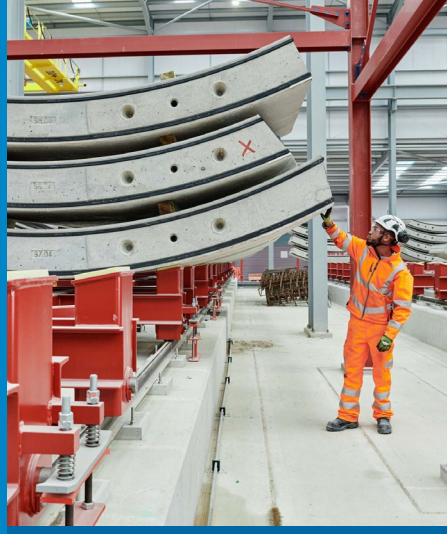
Department for Transport

HS2
Phase 2b Western Leg: Crewe to Manchester

An Update on the Strategic Outline Business Case



HS2 Phase 2b Western Leg: Crewe to Manchester

An Update on the Strategic Outline Business Case

"Transforming UK connectivity to build a balanced and sustainable economy"

January 2022

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Minister of State
Andrew Stephenson MP

HS2 is Britain's largest infrastructure project, and the biggest in Europe. It will transform rail travel in this country, significantly boosting capacity, freeing up space on existing lines, speeding up journeys, and improving connectivity. It is also vitally important to our economic success as we build back from the challenges of recent years. HS2 will help to regenerate left-behind towns and communities, increase opportunity and create thousands of jobs across the country.

We are publishing this business case to accompany the presentation of the High Speed Rail Crewe-Manchester hybrid Bill to Parliament. The scheme set out in the Bill will complete the new high-speed line from London and Birmingham to Manchester, connecting the UK's three largest cities. This marks another major step forward in the Government's strategy to modernise our rail network, redressing decades of underspending in the Midlands and North, and levelling up our country. This document, which is an update to the 2017 Business Case, sets out the rationale for taking the Crewe-Manchester scheme forward to Bill deposit.

In November 2021, the Government set out a £96bn Integrated Rail Plan for the North and the Midlands (the IRP) - the most ambitious package of rail investments since Victorian times - which will deliver better railways, sooner. The HS2 Crewe-Manchester scheme (also referred to as Phase 2b Western Leg (WL)) sits at the centre of these plans, bringing high-speed rail into the heart of Manchester, as well as underpinning the Northern Powerhouse Rail (NPR) scheme, which will expand the high-speed network to the east and west. The scheme will act not as a standalone transport intervention, but as an enabler for enhanced region-wide connectivity and as a wider catalyst for regeneration and growth in the North and North West, capitalising on the significant economic potential that these regions have to offer.

The HS2 Crewe-Manchester scheme builds upon the benefits that are already being realised through work now underway on high-speed lines between London, Birmingham and Crewe. It will help to drive economic prosperity in the North and across the UK by better connecting people and businesses. The new high-speed line will significantly enhance rail capacity into Manchester, freeing up space on existing lines for local services, providing passengers with more travel options, more seats, greater comfort and improved reliability. It will further shorten journey times, so London is just over an hour away from Manchester, and Birmingham around 40 minutes away – more than halving the current journey time from Manchester. Such radical improvements to the services available will also generate significant new opportunities for businesses across the UK, helping them reduce costs, reach new markets and access a wider workforce.

Our environment will benefit too. Rail is already the greenest form of motorised transport in this country - the most sustainable, carbon-efficient way of moving people and goods quickly over long distances. HS2 will bring further reductions in emissions, with its new trains and modern infrastructure, resilience to climate change and deliver low carbon travel for the 21st century.

HS2 is already helping us build back from COVID-19, providing an economic stimulus to the country after two years of the pandemic. For example, 97% of businesses in HS2's supply chain are UK-based, and 65% of current HS2 contracts have been awarded to small and medium size enterprises. In fact 20,000 jobs are already being supported as a result of HS2. The Crewe-Manchester phase will further expand the number of jobs available, with a peak workforce across Phase One, Phase 2a and Phase 2b WL estimated at 34,000.

Our current Victorian rail network is the oldest in the world. After decades of underinvestment and rapidly rising demand, it is no longer capable of supporting our 21st century needs. We need a more resilient, reliable and sustainable railway, that can improve opportunities for millions of people, particularly in the North and Midlands, and contribute to an improved standard of living for generations to come. HS2 is spearheading the development of a world-class rail network for Britain, by dramatically improving inter-city travel, releasing capacity on other lines, and complementing a much wider programme of transport improvements announced in the IRP. HS2 has vast potential not only to transform journeys, but also spread the benefits of economic growth and prosperity across the UK.

