7.43 Providing a New Line diverging main line to Heathrow, option MB1.7.1, has a material impact on the rail market to Heathrow, as shown in Table 7.5. Rail increases by 1.0 million journeys, a 270% increase. Most of the additional rail demand (58%) is abstracted from air, with the bulk of the remainder from car.

TABLE 7.5 2030 HEATHROW ACCESS WITH OPTION MB1.7.1 (000s)

	Car	Rail	Coach	Air	Total
West Midlands	1,371	639	390	0	2,400
North West	151	308	40	1,403	1,901
Scotland	27	471	17	2,039	2,553
Total	1,549	1,418	446	3,442	6,855
Change	*-366*	*1,034*	*-70*	*-598*	

7.44 Option MB3.4.1, which routes the New Lines via Heathrow, has the greatest impact. As shown in Table 7.6, rail demand increases by around 1.4 million trips, a 360% increase. Around 64% of this is from air, with this split broadly 2:1 from Scotland and the North West. Car demand makes up most of the transfer to rail.

TABLE 7.6 2030 HEATHROW ACCESS WITH OPTION MB3.4.1 (000s)

	Car	Rail	Coach	Air	Total
West Midlands	1,331	687	382	0	2,400
North West	136	439	36	1,290	1,901
Scotland	25	657	16	1,856	2,553
Total	1,491	1,783	434	3,146	6,855
Change	*-423*	*1,399*	*-82*	*-893*	

7.45 Table 7.7 provides a summary of the forecasts of access to Heathrow. Without any specific improvements in access to Heathrow (MB1.4.1), rail demand accessing Heathrow does increase significantly, but from relatively low base. Adding services direct to Heathrow, albeit only from Birmingham and Manchester, further increases the rail mode share. Routing the New Line via Heathrow maximises rail access share, with some 1.8 million trips, a 26% share. Interlining remains the dominant access mode, with 46% of the market. Of note, routing via Heathrow only reduces interlining by some 22% assuming a full New Lines option serving Scotland.

TABLE 7.7 SUMMARY OF NEW LINES IMPACT ON ACCESS TO HEATHROW (000s)

	Car	Rail	Coach	Air
2030 DM	1,915	384	516	4,040
MB1.4.1	1,775	834	489	3,756
Change	*-140*	*450*	*-27*	*-283*
MB1.7.1	1,549	1,418	446	3,442
Change	*-366*	*1,034*	*-70*	*-598*
MB3.4.1	1,491	1,783	434	3,146
Change	*-423*	*1,399*	*-82*	*-893*

7.46 Options MB1.7.1 and MB3.4.1 have the same classic line demand and revenue specifications as Option MB1.4.1. Therefore the classic line demand and revenue results of Option MB1.4.1 are adopted.

The Case for New Lines serving Heathrow

7.47 The approach to assessing Heathrow options MB1.7.1 and MB3.4.1 is the same as used in the Stage 1 and Stage 2 assessments as described in Section 6. However, in addition Heathrow user benefits have also been calculated.

7.48 The Heathrow Access Model, used for MB1.7.1 and MB3.4.1, has also been applied to MB1.4.1 to provide a meaningful comparator against which the Heathrow options can be considered. The results for both MB1.4.1 and MB1.4.1 with Heathrow access (MB1.4.1 with HA) are included along with the results for options MB1.7.1 and MB3.4.1 in Tables 7.8, 7.9 and 7.10 below.

Forecast Benefits

7.49 The benefits to rail passengers result from journey time savings and crowding benefits. The benefits to non-users result from reductions in the external costs of car travel such as road congestion, accidents, and carbon emissions due to modal shift from road to rail. A summary of the benefits are presented in Table 7.8.

7.50 Despite the fact MB1.4.1 does not directly serve Heathrow it will provide Heathrow users with benefits. Passenger travelling from cities served by the New Line, such as Birmingham, to Heathrow via London will benefit from the reduced journey time from Birmingham to London. Option MB1.4.1 also impacts on mode shift from air and car. This is due to the end to end journey time being reduced significantly even including access time from the London terminal.

7.51 As can be seen from Table 7.8 the New Line benefits from the Intercity model, which excludes the impact of interlining demand, do not change between MB1.4.1 and MB1.7.1, this is because the New Line services are the same in each option. However the New Line benefits for MB3.4.1 are lower due to the longer journey times for passengers not travelling to Heathrow.

TABLE 7.8 HEATHROW OPTIONS SUMMARY OF BENEFITS

	£bn PV			
Element	**MB1.4.1**	**MB1.4.1** (with HA)	**MB1.7.1**	**MB3.4.1**
New Line Benefits	25.1	25.1	25.1	24.2
Heathrow User Benefits	0.0	0.1	0.4	0.6
Classic Line Benefits	2.4	2.4	2.4	2.3
Private Sector Impacts	-0.8	-1.0	-1.1	-1.3
Car externalities	4.1	4.2	4.4	4.5
Freight Benefits	0.7	0.7	0.7	0.7
Total PVB	**31.4**	**31.5**	**31.8**	**30.9**

Total may not sum due to rounding

7.52 MB3.4.1 has the greater benefits for Heathrow users as it generates more demand by routeing all the services via Heathrow. However, in comparison to the New Line benefits, the Heathrow user benefits are very low. In addition, the longer journey times associated with MB3.4.1 mean that the New Line Benefits are lower than the other options.

7.53 Providing direct links to Heathrow also increases mode shift to car compared with MB1.4.1 and, as would be expected, increases the mode share from air due to the addition of interlining passengers.

7.54 Overall MB1.7.1 adds £0.3bn PV of benefits to MB1.4.1 (with HA). However, MB3.4.1 shows a reduction in benefits of -£0.6bn PV.

Financial Impacts

7.55 The financial impacts of the Heathrow option assessment are set out in Table 7.9.

7.56 The addition of access to Heathrow in option MB1.4.1 (with HA) has increased demand and therefore revenue increases.

7.57 Although the New Line revenue for option MB3.4.1 is the same as for MB1.4.1 (with HA), MB3.4.1 abstracts less of this revenue from the classic line. It therefore has an incremental revenue value of £0.4bn PV. MB1.7.1 has the same level of abstraction from classic line as MB1.4.1 options as it operates the same service, but achieves additional revenue due to serving Heathrow worth £0.6bn PV.

