South Yorkshire PTE and East Midlands Councils

The Case for Upgrading and Electrifying the Midland Main Line

Technical Report

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1 Introduction

1.1 Introduction

This report sets out the case for the upgrade and electrification of the Midland Main Line (MML). The MML runs through Northamptonshire and four of the largest cities in England outside of London; Derby, Leicester, Nottingham and Sheffield. The MML is of strategic importance for the cities and areas that it connects, and their connectivity to London.

Electrifying and upgrading the MML offers the potential to reduce journey times between these key destinations, generating economic benefits and improving connectivity. The scheme package assessed within this report comprises a package of upgrades and the electrification of the Line. Delivering these Line upgrades and electrification in conjunction will offer a complete 'scheme package' to the Line. This scheme package, implemented in full will then allow the range of benefits and enhancements that can be added to MML to be fully realised given the strategic importance of the corridor.

1.2 Context

Stakeholders in the East Midlands and South Yorkshire have lobbied to secure £69m funding. This funding will deliver line speed improvements helping to cut journey times by eight minutes between London and Sheffield with smaller savings for intermediate stations. A Regional Growth Fund bid was prepared to secure some funding, but this application was unsuccessful. In addition to this funding, a further package of line speed improvements and other enhancements to improve capacity and reliability has been identified and stakeholders have also developed proposals to electrify the following route sections:

- Bedford to Sheffield via Leicester and Derby;
- Trent Junction to Nottingham; and
- Kettering to Corby.

Network Rail has previously completed an outline business case which demonstrated that the business case for the above scheme package was very strong, with revenue benefits outweighing operating and capital costs over a 60 year period. South Yorkshire PTE and East Midlands Councils have also identified a number of additional electrification proposals which would deliver important local and regional benefits, as well as in-filling gaps in the national network:

- Sheffield to Doncaster;
- Nottingham to Chesterfield via Langley Mill
- Sheffield to South Kirkby Junction (for connections to the East Coast Main Line and Leeds), including the connection from Aldwarke Junction to Holmes Junction for trains via Rotherham Central;
- Sheffield to Leeds via Barnsley and Wakefield Kirkgate; and

- Link from Wakefield Kirkgate to Wakefield Westgate for connections to the ECML.

The study brief builds on earlier analysis to promote the case for upgrading and electrifying the MML. Since the Parliamentary event held at Westminster in December 2009 to publicise the benefits to a wider range of decision makers. there have been further announcements which help to reinforce the case for delivering these improvements, hence the revival of this study and subsequent reporting. In particular, Network Rail recently published Initial Industry Plan identifies a number of possible enhancements that could be delivered in Control period 5 between 2014- and 2019. Lobbying for these enhancements could inform the development of the High Level output Specification to be published in summer 2012.

1.3 The Benefits

There is a very positive case for electrifying and upgrading the Midland Main Line (MML). The scheme package offers very strong value for money, whilst improving the economic performance of a number of important locations along the route, supporting objectives to rebalance the national economy and helping to sustain population growth and regeneration.

The majority of the scheme package would be delivered by 2020. The proposals are consistent with the recommendations from the McNulty Review which advocate cost reductions over time. Electrification is consistent with this overall objective. Consequently, this report has been prepared in timely manner to highlight these benefits. The six main benefits of electrifying and upgrading the MML are set out below, and are discussed in more detail within the subsequent report chapters.

Improving Journey Times, Capacity and Reliability

Electrification and upgrade of the MML could reduce journey times by 13-14 minutes between London and Sheffield. This will also enable journey time reductions to Derby, Leicester, Nottingham and Northamptonshire. Electric trains will improve service reliability and increase train and line capacity.

Providing Good Value for Money

The scheme package represents very good value for money, with savings in operating costs and increased passenger revenues greatly exceeding the costs of investment over a standard 60-year appraisal period. Electrification reduces significantly the costs of rolling stock, fuel and power, and track access and maintenance costs. Over time it will lead to a lower cost railway, in line with the aims of the McNulty Review.

Generating Significant Economic Benefits, Helping to Rebalance the Economy

The MML connects four of the largest cities and one of the fastest growing areas in England to London and each other. Reducing journey times between these cities will help businesses access markets, and improve the effectiveness of labour

markets. In addition to the standard transport benefits stemming from the journey time savings for passengers, the proposals would generate significant wider economic impacts in terms of higher productivity of business, valued at more than £450m over the appraisal period.

Supporting Future Population Growth and Regeneration

The MML runs through Northamptonshire and four of the largest cities in England outside of London; Derby, Leicester, Nottingham and Sheffield. There has been significant population growth in recent years in these places. The population of the four Local Enterprise Partnership areas which include these cities is expected to grow by almost 800,000 people between 2010 and 2030. This is growth is equivalent to the current population of Leeds. Improvements on the MML will help ensure new housing provision is more sustainable, and will facilitate regeneration in the areas surrounding the main stations.

Reducing CO_2 Emissions

The use of electric trains on the route would reduce carbon emissions by more than 40% from current levels. The introduction of longer distance electric trains to / from London from Sheffield and Nottingham would save over 43,362 tonnes of carbon per annum. Electrification of regional services north of Sheffield will save up to 4,724 tonnes of carbon per annum.

First Step towards an Improved Strategic Network

Most of the scheme package has been identified in the Network Rail Initial Industry Plan, which outlines its proposed investment plans between 2014 and 2019. Its implementation will provide the first step towards creating a modern, efficient inter-urban rail system for the East Midlands and Sheffield City Region. It is an essential prerequisite to creating an integrated fast long distance rail system, ahead of, and alongside High Speed 2.

2 The Existing and Future Situation

2.1 The Existing Line

The level of investment in the MML has been much lower than that for the East Coast, West Coast and Great Western Main Lines. As a result, capacity, reliability and speeds for services using the Sheffield City Region and the East Midlands to London via the MML are significantly less attractive compared with other longer distance routes in the UK. Whilst the Derby to Sheffield section has benefited from line speed improvements enabling 125mph operation in certain areas, line speeds are much lower on other parts of the route, due to infrastructure constraints; for example at Market Harborough, Kettering, Wellingborough and Toadmoor Tunnel near Ambergate.

The characteristics of the MML contrast sharply with the East Coast, West Coast and Great Western Main Lines. These routes have benefited from significant investment in infrastructure to enable 125mph operation on significant parts. In contrast, the MML received just 1% of the total investment nationally in track and other infrastructure allocated to long distance routes between 1997 and 2009.