Minister of State
Andrew Stephenson MP

HS2 Phase 2b WL Benefits

Connectivity and Capacity

3X

London to Manchester **3 times per hour** in 1 **hour 11minutes***

3X

Birmingham to Manchester **3 times per hour** in just 41 minutes*

Manchester Piccadilly to Manchester Airport **in just 7 minutes***

1500 seats per hour between Manchester and Birmingham

3 England to Scotland HS2 services **per hour***

A quadruplling of **High Speed capacity** to Scotland on top of that provided by HS2 Phase 2a*

Wider network impacts

Improves reliability across the network by freeing up key bottlenecks

Enables Northern Powerhouse Rail through the provision of critical infrastructure

Supporting development and regeneration

Will support up to **820,000m²** of **commercial development** in and around Manchester Piccadilly

Supports plans for a new suburban centre around Manchester Airport

Skills and Jobs

2,200

HS2 is already supporting 2,200 UK registered companies with HS2 contracts

>2000

Over 2,000 apprenticeships will be created across Phase One, 2a and 2b WL

The likely per annum GDP impacts from the scheme are

c£800 million

in 2051

Sustainable alternative to long distance travel

HS2 Ltd aim to deliver a 10% net gain in biodiversity

Trains powered using Zero-Carbon energy

A mode shift towards rail

* Based on the current assumed timetable.

Introduction

On 11 February 2020 the Prime Minister announced that the Government intended to proceed with High Speed Two (HS2), recognising its potential to act as the spine of a modern transport network and as a springboard to levelling-up the economy, improving capacity and connectivity and supporting the ambition to reach net-zero by 2050.

This landmark decision preceded the start of construction works for the first Phase of HS2, between the West Midlands and London. This work is now well underway, with the first tunnel boring machines now launched and more than 20,000 people employed at sites along the 140-mile route by HS2 Ltd and its supply chain. This brought economic stimulus at a time in the pandemic when the wider economy was in decline. Despite the impact of the pandemic, DfT and HS2 Ltd continue to expect the first services to start operating between 2029 and 2033, with an ambition to align the start of operations on Phase 2a, which extends the line to Crewe, bringing benefits to the North as early as possible.

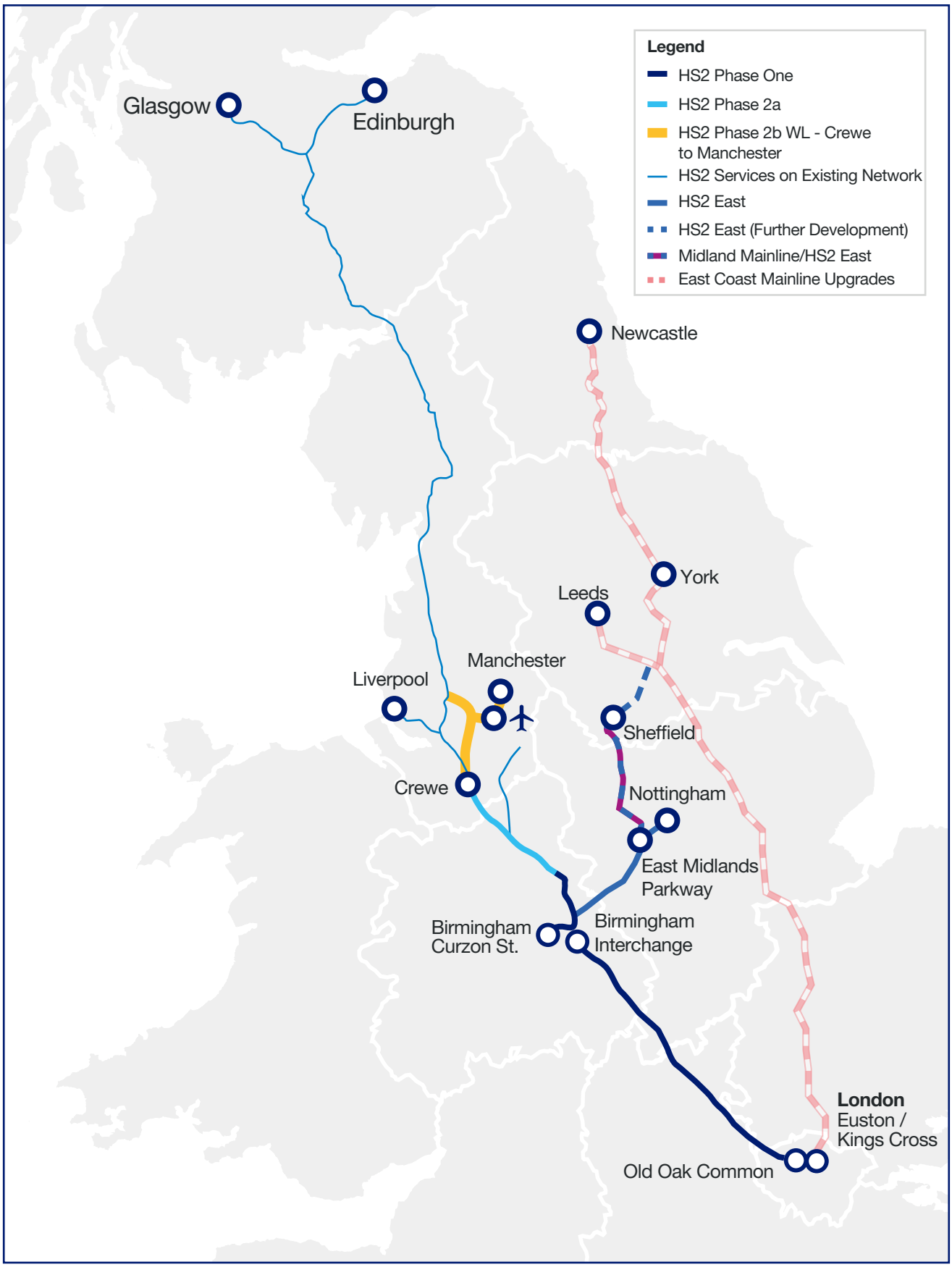
In parallel with the decision to proceed with HS2, the Government committed to deliver an Integrated Rail Plan (IRP) that would review the scope, strategy and sequencing of planned rail schemes in the North and ensure they can be operated as an integrated network. As part of this, the Government also announced its intention to proceed with legislation to support the Western Leg of HS2 Phase 2b (the High-Speed Rail (Crewe-Manchester) Bill), the third phase of the HS2 Programme that brings high-speed infrastructure directly into the heart of the North West, delivering the first new inter-city transport corridor constructed into Manchester since the 1970s and completing the long-held ambition for HS2 to better link the UK's largest economic regions. The IRP was published in November 2021 and sets out a clear strategy for how rail upgrades will build on HS2 to transform connectivity within the region and galvanise productivity to level-up the economy. Delivering this vital long-term strategy will provide a step-change in inter-city connectivity and demonstrate the Government's commitment to enhancing cross-border connectivity and investing in the Union by improving capacity and connectivity of routes to Scotland and Wales.