7.58 The capital costs for both Heathrow options is higher than MB1.4.1 as additional infrastructure is required including an additional station, longer track (particularly MB1.7.1) and increased sections in tunnel.

7.59 Operating costs are also higher for both options. This is due to the additional services being run, especially the intensifying of non-London flows in the off-peak.

7.60 Overall both Heathrow options add another £3bn PV in costs to the scheme.

TABLE 7.9 HEATHROW OPTIONS SUMMARY OF FINANCIAL IMPACTS

Element	**£bn PV**			
	MB1.4.1	**MB1.4.1** (with HA)	**MB1.7.1**	**MB3.4.1**
New Line Revenue	39.4	39.9	40.5	39.9
Change in Classic Line Revenue	-16.0	-16.0	-16.0	-15.6
Subtotal PVR (Revenue transfer)	**23.4**	**23.9**	**24.5**	**24.3**
Capital cost (infrastructure)	24.1	24.1	26.0	25.9
Renewals (infrastructure)	1.4	1.4	1.4	1.4
Maintenance (infrastructure)	3.5	3.5	3.6	3.6
Train services (New lines)	10.4	10.4	11.3	11.4
Train services (Classic rail)	-0.6	-0.6	-0.6	-0.6
Indirect tax	2.6	2.7	2.8	2.8
Car externalities	-0.1	-0.1	-0.1	-0.1
Subtotal PVC	**41.3**	**41.4**	**44.4**	**44.4**

Total may not sum due to rounding

Transport Economic Efficiency (TEE) Results

7.61 Table 7.10 presents the economic performance of the Heathrow options, through quantifying scheme costs and benefits over a 60-year appraisal period.

TABLE 7.10 HEATHROW OPTIONS ECONOMIC RESULTS SUMMARY

	£bn PV			
Element	**MB1.4.1**	**MB1.4.1** (with HA)	**MB1.7.1**	**MB3.4.1**
Present Value of Benefits	31.4	31.5	31.8	30.9
Present Value of Costs	41.3	41.4	44.4	44.4
Present Value of Revenue Transfer	23.4	23.9	24.5	24.3
Net Present Value	13.5	14.0	12.0	10.8
Benefit to Cost ratio	1.8	1.8	1.6	1.5

7.62 Including Heathrow access to MB1.4.1 (MB1.4.1 with HA) adds slightly to the Present Value of Benefits, but also increases the Present Value of Costs therefore the BCR remains the same. However the Net Present Value is higher with Heathrow access due to the additional revenue achieved.

7.63 Of the two Heathrow options, option MB1.7.1 achieves the best BCR, however they are very similar. The Net Present Value is also higher for Option MB1.7.1 as it achieves higher benefits than MB3.4.1 and slightly higher revenue.

7.64 Although these BCRs are above the DfT guidance threshold, when compared to Option MB1.4.1 it can be seen that the addition of Heathrow is detrimental to the overall case.

7.65 Due to the uncertainty surrounding the competitive response of airlines the New Lines strategic business case has not included any benefit arising from changes in flight numbers. At this stage of project development this conservative assumption is thought to be appropriate and as the scheme is further developed this issue should be considered in more detail.

7.66 However aviation also has significant ‘external costs’, such as its impact on air quality and noise levels near airports and carbon emissions. A consequence of the assumption of no competitive response is that the benefits of a potential reduction in aviation activity are not captured. When considering externalities however, there are further difficulties associated with anticipating the response of the airlines. For instance, if service frequencies were reduced on routes competing with New Lines, would the aircraft be redeployed on other routes? By contrast, the impact of modal shift from car, and its associated external benefits, is much easier to predict and our business case includes a quantification of this effect using the standard WebTAG methodology.

7.67 The likely competitive response would be different in different New Line scenarios. Most significantly, serving Heathrow airport with high-speed trains would make it more likely that service frequencies would be reduced. This is because it would allow Rail to compete with both the domestic internal market and the ‘interlining’ market. Although our assessment suggests that the incremental case for serving Heathrow is detrimental to the overall case, if the competitive response of the airlines was to significantly reduce service frequencies, the benefits of this in terms of reduced noise and emissions might strengthen the case. Within the Heathrow options, however, it is unlikely that consideration of the competitive response will change the relatively better performance of the diverging main line option over a routeing via Heathrow.

8 HS1 Options

Introduction

8.1 A connection to HS1 could be provided from the New Line to enable operation of through train services to and from destinations north of London. These could be:

- Domestic services running to Stratford, Ebbsfleet and north and east Kent; or
- International services through the Channel Tunnel to European destinations

8.2 The ease and relative cost of providing connections to HS1 will be influenced by the approach route and choice of London terminus. Similarly the benefits will depend on where the London terminus is actually located. If it were located in the St Pancras/ King's Cross area then the benefits of through running to HS1 may be relatively small. Many passengers could experience better journey opportunities by changing at St Pancras onto Eurostar or Southeastern services. Were the New Line terminus be located more remotely from St Pancras then the benefits may grow, but so would the cost of making a physical connection between the New Line and HS1.

New Line International Services

8.3 Unless custom and security rules were relaxed it would be necessary for New Line platforms, served by international trains, to be segregated with customs and security check arrangements provided to mirror that currently provided at St Pancras. This would add significantly to the cost as separate platforms would be needed at, say both, Manchester and Birmingham. It is unlikely that the arrangements, such as that used at Lille International, where the same platforms are used for both international and domestic trains, but with separate entrances and exits for the two passenger groups and a 15 minute 'sterilisation period' of the platforms between domestic and international trains would be acceptable in the UK.

8.4 If however, trains from the New Line had direct physical access to St Pancras International platforms 5-10, then it would be possible for trains to reverse here. This could be achieved either without opening the doors and effectively non-stopping, or alternatively operating as a through train, say between Birmingham and Paris with a station stop in London to pick up outbound and set down inbound. All passengers would have to remain 'airside' for security and customs purposes, if customs and security rules remained unchanged. Utilisation of the St Pancras domestic platforms 1-4 (MML) and 11-13 (CTRL DS) is probably too high to consider reversing additional domestic services to and from the New Line here. Indeed the physical geography and approach layout to the CTRL DS platforms would rule out their use anyway.

8.5 Running through services to and from HS1 would be similar, in operating terms, to connecting to the classic line network and therefore it would be prudent to assume that the total New Line capacity is reduced by two tph as described earlier. It should be noted that HS1 will soon have the challenge of running an intensive commuter operation, 8tph in the peak, operated with Class 395 units that have very different performance characteristics to the international services operated with Class 373 units on the same lines. This in itself represents another challenge if matching paths between the two routes are to be found.