2.2 Implications of the Slow Line Speeds

Recent improvements have delivered some benefits for the Sheffield to London services. Revisions to the timetable to introduce a consistent service for most of the day, along with revisions to the stopping pattern (the only intermediate stops are now at Leicester, Derby and Chesterfield), and the deployment of modern diesel Meridian trains has cut journey timings to London to 127 minutes. Despite these improvements, timings from Sheffield still compare unfavourably with other routes to London in terms of overall speed.

A comparison of journey times on the MML from Sheffield and the Three Cities to London with other major northern cities reveals the slow speeds achieved on the MML. Table 2.1 illustrates the off-peak speeds from Leeds are comparable to the results from Sheffield, but the fastest journey speeds from Leeds during the peak are significantly quicker. The speeds from York are also faster than the MML, whilst the benefits of the upgraded West Coast Main Line are evident, given the timing of services from Liverpool and Manchester.

Table 2.1: Summary of Current Speeds to London

Station	Distance (km)	Journey Time (mins)	Average Speed (kmph)
Sheffield (Midland Main Line)	265	127	125
Derby (Midland Main Line)	206	93-106	116-133
Leicester (Midland Main Line)	158	69	137
Nottingham (Midland Main Line)	203	105-120	101-116
Leeds (via East Coast Main Line)	298	120-134	133-149
York (via East Coast Main Line)	302	120-137	132-151
Liverpool (via West Coast Main Line)	310	128	145
Manchester (via West Coast Main Line)	314	128	147

Source: National Rail Timetable

2.3 Future Drivers of Change

The number of passengers using the MML is lower when compared with other long distance routes, but this situation is changing rapidly. Recent growth generated by the service frequency improvements in 1999 (the number of trains to / from London was doubled from 2 to 4 per hour, with a fifth train per hour introduced in 2008) has meant that the total number of trips has increased significantly. Since 1997 alone passenger numbers have increased by 122%; a rate of growth twice that when compared with the East Coast or West Coast Main Lines. The journey time reductions resulting from the timetable changes, together with the frequency improvements to / from Sheffield delivered in December 2009 has generated new rail trips..

Network Rail has produced a range of growth forecasts as part of the Network Rail Scenarios and Long Distance Forecasts workstream[1]. Growth forecasts have been prepared for a number of routes between 2007 and 2036, including the MML corridor. The forecasts take account of the planned housing and employment growth, plus other factors that influence demand for travel. Passenger numbers are expected to increase between 35 to 70% by 2036, equating to a 1-2% increase per annum. These growth rates are broadly similar to those for other long distance routes to London. This forecast growth means that additional seating capacity is required to alleviate overcrowding. The recent growth achieved during the last 10 years is significantly higher than the Network Rail forecast growth, although the increases since 1997 are linked to the service frequency doubling.

The MML also plays an important role for freight traffic. Proposed increases in the throughput of the Haven Ports and the improvements between Felixstowe and Nuneaton will place greater demands on route capacity. This additional freight traffic will interact with the MML in the Leicester area and could affect the timing of passenger services.

2.4 Description of the Scheme Package

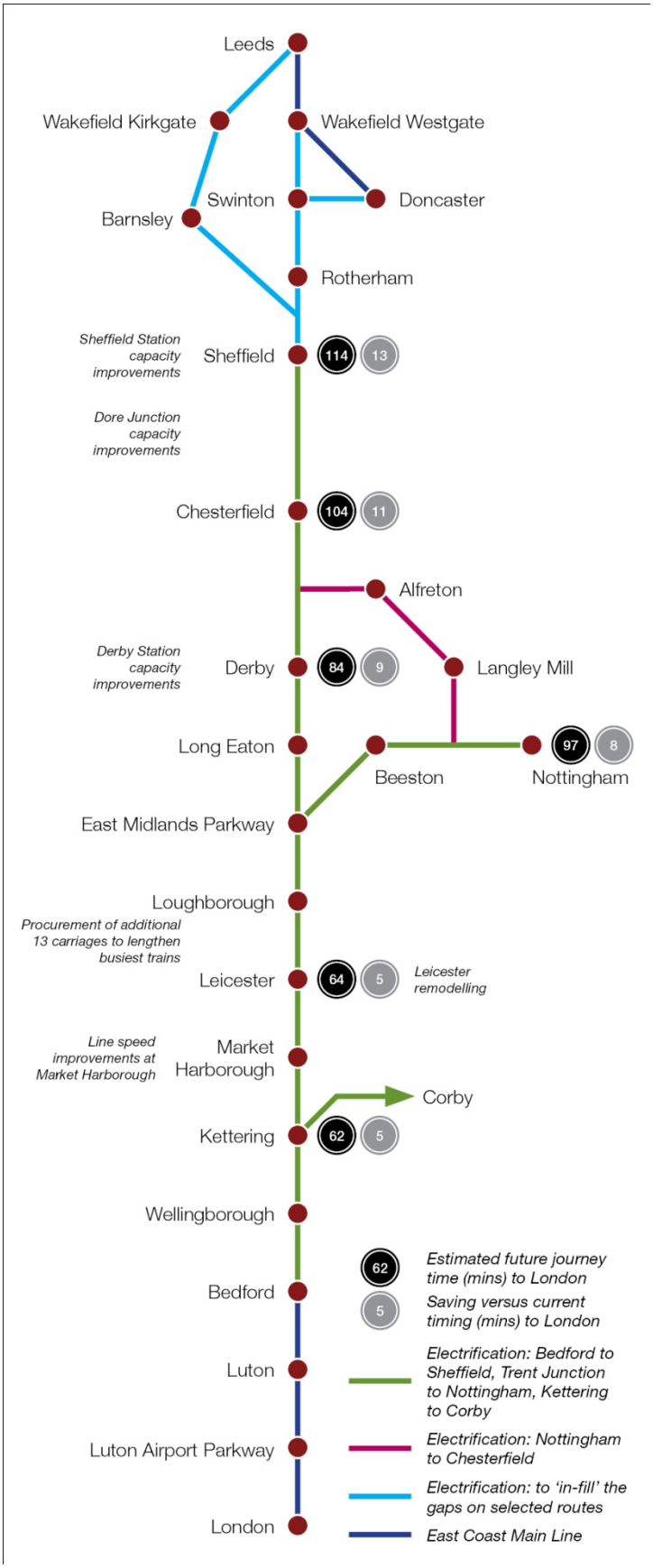
The schematic map in figure 2.1 shows the proposed interventions and estimated journey time improvements on the MML. In detail they comprise:

[1] Network Rail "Network Route Utilisation Strategy", Scenarios and Long Distance Growth