In addition to the IRP, in November 2021, the Government published the Union Connectivity Review, led by Sir Peter Hendy, which seeks to find ways to improve connectivity between the UK nations. This work includes an examination of rail connectivity between England and Scotland and covers the link from HS2 to the West Coast Main Line, which forms part of this Proposed Scheme. The review echoes the findings of the IRP, stressing the importance of Phase 2b WL in reducing journey times and increasing capacity on the route to Scotland.

Based on current plans, the first high-speed services to use the HS2 Phase 2b WL infrastructure will be in operation between 2035 and 2041, enabling up to 14 trains per hour to travel between the North, Midlands, Scotland and London. In due course Phase 2b WL infrastructure will also be used in part by NPR, enabling much wider connectivity across the North West.

The extent of the proposed scheme is the section shown below by the solid orange line. The proposals include a high-speed rail line from the end of the Phase 2a infrastructure near Crewe to Manchester Piccadilly, with a link to the West Coast Mainline at Bamfurlong, near Golborne. New high-speed stations are proposed at Manchester Piccadilly and Manchester Airport. The Crewe-Manchester Bill also provides for the infrastructure required for the Crewe Northern Connection, a link that will allow high-speed services to leave or re-join the high-speed network north of Crewe.

Route map of the HS2 Network



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The Strategic Case

Purpose of the Strategic Case

1.1 The Strategic Case sets out the **strategic context, case for change, scheme objectives**, **benefits, strategic alternatives, risks and stakeholder engagement** for HS2 Phase 2b WL.

- The **Strategic Context** examines the wider policy context in which the scheme is being planned at the national, regional and local levels and sets out at a high level how the scheme aligns to these policies. Further detail on benefits is provided separately in the section **Benefits of the Phase 2b Western Leg**
- The **Case for Change** sets out the current economic, social and environmental contexts, evidencing the need for a large-scale transport intervention
- The section on the **Strategic Goals and Scheme Objectives** sets out the core objectives that HS2 Phase 2b WL will deliver, in the context of the areas set out in the **Case for Change**
- The **Benefits of the Phase 2b Western Leg** section describes how the scheme meets its objectives, and how it contributes to the delivery of government's wider ambitions.
- The **Strategic Alternatives** section considers alternative interventions to HS2 Phase 2b WL, demonstrating that no other option investigated can meet the overarching scheme objectives
- The **Strategic Risks** section highlights the risks to delivery of the scheme objectives, covering uncertainties around factors such as dependent schemes, decarbonisation rates and future demand
- The **Stakeholder** section considers what HS2 Phase 2b WL will bring to its stakeholders and outlines how the scheme will impact the people and organisations who interact with the scheme directly

Strategic Context

1.2 The UK economy has recently undergone the largest economic shock of modern times. In 2020 the COVID-19 pandemic and the necessary restrictions put in place to stop the spread of the virus caused an annual fall of 9.4% in UK Gross Domestic Product (GDP) (ONS data).[1] Committing to deliver the HS2 programme and authorising the start of construction on HS2 Phase One in April 2020 provided a vital short-term injection of capital into the UK economy, supporting businesses and jobs throughout the country at a critical time. However, it is the long-term transformation of the economy that is at the heart of the HS2 programme – this goal has been key during the development of the programme over the past decade, its urgency now has been heightened by the current economic climate.

[1] Office for National Statistics, 2022. GDP quarterly national accounts.

1.3 Despite the recent changes seen in travel behaviour as a result of the pandemic and the restrictions which have been put in place to manage its impact, the case for HS2 continues to remain strong. Although changes in commuting behaviour have been observed in the short-term, the move towards an increased level of working from home may also potentially impact on the economic geography of the country with more people prepared to travel further distances when they do commute to a workplace. Furthermore, as is currently the case for long distance rail, business and leisure travel are likely to dominate the HS2 market, with these areas expected to be more isolated from the long term impacts of COVID-19.

1.4 As the UK continues its transition out of the pandemic, the Government has outlined its ambition to Build Back Better, Build Back Fairer and Build Back Greener. To this end, the Prime Minister has publicly stated that "government is committed to uniting and levelling up every part of the UK",[2] and to delivering net-zero carbon by 2050.