8.6 For these reasons two scenarios have been considered for connection to HS1:

- Scenario 1 assumes that New Line services run into St Pancras allowing direct easy interchange onto HS1 services. In this Scenario there is no requirement to change existing HM Customs arrangements.
- Scenario 2 assumes that New Line services to and from Paris via HS1 run into the International platforms at St Pancras where the trains would reverse in both directions. During the reversal domestic and international passengers will join and alight. In this Scenario existing HM Customs arrangements would require to be changed to facilitate this. It should be noted that this option is unlikely to be operated due to the significant difficulties in developing a reliable timetable that has this level of interaction across long distance lines. This option is designed as a 'best possible case' to determine whether there is any rationale to continue considering New Lines services to Europe.

8.7 Both of these scenarios assume that the New Lines London terminal is at St Pancras. Significant further work is required before it can be confirmed if this is possible and / or appropriate.

Potential demand

8.8 Indicative forecasts have been made of the demand that would switch from air to rail from four principal UK cities; Birmingham, Manchester, Glasgow and Edinburgh to Paris and Brussels.

8.9 A simple mode share model has been developed through analysis of rail and air demand on the London-Paris and London-Brussels markets. The results should be treated as "indicative estimates" only as they have not been modelled to the same detail and rigour as the domestic new lines models.

8.10 Table 8.1 sets out current (2007) and forecast (2030) air and rail demand between the UK regional cities and Paris and Brussels. Total air demand is currently around 1.5 million, rising to 2.9 million in 2030 according to DfT forecasts. Growth is broadly comparable across the six flows. The mode split model has been used to infer the rail demand on the same flows both now and in 2030. The current total rail demand across the six flows is estimated at 61,000, giving an overall share by rail of 4%.

TABLE 8.1 ANNUAL AIR DEMAND (000S) TO PARIS AND BRUSSELS

From	To	2007		2030	
		Air	Rail	Air	Rail
Birmingham	Brussels	160	9	321	18
Manchester	Brussels	149	2	321	4
Scotland	Brussels	119	0	277	0
Birmingham	Paris	348	41	827	97
Manchester	Paris	485	9	823	14
Scotland	Paris	258	0	333	0
Total		1,519	61	2,902	133

8.11 The mode split model has been used to understand how the introduction of New Lines to London would affect the rail share of these flows. No account has been taken of changes in trip patterns or new trips (frequency effects). Rather than show a single forecast, a range has been provided given the uncertainties in the forecast process.

Demand Forecasts for Scenario 1

8.12 The forecasts for scenario 1, where passengers can interchange from New Line services to HS1 are shown in Table 8.2. Overall, through connections may increase the demand on New Lines by between 0.5 million and 0.9 million trips per annum, a mode share by rail of between 16% and 30%. Share is highest on Birmingham related flows, reflecting its proximity to London and HS1. Here rail will have around 9% of the market by 2030, but New Lines would increase this to 29%-46%. Rail shares for Manchester are negligible in 2030; adding New Lines increases this to 9%-21% overall. Shares for Scotland remain at very low levels even with New Lines.

TABLE 8.2 FORECAST IMPACT OF NEW LINES ON PARIS / BRUSSELS DEMAND (000s) – SCENARIO 1

From	To	2030 DM		2030 DS	
		Air	Rail	Air	Rail
Birmingham	Brussels	321	18	278 – 222	61 – 117
Manchester	Brussels	321	4	304 – 269	21 – 56
Scotland	Brussels	277	0	273 – 268	4 – 9
Birmingham	Paris	827	97	617 – 459	307 – 465
Manchester	Paris	823	14	756 – 646	81 – 191
Scotland	Paris	333	0	326 - 405	7 – 28
Total		2,902	133	2,554 – 2,169	481 - 866

8.13 These forecast shares are consistent with the three hour threshold commonly used to define the point where rail becomes competitive with air. Trips between Birmingham and Paris / Brussels with New Lines will be around 3 hours (plus London interchange) and hence the forecast share of up to 46% is reasonable. Manchester is an additional 20 minutes, making journey times 3 to 3½ hours (plus London interchange) becoming uncompetitive with air, hence the lower mode share of 21% at most. Scotland remains uncompetitive with air, with rail journey times of around 4½ hours even with New Lines.

Demand Forecasts for Scenario 2

8.14 The forecasts for scenario 2, where through services are provided through to Paris are shown in Table 8.3. The forecasts shows that even if through services were provided to the continent the majority of the Scottish – European market would remain captive to air, with the share by rail around 35% at most. Conversely, rail would have the largest share of demand on the Birmingham – Paris route. Rail demand on the Manchester based routes peaks at 45%. Overall, the additional demand on New Lines would be 0.8 to 1.1 million trips per annum in 2030.

TABLE 8.3 FORECAST IMPACT OF NEW LINES ON PARIS DEMAND (000s) – SCENARIO 2

From	To	2030 DM		2030 DS	
		Air	Rail	Air	Rail
Birmingham	Paris	827	97	427 - 305	497 - 619
Manchester	Paris	823	14	588 - 463	250 - 375
Scotland	Paris	333	0	289 - 245	44 - 88
Total		1983	111	1304-1013	791-1082

8.15 There are a number of complications in providing through services to the continent;

- Delays on other rail networks could be imported onto the New Line, significantly reducing service reliability; and
- There are capacity constraints on both High Speed 1 and the proposed New Line that could prevent through services being timetabled.

Impacts on the case for New Lines

8.16 The level of demand identified in Scenario 1 would only accrue if the New Line terminal was located at St Pancras. However given the large uncertainties around the location of the central London terminal (which would have a material impact on these forecasts) the benefits and revenue accruing to New Lines from this additional demand has not been included in the appraisal. In any event, the additional demand is unlikely to be more than 1% of overall New Lines demand and as such is not material to demonstrating a case for New Lines.

8.17 However, if the New Line London terminal was in close proximity to London St Pancras international, passengers could easily transfer between the New Line and high speed services which could lead to up to half a million additional trips a year shifting from air to rail at no additional cost or risk to the overall New Line scheme.