- Improvements to enable higher line speeds scheduled to be delivered by 2014;
- Electrification of the line from Bedford to Sheffi eld via Leicester and Derby, Trent Junction to Nottingham, plus Kettering to Corby;
- Line speed improvements and electrification of the line from Nottingham to Chesterfield via Langley Mill;
- Line speed improvements and additional electrification to 'in-fill' the gaps on selected routes between Sheffield and Leeds (Sheffield to Doncaster, Sheffield to South Kirkby Junction (for connections to the East Coast Main Line and Leeds), including the connection from Aldwarke Junction to Holmes Junction for trains via Rotherham Central, Sheffield to Leeds via Barnsley and Wakefield Kirkgate, and the link from Wakefield Kirkgate to Wakefield Westgate for connections to the ECML);
- Accommodating train lengthening for high speed services (up to 11 car formations), which will be realised through procuring an extra 13 train units;
- Derby station track re-modelling to reduce journey times and improve performance;
- Dore Junction re-doubling south of Sheffield, to help reduce journey times and improve operational performance;
- Further line speed improvements at Market Harborough resulting from track re-alignment close to the station;
- Upgrading Sheffield Station, including track re-modelling and platform extensions to facilitate longer trains; and
- Resignalling and track remodelling in the Leicester area.

These improvements would provide significant potential benefits and cumulatively they could reduce journey times by at least 14 minutes. The electrification of the route would also be the catalyst for the introduction improved rolling stock.

Figure 2.2: Schematic Map of Scheme Package



Note: Schematic map is for illustrative purposes only and is not to scale.

The assumptions set out below have been discussed with Network Rail, which indicate that the following benefits could be achieved:

- £69m line speed improvements to be delivered in Control Period 4, reducing journey times to Sheffield from London by about 8 minutes, with smaller benefits for Leicester, Derby and Chesterfield;
- Electrification – journey time savings of 3-4 minutes between London and Sheffield, with smaller savings for Leicester, Derby, Chesterfield;
- Derby station improvements – will deliver journey time reductions of 45 seconds approaching the station from the north in either direction, plus 1 minute saving from the south for trains towards Derby. Operational and performance reliability will also be imporved; and
- Market Harborough line speed improvements – journey time reduction of 30 seconds in both directions.

Table 2.2 below provides a brief summary of the benefits which could be gained if the scheme package was implemented in full.

Table 2.2: Benefits from Integrated Scheme Package

Benefit	Geographical scope	Quantified Benefits					
Total Journey Time Savings from London (in minutes)	By city	Northamptonshire (Wellingborough, Kettering, Corby)	Leicester, Loughborough	Derby	Nottingham	Chesterfield	Sheffield
		3	5.5-6.5	9.5-10.5	7.5-8.5	11.25-12.25	13.25-14.25
Economic Benefits	By MML as a whole	£450m (over 60 year period at 2011 prices)					
Environmental Benefits		1,613 - 4,724 tonnes CO_2 (estimated annual regional CO_2 savings)					
Annual Operating Cost Savings		£30million (estimated by Network Rail)					

Source: Arup review of Network Rail proposals. Timings are subject to confirmation by Network Rail. Different benefits from scheme package only realised in full if implemented in full.

3 Improving Journey Times, Capacity and Reliability

3.1 Summary

Electrification of the MML will allow electric units to operate. Consequently these train units provide increased service reliability and line capacity due to the acceleration and deceleration benefits offered. With the existing network affected by capacity constraints, the opportunity to unlock these bottlenecks is essential. Improved reliability will directly benefit rail passengers.

3.2 Journey Times

Table shows the potential reduction in journey times (shown in minutes) that can be achieved from the integrated scheme package for upgrading and electrifying the MML. It is vital that the scheme package is implemented on the route in full, as it is only through the electrification, capacity and line speed improvements that full benefits can be realised. The scheme package would deliver journey time savings of 13-14 minutes between London and Sheffield and faster journeys between other places on the line. These improvements would benefit existing passengers as well as providing a competitive alternative to journeys by car which will help to attract current car users and generate additional demand.

Table 3.1: Journey Time Benefits from Proposed Scheme Package

Element of Scheme Package	**From London**					
	Wellingborough, Kettering, M. Harborough, Corby	**Leicester, Loughborough**	**Derby**	**Nottingham**	**Chesterfield**	**Sheffield**
Line speed improvements	2	4	6	5	7	8
Electrification	1	1-2	2-3	2-3	2-3	3-4
Derby station	0	0	1	0	1.75	1.75
M. Harborough line speed increase	0	0.5	0.5	0.5	0.5	0.5
Total	**3**	**5.5-6.5**	**9.5-10.5**	**7.5-8.5**	**11.25-12.25**	**13.25-14.25**

Source: Arup analysis of Network Rail proposals. Timings are rounded down to the nearest minute and are subject to confirmation by Network Rail

3.3 Capacity Benefits

The upgrade and electrification of the MML will create a number of capacity related benefits.

Network Capacity Benefits: Parts of the South Yorkshire and wider regional rail network including the MML are already operating close to capacity. The

improved performance offered by electric trains would allow services to be timetabled more efficiently to make better use of existing line capacity. These benefits are particularly relevant if a mix of stopping and fast trains operate, for example, south of Leeds towards Doncaster and Sheffield on the East Coast Main Line. Whilst express trains are faster than the stopping services, there is a 4 minute journey time difference between the Northern electric and diesel trains to Doncaster and Sheffield respectively. Consequently, if the Sheffield train was operated using electric traction, this could improve timetable flexibility and potentially release network capacity to enable an additional service to run;

Rolling Stock Capacity: The formation of Class 222 units operated by East Midlands Trains have been modified to a fleet of five and seven car sets to make best use of existing seating capacity. However, passenger overcrowding occurs on the busiest trains. With growth forecasts of 36-71% depending on the economic scenario achieved[2], current overcrowding problems are set to deteriorate. The procurement of 13 additional units will enable selected trains to be extended to maximum of 11-cars providing additional seating capacity between London St Pancras, Leicester, Derby, Nottingham and Sheffield. Platforms will need to be lengthened at a small number of stations;

Sheffield Station: there are several capacity constraints affecting this nationally important station. There is a shortage of suitable platforms and this constraint will be exacerbated if longer trains and /or additional services to support forecast growth are introduced. SYPTE has undertaken some initial feasibility work to identify a package of measures to boost capacity. This includes additional platforms and track re-modelling to enable future growth to be supported.