1.5 These overarching targets are re-emphasised through cross-cutting priority outcomes with responsibility sitting across multiple government departments to enable delivery. HS2 Phase 2b WL directly contributes to two of these, namely to "*raise productivity and empower places so that everyone across the country can benefit from levelling up*" (led by the Department for Levelling-Up, Housing and Communities (DLUHC)), and to "*tackle climate change: reduce UK greenhouse gas emissions to net zero by 2050"* (led by the the Department for Business, Energy and Industrial Strategy (BEIS)).

1.6 To align with both central government policy and these cross cutting priority outcomes, DfT has set itself four strategic priorities for supporting the transport network, developing and implementing transport policy and delivering transport projects:[3]

- growing and levelling up the economy
- improving transport for the user
- reducing environmental impacts
- increasing global impact

1.7 These, alongside the HS2 Strategic Goals, the IRP Strategic Objectives and local and regional growth strategies, have been used to shape the Strategic Case to ensure that HS2 Phase 2b WL, alongside wider complementary investment, can realise Government ambitions. The Phase 2b WL Scheme Objectives set out in this document, reflect these wider ambitions and apply them to the Phase 2b WL scheme.

[2] GOV.UK, 2021. Ambitious plans to drive levelling up agenda.
[3] GOV.UK, 2021. DfT Outcome Delivery Plan: 2021 to 2022.

Growing and levelling up the economy

1.8 For the UK to recover successfully and rebuild its economy for future generations, it must learn lessons from the past and address long-standing barriers to strong, balanced, and sustainable growth. This means investing in the building blocks of the UK economy, its infrastructure and workforce, with opportunities spread throughout the country, and levelling up regions outside of London and the South East.

1.9 There are significant economic inequalities across the United Kingdom. Research by the Institute for Fiscal Studies identified the UK as one of the most unequal countries in the developed world and found that some of the most economically disadvantaged communities live in large towns and cities outside of London and the South East.[4]

1.10 The Government has made a clear commitment to helping the economy recover in a fair and equitable way and has published its plan Build Back Better: our plan for growth. The plan sets out how investment in skills and high-quality infrastructure is crucial for economic growth and boosting productivity and competitiveness.

1.11 Well-developed transport networks allow businesses to grow and expand, enabling them to extend supply chains, deepen labour and product markets, collaborate, innovate and attract inward investment. This perspective is supported by the National Infrastructure Strategy, which identifies that the majority of transport investment over the last decade has been focused on London and the South East, and that in the period going forward the Government intends to significantly shift its spending to the regions and nations of the UK.

1.12 HS2 Phase 2b WL presents the opportunity to expand on connectivity and capacity improvements provided by Phase One and Phase 2a to bringing the North closer to the South, allowing northern cities and regions to capitalise on business agglomeration benefits.

Reducing Environmental Impacts

1.13 Limiting the rises in the global temperature to avoid the irreversible impacts of global warming is one of our greatest challenges, and one that can only be achieved through a global response. The decisions and actions needed to achieve this goal are required now.

1.14 In 2019 the UK became the first major economy to legislate an ambitious net zero CO_2 emissions target by 2050. In October 2021, this commitment was further strengthened through the publication of the policy paper 'Net Zero Strategy: Build Back Greener'.

[4] Institute for Levelling Up, 2020. Levelling up: where and how?

1.15 Achieving net zero requires an annual rate of emissions reduction that is 50% higher than the UK's previous 2050 target.[5] The UK's climate advisory body, the Committee on Climate Change (CCC) estimates that achieving net zero requires a step change in action with rapid decarbonisation required across all sectors. Domestic transport currently has the highest emissions of any sector across the economy.[6] In response to the challenge posed by climate change, the Department for Transport published its Transport Decarbonisation Plan, which sets out the approach to reducing emissions while protecting the economic and social benefits of transport, as well as the choice available to travellers.

1.16 The Government has also set out its 25 Year Plan to Improve the Environment, which includes a key commitment to embed an 'environmental net gain' principle for development. Building on this, the Environment Act 2021 mandates that new developments, including Nationally Significant Infrastructure Projects[7], will need to deliver biodiversity net gain, ensuring biodiversity is left in a better state post-construction compared to pre-construction.

1.17 HS2 Phase 2b WL will result in an increased mode share for rail journeys for inter-city travel, helping the government meet its net-zero ambition, and has committed to aiming for a net gain in biodiversity.

Improving transport for the user

1.18 Ensuring that our rail infrastructure and train services meet the varied needs and expectations of businesses and the public, while remaining attractive, affordable and sustainable, is a crucial goal for the Government and reflects the priorities identified in the 2021 Williams-Shapps Rail Review.

1.19 As the country recovers from the COVID-19 pandemic, ensuring that transport works for all users will be important in reversing any shift towards car journeys that the pandemic has brought about. Whilst road traffic has almost reached its pre-pandemic level, public transport use, despite showing rapid increases following the end of restrictions in July 2021, has not yet recovered to the same extent. Average bus use in October and November 2021, prior to new winter restrictions coming into place, was at 77% of pre-pandemic usage, with rail slightly lower at 69%.[8] HS2 will not only make rail more attractive for those making long distance inter-city trips, but will also complement wider transport improvements that focus on delivering for the user, such as the announcement that the Midlands and the North will receive a London-style contactless ticketing system to be delivered over the next three years, increasing the value of NPR and wider plans.