8.18 To estimate the benefit of providing a through service to the continent (scenario 2), the demand of scenario 2 was compared to demand achieved in scenario 1 (as this demand would accrue anyway if the terminal was located at St Pancras). It is estimated that 300,000 to 400,000 journeys a year would travel on a through service to the continent, even if a dense network of services was provided. This assumes that Birmingham, Manchester and Scotland are all provided with direct services to Paris.

9 Statement of Outputs

Introduction

9.1 This document has set out the financial and economic case for a New Line. However, the key benefits of a scheme are not always best expressed in monetary terms. This section sets out the impact a New Line would have across a wide number of areas, using monetary and non-monetary measures. It outlines the key advantages and benefits of a New Line.

TaSTS Goals

9.2 To best illustrate how the benefits of the New Line align with government policy these improvements are considered using the five key goals outlined in the Department for Transport's "Towards a Sustainable Transport Strategy". These goals are:

- Maximise competitiveness and productivity of the economy – making best use of existing networks, targeted new infrastructure investments, adapting to changing demand;
- Address climate change – cut emissions of CO2 and other greenhouse gases through carbon pricing, technological innovation and removing barriers to action;
- Protect people's safety, security and health – addressing the negative impact on people's health, tackling crime and improving safety of users and workers;
- Improve quality of life – healthy natural environment and meeting people's expectations on comfort, convenience and quality of service; and
- Promote greater equality of opportunity – ensuring access to transport for everyone, and opportunities to redress inequalities and enhance social inclusion.

Maximise competitiveness and productivity

9.3 The New Line will significantly improve connectivity between major population and employment centres. This improved connectivity will boost economic output and reduce travel time.

9.4 A significant amount of literature over the last few years has addressed the potential for transport to deliver Wider Economic Benefits (WEBs) - that is, additional benefits on the wider economy beyond the direct impacts. These wider economic benefits result from improved connectivity between economic centres. These benefits have not been included in the core business case. However, it has been estimated that these benefits could be worth between £3bn and £6bn to the UK economy for option MB1.4.1.

9.5 Furthermore the New Line will lead to a reduction in travel time between city centres for users of the New Line. This is the equivalent of 50 million hours per annum by 2030. The classic line recast will also lead to journey time benefits equivalent to 6 million hours per annum by 2030.

Address climate change

9.6 The increased attractiveness of rail resulting from the introduction of the New Line, will encourage people to transfer from congested highways. It is estimated that a reduction in CO_2 emissions of 39 thousand tonnes per annum could be achieved by 2030. This is due to the impact of reduced car travel (responsible for 19 thousand tonnes of the overall reduction) and the removal of freight movements from the highways (responsible for 20 thousand tonnes of the overall reduction).

9.7 High speed rail will also provide a credible alternative to domestic air travel. For Option MB1.4.1, the New Line is estimated to lead to a decrease in air journeys of 3.6m per annum by 2030.

9.8 It should be noted that no resultant reduction in carbon emissions is included in the business case assessment due to the uncertainty regarding the competitive response of airlines. For example BA operates a number of domestic flights, in many cases they charge very little for the domestic leg of a journey and make a profit from the trunk route part of the journey. This provides them with a competitive advantage over airlines that do not operate domestic flights e.g. Virgin. For this reason BA may wish to retain its domestic network and may continue to operate these services. Alternatively airlines may decide to leave the domestic market and use these take off and landing slots for more valuable long distance traffic. Due to the inherent uncertainty in this area no benefits were included in the economic assessment. Further work is also being undertaken to determine the carbon emissions of a New Line itself. Once this work is complete a fuller picture of the impact can be developed

Protect people's safety, security and health

9.9 Statistically rail has been shown to be a significantly safer mode of travel than car. A New Line will encourage travellers to use rail instead of road, thereby reducing the number of accidents each year. In 2030, it has been estimated that this impact could lead to safety benefit equivalent to 18 fatalities for Option MB1.4.1 and 14 fatalities in the case of MB1.6. The removal of freight from roads is also expected to have a safety benefit equivalent to 1 fatality a year.

Improve quality of life

9.10 New rail lines will offer the travelling public a step-change in the transport experience – both for existing users and those switching from alternative modes. The New Line will provide a more comfortable, convenient and faster service.

Impact on Crowding and Congestion

9.11 The DfT's 2007 White Paper "Delivering a Sustainable Railway" sets out the number of additional passengers that will need to be carried by 2013/14. For services into London Euston this equates to 3400 passengers in the peak three hour period and 1600 in the high peak hour. Although the New Line is not assumed to be in operation until 2020, it will provide 9100 seats per hour into the New Line London terminus. Crowding can be measured by multiplying the time spent in crowded conditions by a penalty based on the level of crowding. Using this measure the New Line will lead to a reduction in crowding worth 4.2 million crowded hours per annum by 2030, in the case of MB1.4.1.

9.12 As well as reducing train crowding the New Line will also improve road congestion by reducing the number of car kilometres travelled. The forecast reduction in car km in 2030 by road type are outlined below for Option MB1.4.1. In total car users benefit from journey time benefits worth 12.4 million hours a year.

TABLE 9.1 2030 REDUCTION IN VEHICLE KM (MILLIONS) BY ROAD TYPE

	Car	Freight	Total
Low Congested Motorway	27	26	53
Medium Congested Motorway	134	19	152
High Congested Motorway	57	15	73
Conurbation - Trunk & Principal	99	2	101
Conurbation - Other	121	1	121
Rural & Urban - Trunk & Principal	235	8	243
Rural & Urban - Others	negligible	negligible	negligible
Total	**673**	**71**	**744**

Impact on Performance

9.13 The same White Paper set a PPM target of 92% to be achieved by the end of control period 4 for Intercity services. The introduction of a New Line will have a significant positive impact upon rail reliability. This will be achieved in two main ways:

- Due to the segregated, homogenous nature of services on a New Line, they should be much more reliable than classic lines used by mixed traffic. Therefore passengers on the New Line will have significantly improved reliability of travel; and
- The introduction of a recast timetable will lead a greater uniformity of service on the Classic Line, potentially improving performance.

9.14 The improvement in service reliability will depend on a number of factors. In the case of services on the New Line, for Option MB1.4.1 where services are wholly on the New Line almost perfect reliability could be achieved due to a combination of new infrastructure and segregated operation. However, in the case of Option MB1.6 the benefits would be less marked. When services penetrate onto classic line infrastructure, two key performance risks are introduced. The service will be operating over old infrastructure which is likely to be less reliable than the New Line. More critically the service will also have to interact with other services over the Classic Line. If there are problems with these services this would have a knock on effect on the reliability of New Line services.