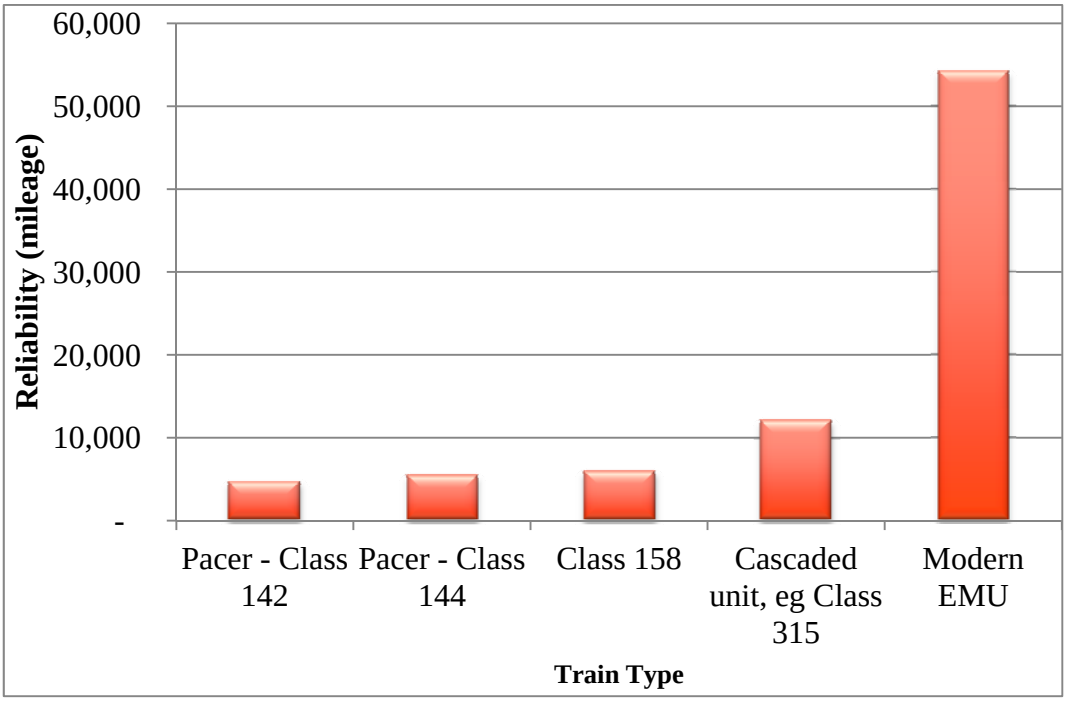
3.4 Reliability Benefits

The reliability of Northern's Class 142 and Class 144 diesel units has improved from 3,800-4,600 miles [3] (2007/08) to 4,600-5,500 in 2009/10, representing an increase of about 20%. The results for the Class 158 units used to operate the semi-fast trains via Barnsley achieve reliability statistics of 6,000 miles.

Whilst the improved diesel rolling stock reliability has contributed to the overall enhanced network performance, the introduction of electric traction would help to significantly improve rolling stock reliability. Although the type of rolling stock that could be introduced to operate these local and regional services is presently unclear, for examples, cascaded or new build, electric traction would enhance the overall reliability. For example, Class 315 units could be cascaded once replacement rolling stock has been introduced in London, and these units currently achieve reliability statistics of 12,200 miles. Alternatively, a new build unit could achieve reliability statistics over 50,000 miles. **Figure 3.1** illustrates that electric trains are significantly more reliable than the current diesel units, both for the local / regional services and the longer distance services to London.

[2] Taken from the Network Rail RUS: Scenarios and Long Distances Forecasts
[3] Reliability data is recorded by the National Fleet Reliability Improvement Programme (NFRIP) and is measured in terms of the distance travelled between incidents which cause a delay of at least 5 minutes. Data is presented as a Moving Annual Average and taken from Modern Railways January 2009 and January 2011.

Figure 3.1: Reliability of Selected Diesel and Electric Units



Source: Arup analysis of National Fleet Reliability Improvement Programme Data

4 Providing Good Value for Money

4.1 Summary

The 2009 Network Rail Electrification Route Utilisation Strategy (RUS) states that electrification of the MML would have a high benefit to cost ratio. Electric trains are cheaper to operate than diesel trains, with lower maintenance, lease, track access and fuel costs. These lower operating costs and higher passenger revenues from faster journey times exceed the capital costs over a standard 60 year appraisal period.

4.2 The Case

Upgrading and electrifying the MML will provide a modern, improved railway network. These improvements lead to a reduction in maintenance costs, from lower cumulative costs from wear and tear, plus the lighter trains. Also, electrified train units experience reduced operating costs and there are also efficiencies gained in running electric traction units. All of these elements comprise an impetus to deliver better services with lower operating costs. It is these savings in costs which can offset initial capital expenditure required to implement improvements, hence providing good benefit cost ratio over scheme appraisal periods and a subsequent delivery of a value for money scheme package. Other proposals also offer good value for money, with higher revenues and journey time savings.

Elements of the scheme package identified to form part of the MML upgrade and electrification have been assessed in terms of their value for money. Demonstrating that proposals offer strong value for money is a pre-requisite to secure the necessary funding. The following summarises the results:

- **Line speed improvements proposed for Control Period 4 (1):** previous analysis has demonstrated the £69m scheme to reduce journey times between Sheffield and London by 8 minutes will deliver excellent value for money. The scheme will deliver additional revenue, plus a further £450m from the Wider Economic Benefits.
- **Electrification (2):** results presented in the Electrification RUS indicate the financial benefits outweigh the scheme costs. Journey time savings resulting from the introduction of electric trains form a relatively modest part of the overall scheme. However, operating costs for the replacement electric units are expected to be reduced by about 15% compared with the current diesel units. These cost savings over a 60 year period, plus the increased revenue from faster journey times offset the capital costs (£500m at 2011/12 prices);
- **Derby station (3):** the results of the initial business case are presented in the East Midlands RUS. A combination of performance and journey time savings which generate higher revenues contribute to the £34m benefits. Scheme costs range from £61m to £66 at 2011/12 prices. Over a 60 year period, generating a strong benefit cost ratio of about 2:1;
- **Market Harborough (4):** line speed improvements would reduce journey times by around 30 seconds. The capital costs at £20.65m at 2011/12 prices. Previous analysis by Arup indicated the scheme costs would be outweighed by

the higher revenues and standard transport benefits over a 60 year period, generating a very strong benefit cost ratio of approximately 3.3:1;

- **Train lengthening:** the East Midlands RUS estimates the benefit cost ratio is about 3.3:1, with crowding relief generating the majority of benefits. This proposal was re-examined as part of the Network Rail Initial Industry Plan, with a higher cost estimate produced (£33-35m);
- **Dore Junction improvements:** scheme appraised as part of wider Northern Hub Proposals (costs not confirmed, hence exclusion);
- **Sheffield station:** an initial assessment of additional platforms and track-remodelling required to support the forecast growth has been completed. Further work is needed to understand the potential benefits associated with this scheme are required.