[5] Alstom, 2021. The UK's new green age.
[6] Department for Business, Energy & Industrial Strategy, 2021. UK Greenhouse Gas Emissions.
[7] For legislative purposes HS2 is not defined as an NSIP and the biodiversity net gain requirement in the Act is not intended to include HS2.
[8] GOV.UK, 2020. Transport use during the coronavirus (COVID-19) pandemic.

1.20 DfT published its Inclusive Transport Strategy in November 2020, setting out how the future transport network will evolve to better meet the needs of all passengers. In this context, HS2 Ltd has committed to delivering inclusive design in the widest context, so that all aspects of travel (from booking and planning a route, to arriving at and navigating around the station, as well as undertaking the journey itself), work for users of the network. This includes consideration of the end to end journey and seamless integration with local cycling, walking and public transport networks.

1.21 HS2 Phase 2b WL presents an opportunity to provide infrastructure that meets the needs of all users and enables wider improvements to transport networks across the North West.

The Integrated Rail Plan for the North and the Midlands (IRP)

1.22 Published in November 2021, the IRP sets out the largest and most ambitious programme of investment ever seen in the railway, outlining a £96bn strategy of rail construction and upgrades for the Midlands and the North. Transforming connectivity, this plan is designed to deliver increased capacity, faster journeys or more frequent services on eight out of the top ten busiest rail corridors across the North and Midlands. Unlike previous proposals, the plan considers the rail network across the regions holistically, with each project complementing the wider investment. At Manchester, NPR and HS2 will sit alongside other complementary schemes, such as the electrification of the Wigan – Bolton – Manchester commuter corridor, to support the North West and place Manchester at the heart of a highly connected, modern rail network.

Northern Powerhouse and Northern Powerhouse Rail (NPR)

1.23 The Northern Powerhouse is the Government's vision for a super-connected, globally competitive northern economy with a flourishing private sector, a highly skilled population, and world-renowned civic and business leadership. It is central to the overall strategy for delivering inclusive growth across the UK, counterbalancing the dominance of London and the South East and addressing key barriers affecting UK productivity.

1.24 The Northern Powerhouse Independent Economic Review (NPIER), commissioned by Transport for the North (TfN) set out to understand the economic context of the North, looking holistically across strengths, weaknesses and barriers to growth and development. Its overarching conclusion is that a transformed North will depend on investment and improved performance in several critical areas, including skills, innovation and inward investment, in addition to transport infrastructure. It also highlighted the North's distinctive economic strengths, namely:

- advanced manufacturing, with a particular focus on materials and processes
- energy, in particular expertise around generation, storage and low carbon technologies, especially in nuclear and offshore wind
- health innovation, with a focus on life sciences, medical technologies and e-health

- digital, focusing in particular on computation, software tools, design and content, data analytics, simulation modelling and media

1.25 If fully exploited, these strengths, through strategic and targeted investment, alongside the enabling capabilities of financial and professional services, logistics and higher education, could be used to push the North towards its full potential. Good transport links providing connectivity between different economic centres is a key thread running through the report; Transport for the North (TfN)'s 2019 'Strategic Transport Plan' which builds upon the findings of the NPIER, and sets out how transport, including HS2, will contribute to realising the full economic potential of the North.

1.26 An overarching goal of TfN is to facilitate the delivery of NPR. NPR is a plan for rail services across the North that will radically improve capacity, journey times and frequencies between its major cities, enabling the region to function as a single, cohesive and growing economy, and supporting the North's unique strengths. The IRP detailed the Government's commitment to deliver this goal.

1.27 Since 2015, TfN, DfT and HS2 Ltd have worked together on proposals for how NPR might connect to HS2, making use of capacity on sections of HS2 to enable the NPR programme to achieve its aspirations for journey times and service frequencies between major city regions. HS2 Phase 2b WL will provide infrastructure for NPR south of Manchester Piccadilly, allowing the scheme to build on the economic opportunities released through the improved north-south links generated by HS2 and distributing and enhancing these benefits across the North. Further detail can be found within the Benefits of the Phase 2b Western Leg.

Local Growth Strategies in the North West

1.28 Many growth strategies developed in the North West are predicated on the arrival of HS2, with the Proposed Scheme already well integrated with the plans for the regeneration of cities, towns and local centres. For many places, the transformational impact of HS2 combined with NPR should bring about opportunities that would not be realised otherwise.

1.29 The Greater Manchester HS2 and Northern Powerhouse Rail Growth Strategy – The Stops Are Just The Start sets out proposals for local infrastructure investment that is enabled by HS2 and NPR, and will ensure that people are well connected to the new homes and job opportunities these investments offer. The Greater Manchester Combined Authority (GMCA) has already carried out extensive work through the development of this strategy to ensure that HS2 and NPR can realise the wider economic benefits that both schemes have the potential to generate. This includes significant development and redevelopment around both HS2 Manchester stations.

1.30 Wigan Council Town Centre Regeneration Strategy includes an "HS2 Growth Strategy", which places Wigan station as its focal point, taking advantage of HS2 services that will call there, connecting it directly with London. In Carlisle, a station Gateway Plan has been developed to make the station an integrated transport hub to grow the local economy. At Crewe, an Area Action Plan sets out the vision for the upgraded station and the immediate surrounding area. Cheshire East, Cheshire

West and Chester, and Warrington Borough Council are currently preparing a joint business case ensuring that these areas are able to maximise the potential that HS2 has to offer.