Impact on Other Measures of Quality of Life

9.15 The development of a New Line is also expected to have benefits in terms of noise. Although rail travel can present a noise nuisance in itself, the impacts are more isolated in terms of location (confined to a rail corridor) in comparison to road noise. A much larger number of car journeys is also required to move a set number of people.

Therefore increased rail travel leads to a reduction in noise nuisance per trip. This benefit is expected to be worth £3.8m an annum by 2030 (2009 prices) for Option MB1.4.1 and £3.4m an annum for Option MB1.6.

Promote greater equality of opportunity

9.16 The New Line improves connectivity between regional cities, which will enable the further development of areas away from London and the South East. The New Line also enables a recast of the classic line timetable. As well as providing more capacity for commuters, this also improves links for smaller regional centres. Links will be improved between these centres and London, and for flows from regional centre to regional centre. In the case of Option MB1.4.1, 100 additional flows would be served with a direct West Coast train, compared to the do minimum. Examples of such flows include:

- Blackpool North to and from London;
- Wolverhampton, Macclesfield and Warrington to and from Milton Keynes;
- Telford Central and Shrewsbery to Coventry;
- Glasgow Central to Wolverhampton; and
- Runcorn and Crewe to Sandwell and Dudley.

Summary

9.17 Table 9.2 below summarises the benefits of the scheme outlined in this section

TABLE 9.2 SUMMARY OF STATEMENT OF OUTPUTS

Target	Benefits
Maximise competitiveness and productivity	Wider economic benefits of £3bn to £6bn NPV
	Reduction in travel time for New Line users of 50m hours per annum by 2030. Reduction in travel time for classic line users of 6m hours per annum.
Address climate change	39 thousand tonnes of CO2 emissions a year avoided due to transfer from highway by 2030
	Decrease in air domestic air journeys of 3.6m per annum by 2030
Protect peoples safety, health and security	Safety benefit equivalent to 19 casualties a year by 2030 (Option MB1.4.1)
Improve quality of life	Crowding benefit of 4.2m crowded hours by 2030 (Option MB1.4.1)
	Total reduction in car km on of 774m km per annum by 2030. (Option MB1.4.1) And car user journey time benefits of 12.4m hours per annum by 2030.
	Noise benefit equivalent to £3.8m per annum by 2030 (Option MB1.4.1)
Promote greater equality of opportunity	100 additional flows provided with a direct West Coast service to and from economic centres.

10 Environmental Impact Assessment

General Environmental Impact of a New Line

10.1 There is significant debate surrounding the environmental impact of high speed services. Higher speeds significantly increase electricity consumption, and the construction of a new line will entail significant resource commitments. However high speed rail does have the potential to divert passengers from other, more energy intensive modes.

10.2 Due to the importance of this debate AEA Technology has been commissioned by Network Rail to fully consider the environmental impact of a new line. In particular this commission is considering the following issues:

- Performance (energy consumption) of rolling stock;
- Seating occupancy levels in high speed vs. conventional services;
- Estimated direct and indirect greenhouse gas emissions from diesel and electric rolling stock (both in current and likely future electric mix);
- Estimated emissions resulting from the construction, maintenance and decommissioning of rolling stock;
- Information relating to the potential energy consumption/emissions resulting from construction of new infrastructure;
- Materials used in the construction of infrastructure (and the energy/emissions per kg of these materials); and
- Energy use/emissions resulting from infrastructure construction activities.

10.3 The outputs of this Strategic Business Case will feed into the study by AEA.

10.4 Given this ongoing work the rest of this section considers the environmental impact associated with the high level routes under consideration in this paper. Only an indicative consideration is given to the likely impact on global environmental issues e.g. the release of greenhouse gases.

Issues Related to the chosen scheme

10.5 This section examines the possible effects of the development of a new high speed railway line on high-level environmental resources (i.e. designated areas of protection important at the nation and international levels).

10.6 The approach used is based on the DfT's guidance on appraising transport options against the Government's environmental objective for transport (webTAG), which deals with impacts on both the built and natural environment and on people. Eight of the ten environmental sub-objectives, which are derived from the environment objective to protect the built and natural environment, have been examined[8]. This is also consistent with the requirements of Strategic Environmental Assessment (SEA) legislation at UK and European level.

10.7 The main conclusions of the appraisal are set out in Table 10.1 below. This shows that the development of the New Line is likely to have a slight or moderate adverse impact on noise, landscape, heritage, biodiversity and the water environment. It is expected to improve local air quality and greenhouse gas emissions.

TABLE 10.1 SUMMARY CONCLUSIONS OF ENVIRONMENTAL APPRAISAL

NATA sub-objective	Assessment
Noise	Moderate adverse effect
Local Air Quality	Slight beneficial effect
Greenhouse Gases	Moderate beneficial effect
Landscape	Moderate adverse effect
Heritage	Slight adverse effect
Biodiversity	Slight adverse effect
Water Environment	Slight adverse effect

Assumptions

10.8 The following operational assumptions, consistent with other workstreams in the study, have been used to enable the appraisal of environmental effects at a strategic level:

- The option alignments are assumed to fall into a wide band based around 'crow-flies' direct route between the main termini and other locations served, with the existing WCML alignment used north of Preston.
- The route is assumed to be electrified. Although the rolling stock type has not been specified, it is assumed to have AGV traction and performance characteristics. This would provide some reduction in energy use on that achieved currently on HS1 with Class 373 Eurostar units.
- A maximum route planning capacity of 16tph in each direction has been assumed (14tph in each direction where there is through running to the classic lines).
- A maximum line speed of 200mph (320kph).

[8] Two further sub-objectives, i.e. physical fitness and journey ambience, are considered to be inapplicable in the context of this study.

10.9 It should also be noted that:

- The analysis on which this appraisal is based focuses on designated areas of protection. However, this does not mean that significant environmental effects will not occur in other places at the local level; and
- This analysis relates to environmental effects relating to the physical presence of the rail infrastructure and the operation of high speed trains. Significant environmental effects may occur at the local level during construction works also.

11 Risks and Opportunities

Risks

11.1 At this stage of project development there is a significant level of uncertainty surrounding the potential scheme and the external environment in which it will operate. This Strategic Business Case provides a best estimate of expected outcomes given the information available at this stage. However it is expected that there will be some divergence between what is expected and actual outcomes. As a result it is important to identify and consider potential risks.