Table 4.1 sets out the estimated capital costs for the scheme package comprising the upgrade and electrification of the MML, showing that the costs are in the region of £700m.

Table 4.1: Proposed MML upgrade and electrification scheme package costs

Scheme	Cost
Line speed improvements	£69m
MML electrification	£500m
Derby station improvements	£61-66m
Sheffield station improvements	£19-21m
Market Harborough line speed improvements	£21m
Train lengthening	£33-35m
Total	£703-712m

Source: Network Rail IIP. Costs for Dore Junction still to be confirmed

The improved services offered on the MML will attract additional passengers by promoting a mode switch to rail. This increase in passengers will generate additional revenue, hence making services even more viable. The benefit to cost ratios for the other line proposal upgrades also offer strong value for money, with higher revenues, and economic benefits exceeding the capital costs. Table 4.2 is also able to highlight the cost efficiencies gained by using electric traction trains over current diesel trains, by showing values as sourced from Network Rail.

Table 4.2: Electric Vs Diesel Costs

	Electric	Diesel	% saving
Fuel per mile	26p	47p	45%
Maintenance per mile	40p	60p	33%
Leasing cost of vehicle per year	£90,000	£110,000	18%
Track wear and tear per vehicle mile	8.5p	9.5	11%

Source: Network Rail.

5 Generating Significant Economic Benefits, Helping to Rebalance the Economy

5.1 Summary

Electrified and upgraded rail links on the MML will enhance the connectivity between four of the largest cities in the country, Derby, Leicester, Nottingham and Sheffield and to one of the fastest growing areas Northamptonshire. The four Local Enterprise Partnership (LEP) areas on the line of Derby, Derbyshire, Nottingham and Nottinghamshire (D2N2); Leicester and Leicestershire Enterprise Partnership (LLEP); Northamptonshire Enterprise Partnership (NEP); and the Sheffield City Region (SCR) contain more than 2.1 million jobs. By reducing journey times between these significant economic centres there will be substantial economic benefits both in their Local Enterprise Partnership areas and in the UK overall. In addition to the standard transport benefits, this would generate substantial wider economic impacts of net present value of at least £450m, over a 60 year appraisal period or £12.4m per annum.

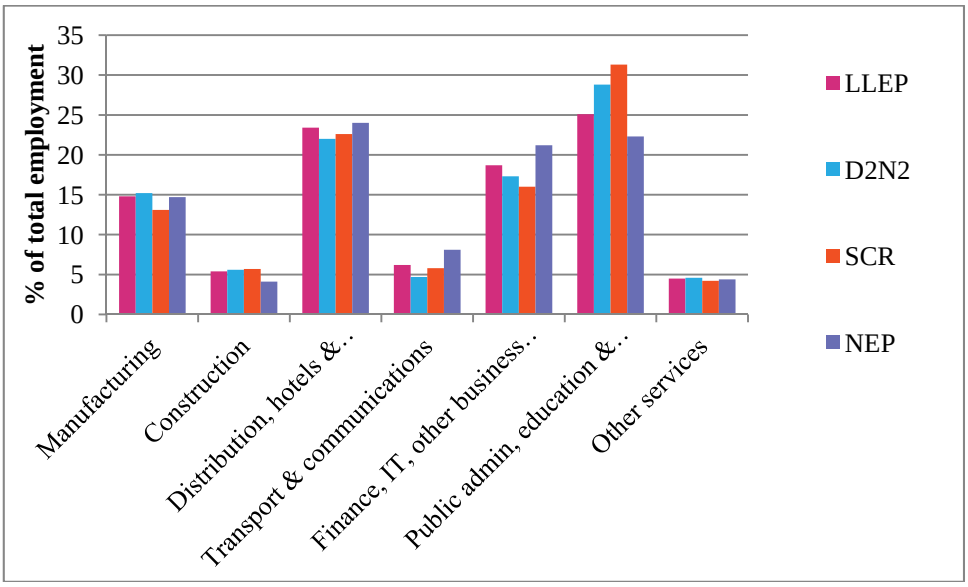
5.2 Reducing journey times could improve integration between four of the largest cities in the country

The Midland Main Line connects four of the country's largest cities with London, which is itself the main driver of the UK's economy. Cumulatively the four LEPs on the MML contain more than 2.1m jobs and therefore represent key drivers of economic growth and success. The economies of these four areas have been growing, between 1998 and 2008 alone employment increased cumulatively by almost 160,000 jobs.

In addition to generating a significant number of jobs these cities and their wider functional economic areas are also of strategic importance due to the types of employment found within these areas. For example, approximately 385,000 of all jobs within these three LEP areas are in financial and business services, a sector which benefits from improved rail connectivity. Figure 5.1 indicates employment in financial and business services represents a significant proportion of the economies of these functional economic areas.

Reducing journey times between these places could help to develop more integrated labour markets, which by being more able to cluster could generate significant agglomeration benefits (discussed below). Reducing the journey times between these could help to represent a more integrated economic zone, buildings upon the area's strategic strengths.

Figure 5.1: Percentage of jobs by sector for the four LEP areas



Note: parts some places fall within both the Sheffield City Region and the D2N2 area

5.3 The wider economic impacts of the proposals

5.3.1 Methodology

Wider Economic Benefits (WEBs) have been estimated using the journey time savings agreed with the client. WEBs are important benefits which are additional to those estimated by standard transport appraisal. We have estimated the pure agglomeration benefits of the proposed MML upgrade and electrification. This element of WEBs captures the productivity benefits to businesses of being 'effectively' closer together. An increase in 'effective density' can be driven either by increased density of employment (more jobs in a productive area) or by transport making productive areas quicker to get to. It is the latter impact that we estimate here – ie the MML improvements making productive places 'effectively' closer together because it is now quicker to get between them.

The geographic coverage of the modelling is similar to previous analysis by Volterra and Arup in this area. It includes:

- Leeds City Region (LCR);
- Sheffield City Region (SCR) (which includes Barnsley);
- East Midlands (excluding districts contained with the SCR);
- North East;
- West Midlands, Greater Manchester, Merseyside, Lancashire, Cheshire, Cumbria, Staffordshire and Scotland (for completeness); and
- London.