Increasing Global Impact

1.31 Following the UK's exit from the European Union, a Global Britain can take advantage of the opportunities that come with our new status as a fully sovereign trading nation. Transport has a core role to play in increasing Britain's global reach, with domestic as well as international connectivity key to supporting global trade in goods and services. Higher connectivity as a result of HS2, alongside other complementary investments, will increase the attractiveness of the UK as a global centre for business. Improving access to Manchester airport and unlocking land around the airport for development can enhance its role as an international gateway.

The Case for Change

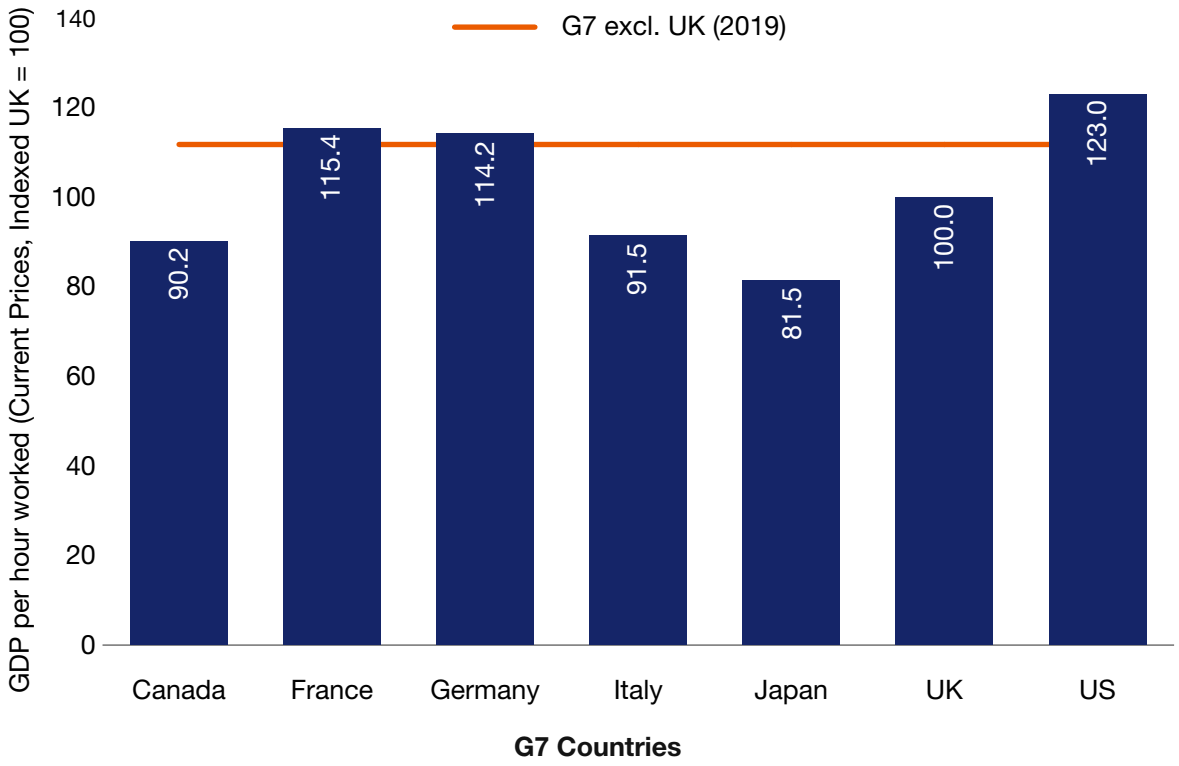
1.32 Over the last 20 years the UK's average investment in its infrastructure as a percentage of GDP has been the lowest in the G7.[9] This, coupled with other factors, such as the decline of major industries which have traditionally supported the northern economic centres, has contributed to an unbalanced national economy in which few areas perform on an equal footing with London and the South.

The need to improve UK-wide productivity

1.33 Productivity, defined in simple terms, is the amount of economic value each of us creates per hour worked. High productivity is key to economic prosperity and is critical in determining standards of living. It is a core determinate of wages, and hence the wealth of the population. However, the UK faces a productivity problem; despite its diverse and resilient economy, it has a long-standing productivity gap compared to the other major economies across the world. UK productivity currently sits below the average across the G7 countries and is only around 80% of that of the strongest economies within the G7.

[9] The World Bank, 2020. Gross fixed capital formation (% of GDP) - United Kingdom, United States, Germany, Canada, France, Japan, Italy.