11.2 In addition, in order to assist decision makers take decisions with confidence, they need to understand whether within a margin of uncertainty, one option performs better than another, namely whether there is ‘clear water’ between them, e.g. even if it can’t be established that the answer is 16, it can be established that “14-20” is greater than “5-9”.

11.3 In order to address uncertainties around key parameters (e.g. GDP growth, X and Y) the sensitivity of key performance indicators (e.g. BCR, NPV) to plausible variations is tested. The results provide an indication of the robustness of the case for an intervention.

11.4 A strategic risk register has been developed and maintained throughout the commission with specific focus on cost and deliverability risks. During the detailed assessment phase further risks have been identified relating to the accuracy of demand forecasts and the magnitude of benefits actually realisable.

11.5 This Section describes the principal risks identified, how they could affect delivery of the new lines programme and how this has been reflected in the Strategic Business Case process.

Capital cost risks

11.6 A work breakdown structure was produced in order to identify the principal cost centres for this major programme of works. Unit rates for each work element were sourced from Network Rail’s estimating database. Contractors preliminaries, overhead and profit have been added in order to provide estimates of construction cost which are comparable with out-turn costs presently being incurred for similar work packages. Design costs have been attributed according the asset discipline, for example signalling is more expensive than civils design.

11.7 Considerable effort has been expended to ensure that all potential sources of cost have been included in the base cost estimate. For example land acquisition, utility diversions, possessions and isolations, TOC / FOC compensation and costs for the acquisition of the necessary consents to construct the route have all been included in the base estimate. Overlaid on this is a 2.5% uplift to provide some contingency for unmeasured items.

11.8 The non construction cost elements have been checked through bottom-up analysis, i.e. estimating the number of staff actually required to deliver such a programme of works. This check verified the non construction costs as applied at 35% of the construction costs was conservative. No assumptions have been made in the estimate regarding "technical innovation" to provide cost efficiency. Standard cost rates from Network Rail which are based on actual out-turn costs have been used.

11.9 Optimism Bias has been applied In accordance with the Green Book Guidance at the pre-feasibility rate of 66% to the total base cost, i.e. to both construction and non construction costs. No areas of known cost have been attributed as being covered by optimism bias, therefore the sum purely covers estimating errors, project risks and contingency.

11.10 At this stage in the project lifecycle the route alignment nor station locations are fixed. The costs for station construction and tunnelling are high and as such, the cost model is extremely sensitive to changes in the volumes of these. In order to test the robustness of the optimism bias provision, a sensitivity test was run on the capital cost for each route option to understand the impact of significant changes to tunnelling and station construction. The tests are:

- Increased the unit cost of tunnelling by 50% from £49m to £73m per km;
- Increased the volume of tunnelling required on each route option (amount detailed in table below);
- Doubled the estimated base cost (excluding OB) of the London terminus from £1Bn to £2Bn; and
- Doubled the estimated base cost (excluding OB) of each country end termini from £265m to £530m;

11.11 The outputs of the test are shown in Table 8.1 below:

TABLE 11.1 CAPITAL COST ESTIMATE - TUNNEL AND STATION COST INCREASE TEST

Option	Base cost (£bn)	Optimism Bias at 66% (£bn)	Base tunnel distance (km)	Revised tunnel distance (km)	Increase in Base cost (£bn)	Remaining Optimism Bias (£bn)
MB1.0a	9.0	6.0	25	80	5.5	0.4
MB1.0b	9.5	6.3	25	85	5.8	0.5
MB1.1	11.1	7.3	25	93	6.7	0.6
MB1.2.1	19.3	12.8	55	165	11.0	1.8
MB1.3	12.6	8.3	35	105	7.2	1.1
MB1.4.1	20.5	13.5	55	173	11.9	1.7
MB1.6	12.7	8.4	35	105	7.2	1.2
MB2.0	9.9	6.5	39	84	5.5	1.0

11.12 The table above shows that even if the unit cost of tunnelling increases by 50%, the volume of tunnelling increases, and the cost of the London termini and country end termini doubles, the total additional cost is still within the contingency included in the appraisal in the form of optimism bias. This test demonstrates these large increases in the base cost can be accommodated within the allocated optimism bias provision for each option.

11.13 This particular test was chosen because most of the key cost risks to the scheme will, if realised, result in increased tunnelling volumes and / or tunnelling costs and / or station costs. Those risks are:

- Consents to construct the works are made conditional on more tunnelled route to mitigate environmental impacts;
- Larger tunnel bores to accommodate specific rolling stock;
- Tunnelling in areas of poor ground conditions;
- Constraints on the availability of suitable station sites in city centre locations result in increased land, disruption or construction cost. Availability of a suitable site is a specific risk to the estimated cost of £1Bn (excluding Optimism Bias) for the London terminus because of the costs of disruption and working in a constrained site rapidly become very significant; and
- Optimum station site from a construction and operational perspective requires significant work to improve other public transport connections.

Benefit risks

11.14 The benefits assumed through the assessment process have been forecast using DfT guidance. Changes to the underpinning assumptions will have an impact on the level of benefits forecast. In order to understand the magnitude of the impact, a number of sensitivities to the assessment have been run. These are reported in Section 6. The key risks identified that affect the Strategic Business Case and the suggested mitigating actions are :

- Air travel does not follow predicted pattern of growth undermining assumptions and therefore scheme viability. The impacts of this risk have been modelled as a sensitivity and lead to a reduction in the BCR of Option MB1.4.1 to 1.7:1.
- Different pattern of socio-economic change means that the preferred option is no longer the best. This could also be linked to government policy on land use changing. Both will result in an undermining of the Strategic Business Case assumptions and the scheme viability. This risk can only be managed through ongoing monitoring and maintaining flexibility to manage such changes;
- Affordability constraint requires a change in scope to the functionality or delivery timescales for the project. This risk is potentially exacerbated by the recent provision of significant financial support to the banking sector. To mitigate this risk, the next stage of the project should consider the potential for phasing the scheme. The project schedule should be cost loaded in order that an accurate funding plan can be prepared and consulted;
- Delays are incurred in selling access rights to make full and efficient use of the new network, resulting in lower revenue returns. The commercial strategy for the

selling of access rights and required revenue returns to be developed in parallel with GRIP 2 and 3 design. This will ensure the infrastructure specification is attractive and efficient for operators to use. Commercial strategy should also consider how access rights should be bid for. Consultation to take place with DfT to ensure fit with EU legislation;

- The key requirements for the new rolling stock are not captured properly. This results in changes to scope once design development has commenced or leads to incorrect performance assumptions being used in timetable and business case modelling. This risk can be managed by making maximum use of standard systems and components. In addition, early engagement with a train operator / manufacturer would permit specifications to be developed on an informed basis;

- Other projects delivered by the DfT undermine the New Lines Strategic Business Case. The project would then stall whilst strategic plans for resolving capacity issues are agreed between DfT and Network Rail. The consequential delay will add to project cost and defer realisation of benefits. Close liaison should be maintained with the DfT on strategic requirements for the UK rail network - both classic and potential high speed lines.