We have used the economic assumptions from the latest DfT economic dataset for the following assumptions:

- Output and employment per worker;
- Agglomeration Elasticities; and
- Distance Decay parameters.

The guidance recommends that for inter-city schemes, a sensitivity is carried out which applies a fixed decay parameter which is set equal to the average of the decay parameters for consumer and producer services. This sensitivity has been carried out. In order to remain conservative, we have not assumed any employment growth in the analysis. In line with guidance, we only estimate the pure agglomeration benefits, and do not estimate any move-to-more-productive jobs benefits. All analysis is presented in 2011 prices.

5.3.2 Results

Table 5.1 sets out the results of the analysis, by region and by sub-sector. We can see that the journey time savings deliver £12.4m per annum of wider economic benefits through pure agglomeration, which is equivalent to a 60 year net present value of £450m. Most (over 70%) of these benefits are due to agglomeration benefits in "Producer Services" i.e. financial and business services. Two-fifths of these benefits accrue to the East Midlands, with large benefits also accruing to London and the Sheffield City Region.

Table 5.1: Wider Economic Benefits, by city region and sub-sector

	Per Annum					**60yr NPV (£m)**
	% Manufacturing	**% Construction**	**% Consumer Services**	**% Producer Services**	**TOTAL (£000s)**	
Leeds City Region	14%	7%	16%	63%	1,100	£40m
Sheffield City Region	7%	5%	14%	75%	2,580	£95m
East Midlands*	7%	3%	12%	77%	5,405	£195m
North East	23%	8%	14%	55%	280	£10m
London	13%	8%	14%	65%	3,030	£110m
Total	**10%**	**5%**	**13%**	**72%**	**12,395**	**£450m**

Source: Volterra estimate. Totals may not sum due to rounding.

** Excludes those districts also in the Sheffield City Region*

Table 5.2 shows the WEBs for the key cities within the study area. We can see that after London, Sheffield, Leicester, Derby and Nottingham get considerable benefits. The majority of benefits in all of these cities stem from Producer Services.

Table 5.2: Wider Economic Benefits for key cities

	Per Annum					60yr NPV (£m)
	% Manufacturing	% Construction	% Consumer Services	% Producer Services	TOTAL (£000s)	
Leeds	12%	6%	14%	68%	440	£15m
Rest of LCR	16%	8%	17%	59%	670	£25m
Sheffield	6%	4%	12%	79%	1,640	£60m
Rest of SCR	8%	6%	18%	68%	940	£35m
Leicester	9%	3%	11%	77%	1,190	£45m
Derby	10%	3%	11%	76%	950	£35m
Nottingham	3%	2%	10%	86%	880	£30m
Rest of East Mids	7%	4%	15%	74%	2,380	£85m
North East	23%	8%	14%	55%	280	£10m
London	13%	8%	14%	65%	3,030	£110m
Total	10%	5%	13%	72%	12,395	£450m

Source: Volterra estimate. Totals may not sum due to rounding.

The majority (80%) of the benefits to Sheffield City Region are as a result of the faster journey time to London and 20% are due to improved connectivity across Yorkshire, the East Midlands and the North East. 85% of the benefits to the East Midlands are as a result of the faster journey time to London and 15% are due to improved connectivity between the Eastern regions. With the exception of Barnsley, the MML improvement does not lead to shorter journey times from the Leeds City Region to London. This means that 90% of the benefits to the Leeds City Region are as a result of improved connectivity between the Eastern regions.

5.3.3 Sensitivity analysis

We have assumed a start year of 2017 for the scheme. We carried out sensitivity tests to see the impact of a later start year (2019), as well as the DfT's recommended sensitivity for inter-city schemes described earlier. Based on these sensitivities we conclude that the MML upgrade and electrification would deliver WEBs in the region of £405m-£445m (Present Value), with a central estimate of £430m.

5.4 Other economic benefits of the proposals

Upgrading and electrifying the MML will create a range of economic benefits, some of which can be difficult to quantify. These benefits include:

- The economic benefits of the additional capacity created on the line, as a result of more services being able to operate;

- The improved image and profile of the line as a result of it having an electrified service; and
- The impacts on jobs through the construction of these improvements to the Line.

6 Supporting Future Population Growth and Regeneration

6.1 Summary

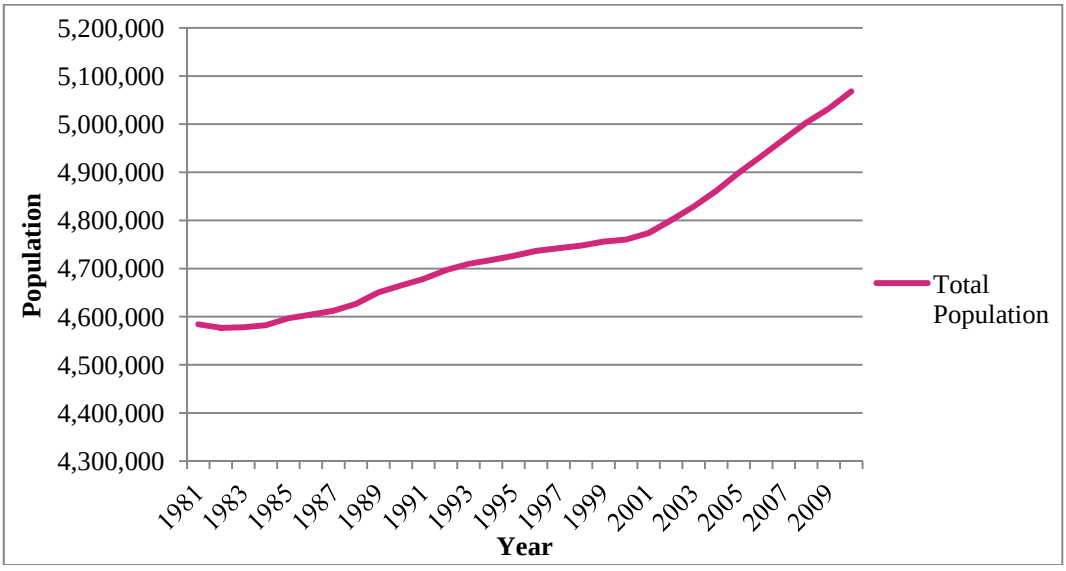
There has been significant growth in the population of the D2N2, LLEP, NEP and SCR LEP areas in recent years and these areas have a population of 5.1 million people. This has been fuelled by growth in the largest four cities on the MML of Derby, Leicester, Nottingham and Sheffield and the growth area of Northampton. The population of the four LEP areas on the line is expected to grow by almost 800,000 between 2010 and 2030. This could place additional pressures on the MML as a result of the increase in trips that this is likely to generate.