Figure 1.1: Productivity of G7 Countries measured by GDP per hour worked



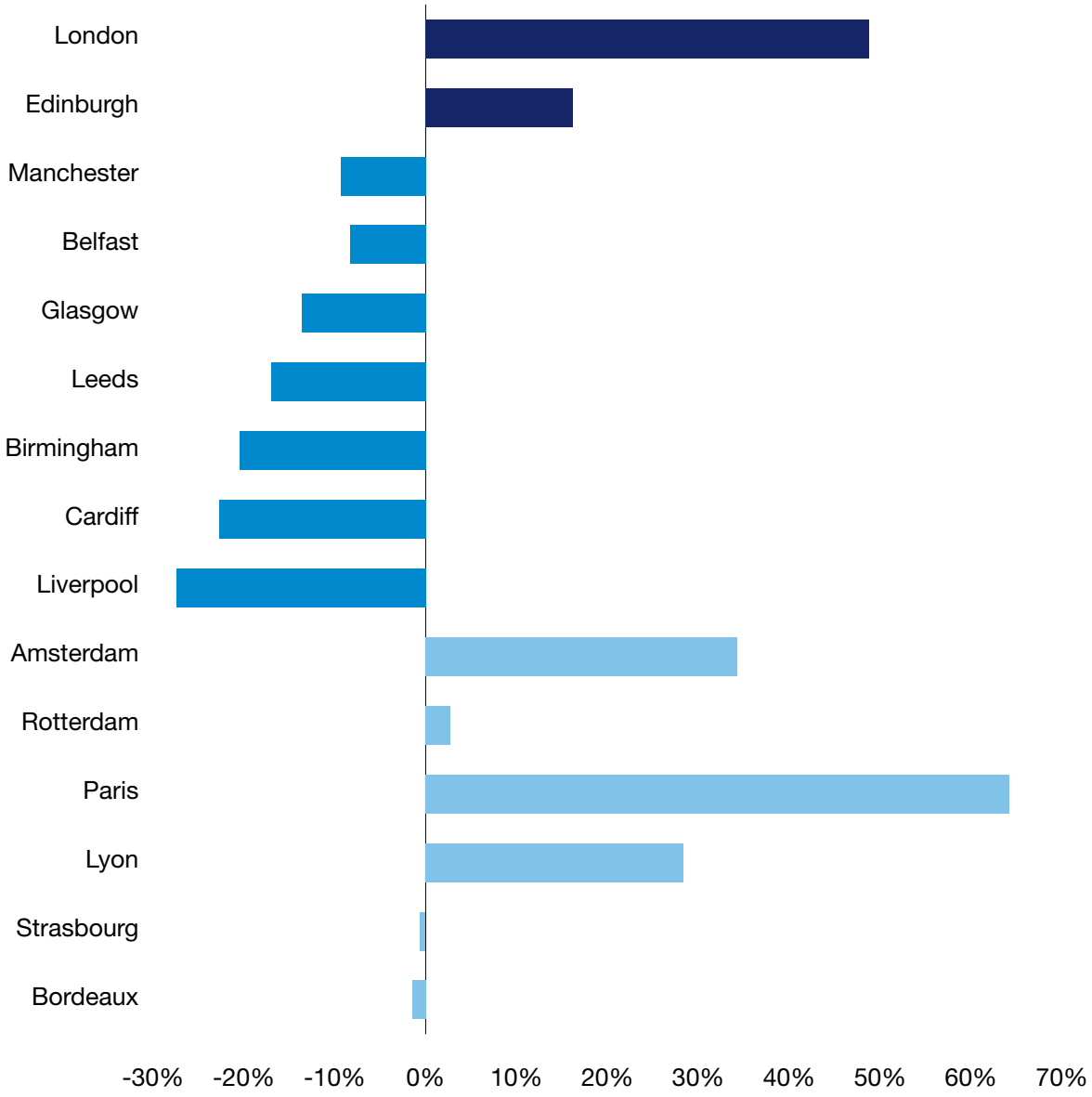
Source: OECD

1.34 When considering productivity at city and regional levels, the problem is even more stark. Many regions of the UK have below average productivity relative to their size and population, with some of the biggest regional gaps among developed countries; this can be attributed in part to high congestion and poor transport links.[10]

1.35 However, poor productivity outside of a nation's core economic centre does not have to be a default position. Figure 1.2 below shows GDP per head as a percentage of the national average for major towns and cities in the UK, The Netherlands and France. Unlike their European counterparts, Manchester, Leeds, Glasgow and Birmingham all sit below the national average for GDP, whereas both the Netherlands and France are able to maintain multiple strong economic centres.

[10] Centre for Cities, 2021. Measuring Up.

Figure 1.2: Percentage difference in GDP per head to national average



Source: OECD data

1.36 Furthermore, when comparing GDP per hour worked, regional UK cities do not perform as well in direct comparison with their European counterparts. For example, Manchester is considerably less productive than Lyon, Hamburg, and Barcelona, which are described by Centre for Cities as being structurally similar to Manchester.[11] OECD data from 2018 shows that Manchester was 30% less productive than Lyon, 27% less productive than Hamburg, and 14% less productive than Barcelona.

[11] Centre for Cities. City factsheet Manchester.

1.37 Current lower levels of productivity result in part from segments of the local economies having become entrenched within the lower skill and low wage sectors. Data shows that the gap in wages between Greater Manchester and the national average has widened over the last decade, with Manchester's wages sitting approximately 6% below the national average.[12] The Greater Manchester Independent Prosperity Review found that the area also has significant gaps in qualification levels and employment rates.

1.38 However, this low productivity does not have to remain entrenched; instead, targeted investment has the potential to allow UK cities to capitalise on their assets more effectively. Estimates by the Centre for Cities show that supporting Manchester, Birmingham, and Glasgow to reach full "productivity potential" could add an additional £33bn (2018 prices) to the UK Economy each year, while helping address regional disparities.[13] Furthermore, OECD calculations based on the UK Annual Survey of Hours and Earnings (ASHE) microdata identify Manchester as the UK city with the highest potential to see increased productivity.