- The Strategic Business Case is undermined because delivery costs are underestimated. The delivery programme is delayed whilst the funding gap is addressed resulting in deferment of benefit realisation and further increases to project cost through the delay. As described above, estimates of capital cost used in the assessment are based on out-turn costs of recent and comparable construction projects. No assumptions for "efficiencies due to improved technology" or "innovative procurement" have been incorporated. Additionally, no costs have been knowingly assumed as being contained within the 66% optimism bias provision.

- A general risk exists that Strategic Business Case outputs are taken too literally by the project team when seeking to specify the key project outputs and requirements. The loss of such "sense checks" will result in a more poorly defined project which does not meet the optimum requirements - less benefits may then be realised from the investment committed. To mitigate this, the Strategic Business Case should run a number of sensitivities and the project team clearly communicate the results and how to interpret them.

Programme risk

11.15 The most likely sources of programme delay will result from failure to maintain continuity in progressing through the project lifecycle. This risk exists at all stage gates in the lifecycle when a decision to proceed to the next phase must positively be confirmed. However, two phases are of specific risk:

- Obtaining the necessary powers to construct the works – the preferred route to obtain the required powers needs to be defined, timescales agreed and resources allocated. Investment in pro-active and open consultation during the design development phase of the programme will assist the Public Inquiry process;

- Obtaining the funding required to delivery the programme – specifically once the necessary consents have been obtained. At this point the funding commitment changes from that which can be managed on a stage by stage basis to a full commitment to allow construction contracts to be managed.

Construction risks

11.16 At this phase in the project lifecycle, most construction risks can be avoided through careful route selection and mitigated or transferred through careful specification. The key is that sufficient time is provided to fully optioneer the potential route alignment options and that site surveys and ground investigations are conducted and their results form part of the decision making process for selection of a preferred alignment. The largest factors affecting project cost are tunnelling and the locations and specification of the terminus stations. Both of these also present the largest construction risks both in terms of safety, complexity and programme.

11.17 The other key construction risk this that the market does not have sufficient skilled resource to efficiently deliver works in the required timescales. This would result in delays to programme and / or uncompetitive procurement competitions due to the lack of competent bidders. This risk can be mitigated through regular market sounding and early development of contracting strategy - commence in GRIP stage 2.

Political risks

11.18 The political risks generally fall into two categories:

- Decision making is delayed or ineffective because of the large number of influential stakeholders and affected parties who require consultation. This can only be managed by agreeing clear and unambiguous objectives to be delivered by the programme with the key stakeholders prior to commencing GRIP stage 2. The large numbers of stakeholders and volume of communication which will be required will require provision of a dedicated and well resourced consultation team; and

- Changes in governmental policy force change to project timescales, remits or specifications. A key area subject to external influence will be the preferred alignment for which construction powers are sought. It is suggested that prior to progressing to GRIP stage 2 the delivery programme for the remainder of the design development phase, i.e. to GRIP 4 be planned out in detail and consulted with the stakeholders.

11.19 The location for a central London terminus will be a compromise between obtaining efficient access to the north and west out of London, i.e. with minimal tunnelling and connections within the London area. Difficulties in distributing passengers from a central London station may lead to significant increases in cost or TfL opposition to the scheme which will result in programme delay. Consistent and early consultation to involve TfL and DfT is required to establish the key requirements for the programme. Once these are agreed, it is required that their investment be maintained during the design development phase.

Opportunities

Additional Intermediate Stations

11.20 In the most developed Options MB1.4.1, and MB3.4.1 there are only two and three intermediate stations respectively. As discussed previously, additional stations on the core route section reduce route capacity and impose a significant journey time penalty of six minutes for each station stop. However, as has been demonstrated by Warrington and Preston, they can add value to the case. Until the route alignment is better known it is not possible to consider further station stops at this stage. Once route alignment options are clearer then it may be worth considering if other station stop opportunities exist such as:

- Where the New Line crosses other major rail or road routes or near airports;
- In the catchments of the major cities; and at
- Other regional cities or large towns where the New Line route alignment passes.

Additional Regional Services

11.21 The Strategic Business Case has evaluated the benefit of some non-London inter-regional services. As has been demonstrated these can add value. Once the best service option is chosen it will be possible to consider the addition of further non-London inter-regional services on the New Line e.g. Liverpool, Warrington and Birmingham.

11.22 At a more local level the New Line route capacity has significant 'white space' available. As noted above there are additional inter-regional services to be considered as potential users of this capacity. In addition it might be worth considering using the New Line to address some of the capacity constraints on the approaches to, and at the terminus stations of, the major cities including Birmingham, Manchester, Liverpool, Glasgow and Edinburgh, which all have constraints today.

Freight Services

11.23 The operation of freight trains on the New Line has not been considered. In most options there is no spare capacity to run freight trains during the modelled period of operation, although the classic line recast has been used to provided additional freight capacity. It is possible that freight could use the line outside the period of passenger operation.

Hours of Operation

11.24 This study has only looked at New Line services that start their journey between 06:00 and 22:00. It has been assumed that any operation beyond this time envelope is cost benefit neutral. At the next stage of the programme it will be worth considering the value of extending the hours of operation and even a limited 24 hour service for the principal market e.g. 1tph London-Birmingham-Manchester, using the proposed single line bi-directional working capability which is costed and assumed to be provided.

Route Choice

11.25 Section 3 considers the impact on journey times of using existing classic line route corridors and Section 7 and 8 consider the ease of providing connections to Heathrow and HS1. If it were possible to utilise one of the classic line route corridors it may represent a significant cost and programme opportunity, particularly in urban areas where tunnelling could be avoided.