6.2 Many of the places on the line have been experiencing significant population growth

Many of the cities on the MML and their surrounding areas have been experiencing rapid population growth over recent years. Between 2000 and 2010 the population of the four LEP areas grew by more than 300,000, at a rate above the national average (6.5% for these areas compares to 5.7% for Great Britain). Cumulatively these four LEP areas had a population of 5.1 million people in 2010.

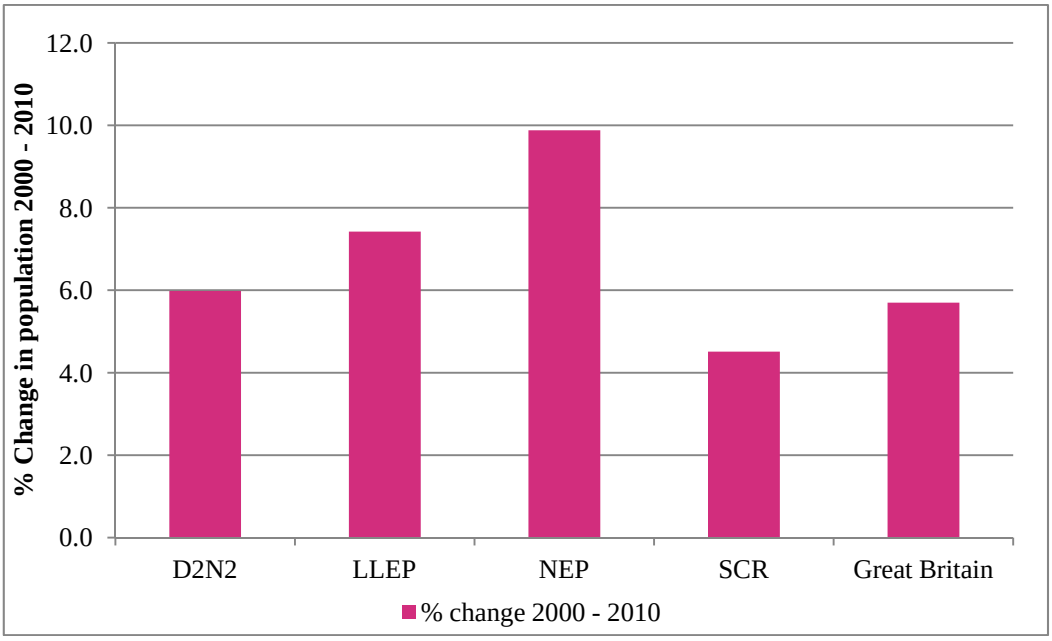
The area also contains four of the largest cities in the country and the growth area of Northamptonshire. Derby, Leicester, Nottingham, Northamptonshire and Sheffield contain more than 2.1 million people and all grew at a rate faster than the national average between 2000 and 2010.

Figure 6.1: Cumulative population growth in the four LEP areas, 2000-2010



Source: ONS, Midyear population estimates, Arup analysis

Figure 6.2: Percentage change in population between 2000 and 2010 in the four LEP areas on the line, compared with average growth in Great Britain



Source: ONS, Midyear population estimates, Arup analysis

Such a significant residential population requires strong transport links. This is important as it enables people to connect to services and employment opportunities.

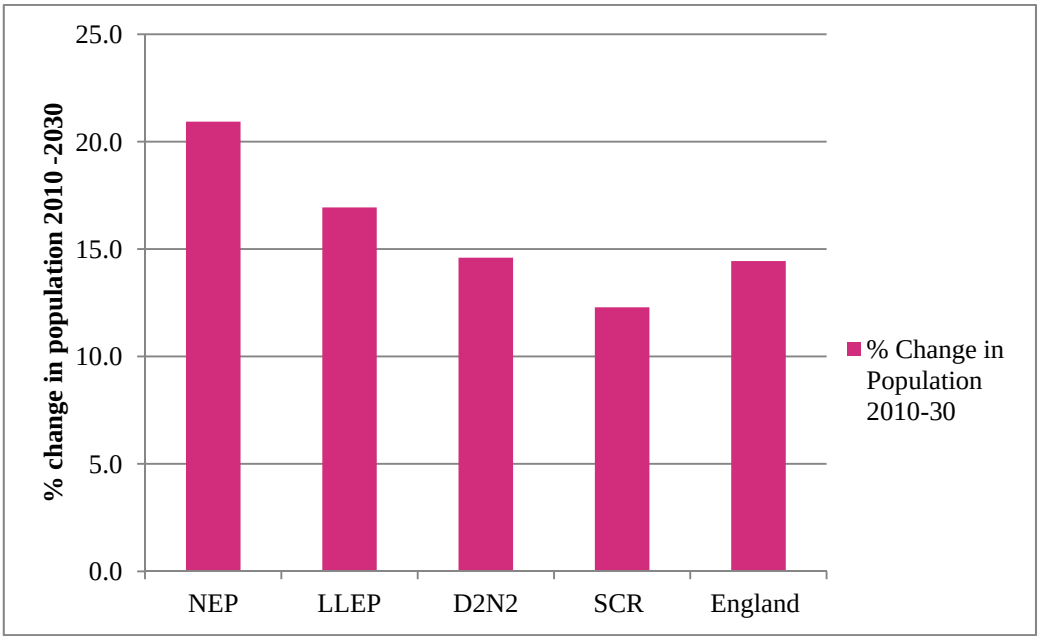
6.3 The population of cities on the line is forecast to grow in the future

The most recent population projections show that the population in the four LEP areas on the MML is projected to grow significantly in the future. The figure below shows the forecast level of population change within areas between 2010 and 2030, which in three out of the four areas represents a higher percentage change than for England as a whole. Ultimately these four LEP areas are projected to cumulatively grow by almost 800,000 people between 2010 and 2030.

To put this scale of growth in context, the city of Leeds also currently has a population of around 800,000 people, so this level of growth would effectively equate to the creation of a new Leeds between these four LEPs alone during this time period.

This growth in population will also be accompanied by an increase in households in these four cities. This growth in population is also therefore likely to increase passenger numbers on the line. This would place additional pressures on the MML to respond to this level of growth.

Figure 6.3: Percentage change in population in the four LEP areas on the MML, 2010-2030



Source: ONS (2010) Sub national population projections, 2008 based, Arup analysis

7 Reducing CO_2 Emissions

7.1 Summary

Electric traction trains are less carbon intensive than comparable diesel train units, and some existing local and regional services could operate using electric traction, rather than diesel. Analysis has found that CO_2 emission savings of up to 41% could be delivered due to the switch to electrified train units.