London Terminus

11.26 Identifying a suitable location for the New Line London terminus has been identified as one of the top three risks to the programme. A number of schemes are underway, or under consideration, which may facilitate an existing London station being modified and enhanced for New Line train services.

11.27 In each case it would be necessary to displace existing services that terminate at the station today. The two most obvious examples are London Euston and London St Pancras/King's Cross.

London Euston

11.28 For London Euston to accommodate New Line trains it would be necessary to displace existing services. In the less developed New Line options with services only between London and Birmingham/ Manchester there remain many long distance Intercity services. As passengers move to the New Line, as additional services are added, the character of the WCML fast line service changes from being an Intercity operation to a regional service, more akin to the service that operates from London to longer distance destinations south of the Thames.

11.29 In most of the New Line options considered in this study there remains a significant quantum of fast line services, albeit formed in the off peak with shorter trains than are operated today. These trains also enable growth in medium and long distance commuting and improve the connectivity between many stations en route.

11.30 However, it is quite possible that a better case could be made for the New Line if some of these opportunities were set aside to allow the capacity at Euston to be used for New Line services.

11.31 As discussed in the Demand-Capability Gap Analysis report, it might be possible to connect the WCML to the GWML in the Willesden/ Old Oak Common area. This would enable some London Midland inner services that currently operate to and from Euston to be diverted into Crossrail. In addition, it is possible that the DC line services could be replaced by the Bakerloo line north of Queens Park and/or DC services diverted to the North London Line via Primrose Hill. Each of these ideas are worthy of early investigation.

London St Pancras

11.32 If the London Central terminus station is St Pancras the MML domestic platforms could be used, to connect with the Underground, Thameslink, ECML, Eurostar and Kent domestic services and possibly Crossrail Line 2 at a future date. This could be enabled by displacing all existing East Midlands train services currently operating to and from St Pancras. These could be replaced by:

- A New Line service from St Pancras to Leicester, Nottingham and possibly beyond to Sheffield, Leeds etc; and

- Extension (with electrification of the MML) of Thameslink services north of Bedford to Wellingborough, Kettering, Corby, Market Harborough and Leicester.

11.33 The above list is neither exhaustive, or necessarily the right response, and as such, it is illustrative

The New Line to Birmingham, Manchester and Scotland as part of a Network

11.34 Were the New Line to be considered as part of a network, or programmed as the first stage of a planned network, then it might be possible to consider different services, routes and infrastructure strategies and address the risk associated with construction of a major terminal in central London.

The Opportunity in London

11.35 London presents one of the more significant challenges in developing one or more New Lines. Access to central London and good connectivity to Greater London and the South East regional market is very important in meeting the objectives of the programme. Indeed, a New Line that does not provide direct access to the target destinations with short walking, taxi, bus or Underground links will not be as effective in meeting the objectives as one that does.

11.36 However, London itself could present an engineering, planning and affordability challenge that delays or prevents the programme being progressed. This study has earlier considered the London terminus and approach routes and these were briefly described in paragraph 3.33 onwards. In order to address some of the difficulties it may be necessary to consider alterative ways of solving these problems. An option might be to run through London serving two London stations perhaps to the north and south of London. This would lead to improved accessibility to the New Line and might help overcome issues related to station location as a through station would have a smaller footprint than a terminal station.

11.37 A further examination of the opportunities described in this section should be considered at the next stage of programme development.

12 Conclusions

12.1 Through an examination of capacity constraints on the current rail network, and an analysis of markets, it has been established that the key targets to be served by a New Line are London, Birmingham and Manchester.

12.2 Option assessment was undertaken to determine the core route for the New Line. This identified the best performing core route option is between London and Manchester with a diverging main line to Birmingham with services between all three cities.

12.3 Even though the option links the top target markets, the economic analysis shows that the case for a route and service between London, Manchester and Birmingham alone appears marginal. However, this option has not been optimised as a stand-alone scheme. It includes infrastructure costs that a railway requiring just the capacity for eight trains per hour in each direction would not need.

12.4 When additional target markets are added to the core route, the incremental value means that the options perform better, all achieving BCRs above 1:1. The fundamental reason for this is that the majority of the core infrastructure costs can be offset against the increased overall revenue and benefits – making the incremental economic case very attractive (affordability being a separate matter to consider). The best performing options in economic terms are the full options (MB1.4.1 and MB1.6) which serve all the target markets including Scotland and increase the use of the potential line capacity. These options achieve comparable BCRs of 1.8:1 and 1.9:1 respectively.

12.5 Adding additional target markets to the line also gives the opportunity to address capacity on the West Coast Main Line (by enabling more services to be transferred to the new line, thereby freeing up more ‘useful and usable’ tranches of capacity that provide the freedom to better optimise the classic line services). This is especially true of MB1.4.1 as a self-contained option with no classic line running, as it would relieve capacity at the current significant pinch points across the WCML.

12.6 The New Line achieves considerable modal shift from road through all options. The options that run to Scotland also achieve modal shift from air, particularly the all New Line options, thereby providing support to the government’s climate change objectives.

12.7 From the two full options, MB1.4.1 has the highest Net Present Value (NPV). However, although offering excellent revenue and benefits, as well as addressing the broad objectives of this study MB1.4.1 also raises considerable affordability issues. MB1.6 delivers a similar BCR, but with a lower NPV and lower capital costs.

12.8 Options that serve Heathrow have also been considered. Firstly, by routeing the services in Option MB1.4.1 via Heathrow (Option MB3.4.1) or by providing a diverging main line to Heathrow (Option MB1.7.1) and extending two existing services to and from Heathrow. However these options had a negative effect upon the case for a New Line due to the proportional increase in costs being greater than the increase in benefits and revenue, hence producing a lower NPV and BCR than MB1.4.1.

12.9 Options for through train operation to and from High Speed 1 have also been considered. It was concluded that available capacity on the New Line would be best used for services to and from London Central, with improved onward connections for High Speed 1 domestic and international services.

Recommendation

12.10 The recommendation of this report is that there is a case to take the London to North West & Scotland corridor forward for further investigation. Due to the large capital costs involved, a phased approach to construction should be investigated to consider whether the full option could be built affordably and so avoid the preclusion of expansion as funding and financial resources become more available.

12.11 As the corridor is taken forward in the GRIP process, all the demand, revenue, benefit and cost estimates should be developed to a commensurate level and would benefit from further benchmarking against other tools and experience.