In additional, the scheme package will help to deliver government policies to reduce CO_2 emissions from transport, as set out in The Climate Change Act (2008).

7.2 Long Distance Services

Previous analysis has estimated the potential carbon impacts if the existing long distance services from Sheffield, Derby and Nottingham were converted to electric traction.

At present, East Midlands Trains operates a mixture of High Speed Trains and Class 222 diesel units. Rolling stock mileages were multiplied by the carbon emissions per total train kilometre for the existing fleet. This number was compared with the CO_2 emissions generated by an electric train. It is estimated that carbon emissions could be reduced by 43,362 tonnes per annum if the existing long distance services from Sheffield, Derby and Nottingham to London are converted to electric traction[4]. This reflects the long-distance nature of the route and the high CO_2 emissions from the current fleet.

7.3 Regional Services

Electrification would allow some local and regional trains to operate using electric traction rather than diesel, and the following regional services could most effectively switch to electric traction operation:

- Sheffield to Leeds via Wakefield Kirkgate (semi-fast);
- Sheffield - Castleford - Leeds (stopper);
- Nottingham to Leeds via Sheffield and Wakefield Kirkgate (semi-fast);
- Sheffield to Adwick (stopper); and
- Sheffield – Leeds via Swinton (stopper).

To assess the potential carbon benefits, the total annual train miles have been calculated. Carbon emissions for the current diesel and electric units have been collated using industry sources, with a range of values used for the electric traction.

Table 7.1 shows the total annual CO_2 emissions from these regional services based on diesel and electric traction. It is estimated that introducing electric traction for these services would deliver CO_2 emission savings of between 1,613

[4] Base data for these calculations is taken from the Department for Transport (2007) Rail Technical Strategy and TAS (2008) Rail Industry Monitor

and 4,724 tonnes, depending on the type of electricity production. This is a 14%-41% reduction compared with the current diesel units.

The carbon savings from the semi-fast trains between Nottingham, Sheffield and Leeds via Wakefield Kirkgate generate the highest totals. This is attributable to the extra distance for trains between the East Midlands and Leeds, and the higher emissions per train kilometre produced by Class 15X units.

Although the conversion of some regional services to / from Sheffield from diesel to electric traction saves about 1,613 to 4,724 tonnes per annum, this is significantly smaller than the total for the long distance high speed services. The additional mileages for trains to / from London, coupled with the higher emissions from the existing units are the main contributory factor for this outcome.

Table 7.1: Annual CO_2 Emissions of all services operating in different scenarios

	Scenario		**Savings**
	Diesel Traction	**Electric Traction**	
Annual CO_2 Emissions (tonnes)	9,871	5,847-8,542	1,613 – 4,724 (14% - 41%)

Source: Arup calculation using the SRA Rail Emission Model November 2001, Rail Safety and Standards Board Traction Energy Metrics 2007, Department for Transport Technical Rail Strategy 2007

Although the conversion of some regional services saves between 1,613 to 4,724 tonnes of CO_2 per annum, this is significantly smaller than the total for the long distance high speed services, given the higher train mileage to London compared with the regional/local services.

In addition, environmental benefits would be delivered as improved services would promote modal switch and attract more rail passengers; in some instances from private car use to rail.

8 First Step towards an Improved Strategic Network

8.1 Summary

The upgrade and electrification of the MML would be independent, but complementary to High Speed Rail. Ahead of HS2 delivery, these wide and beneficial improvements to the MML would provide the first step in improving the network, services and connectivity.

8.2 The Benefits

Upgrading and electrifying the MML will improve rail services to four of the largest cities and one of the fastest growing areas in the country. The proposals are an important precursor to the development of the proposed high speed rail network, not an alternative. This is because high speed rail represents a long term project. The proposals for the MML could deliver reduced journey times and significant economic benefits in the short to medium term. However, upgrading and electrifying the line will not achieve the step change in connectivity between some of the largest cities in the country and address capacity constraints in the way high speed rail can.

The MML remains the only main line to London that has not been electrified, or where there are not confirmed plans to electrify the line. It is also the only main line to London that has not had its infrastructure upgraded extensively. Upgrading and electrifying the route would therefore provide rail services of a more comparable standard to other main lines. It is essential the scheme package is implemented in full, to maximise the benefits. Line speed improvements, capacity improvements and electrification are all required. This essential long term investment would benefit existing passengers and generate additional demand, leading to wider benefits.

Upgrading and electrifying the MML will reduce significantly the costs of rolling stock, fuel or power, and track access and maintenance costs. Over time it will lead to a lower cost railway, in line with the aims of the McNulty Review. It will contribute to the development of a more flexible rail network.

Upgrade and electrification of the existing MML route is essential to create a modern integrated fast inter-urban rail network, and it would complement subsequent investment in a high speed rail network. A high speed network would free up capacity on the MML, which could then be used to improve services to those places not on the high speed network. It would allow inter-operability between high speed and conventional routes enabling “classic compatible” high speed rail trains to serve a wide range of destinations, spreading the benefits of this significant investment. Upgrading and electrifying the MML can also help to build demand prior to the commencement of high speed services, and once electrified, will provide released capacity benefits that are so important to the overall case for high speed rail.

This case for upgrading and electrifying the line should also be considered in light of the proportionate underinvestment in public transport in the north of England and the West Midlands when compared with the spend per head in London.

Recent analysis has shown that the gap between these areas has widened in the last year, with spending on transport in London now at £774 per head compared with £285 per head for the West Midlands and the North of England combined[5].

Finally, there are two Network Rail documents which widely promote and support the upgrade and electrification of the MML; the Electrification RUS and Initial Industry Plan[6] (IIP). The recently published IIP describes the electrification scheme which is proposed between Bedford and Sheffield via Derby, Kettering to Corby and Trent Junction to Nottingham. The IIP makes a strong case for the upgrade and electrification of services on the MML proposing that the electrification of the MML is one of the prioritised schemes for delivery in control period 5. Further details from the IIP state:

> "The RUS identified the Midland Main Line as a route for which there was likely to be a strong business case for electrification. The southern end of the route (south of Bedford) is already electrified but there is a strong business case for extending the electrification to the north as far as Sheffield. The case remains strong even with High Speed 2 (HS2), giving significant benefits to travellers to and from Nottingham, Derby and Leicester."

[5] PTEG (2011) Funding Gap Report
[6] Initial Industry Plan for England and Wales, Proposals for Control Period 5 and beyond, September 2011