Supporting Agglomeration

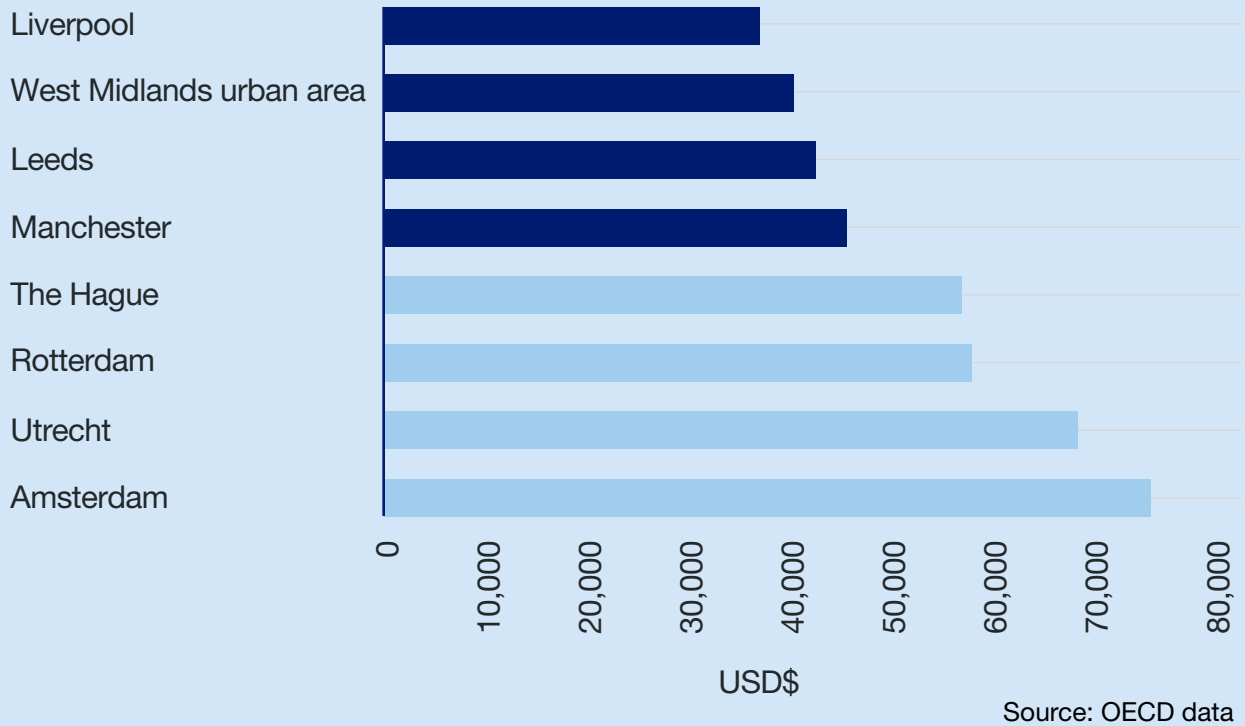
1.39 Agglomeration relates to the benefits that result from businesses and people being close to each other. A lack of agglomeration is frequently cited as a reason for the North and North West's performance gap with the South of England. Employment density measures the number of jobs within a given area and can be used as a proxy for the level of city region agglomeration in the North West. The average employment density for regions in the North West is lower than that of the South and South West, and significantly lower than London. Agglomeration can be driven through the direct expansion of cities, but lack of land availability and the environmental impact of expansion into green spaces make this unsustainable. Instead, improved transport connectivity offers the opportunity to bring city economies closer together.

[12] Greater Manchester, 2021. Local Skills Report & Labour Market Plan.
[13] Centre for Cities, 2020.

Agglomeration Case Study

Comparisons can be made between the North of England and the Randstad region of the Netherlands, as it has a similar concentration of urban areas concentrated close to one another. However, unlike the North of England which has productivity levels significantly below that of London and below the national average, the Randstad has a productivity per worker that is higher than the national average of the Netherlands, and is often considered to be one of the best poly-centric performing regions within Europe.

GDP per Capita measured in USD$ for cities in the Randstad, Netherlands and Midlands and North, UK (2018)



Source: OECD data

Randstad includes the four most populous cities in the Netherlands (Amsterdam, The Hague, Rotterdam and Utrecht). Its population is almost eight million people and it generates around half of the Netherlands' output. The four cities are between 30 and 50 miles apart and served by an extensive road network as well as fast and frequent rail services. The Randstad supports Europe's largest seaport (Rotterdam) and one of Europe's largest hub airports (Schiphol). Agglomeration benefits are most strongly seen within each of the centres, but there are also strong links between each centre, with the cities retaining their unique characteristics and at the same time allowing each other to benefit from their relative proximity and good transport links.

Unlocking the potential of Manchester and the North West.

1.40 Manchester and the North West are well placed to take advantage of this 'productivity potential' realised through higher levels of agglomeration when supported by appropriately targeted investment in transport, in particular large infrastructure investment.

1.41 The North West has a population of over 7 million and is the third most populated region in the United Kingdom, after the South East and Greater London.[14] The region has the largest concentration of advanced manufacturing and chemicals production and largest media hub outside of London and is home to major global manufacturing companies such as BAE Systems (3 sites across Lancashire and Cumbria), Unilever (Birkenhead),Astra-Zeneca (Macclesfield and Speke) and Siemans (UK Head Office in Manchester). Furthermore, as identified in the NPIER, the North as a whole has unique characteristics that can be further exploited, with existing key strengths in advanced materials, energy, health innovation and the digital sector.

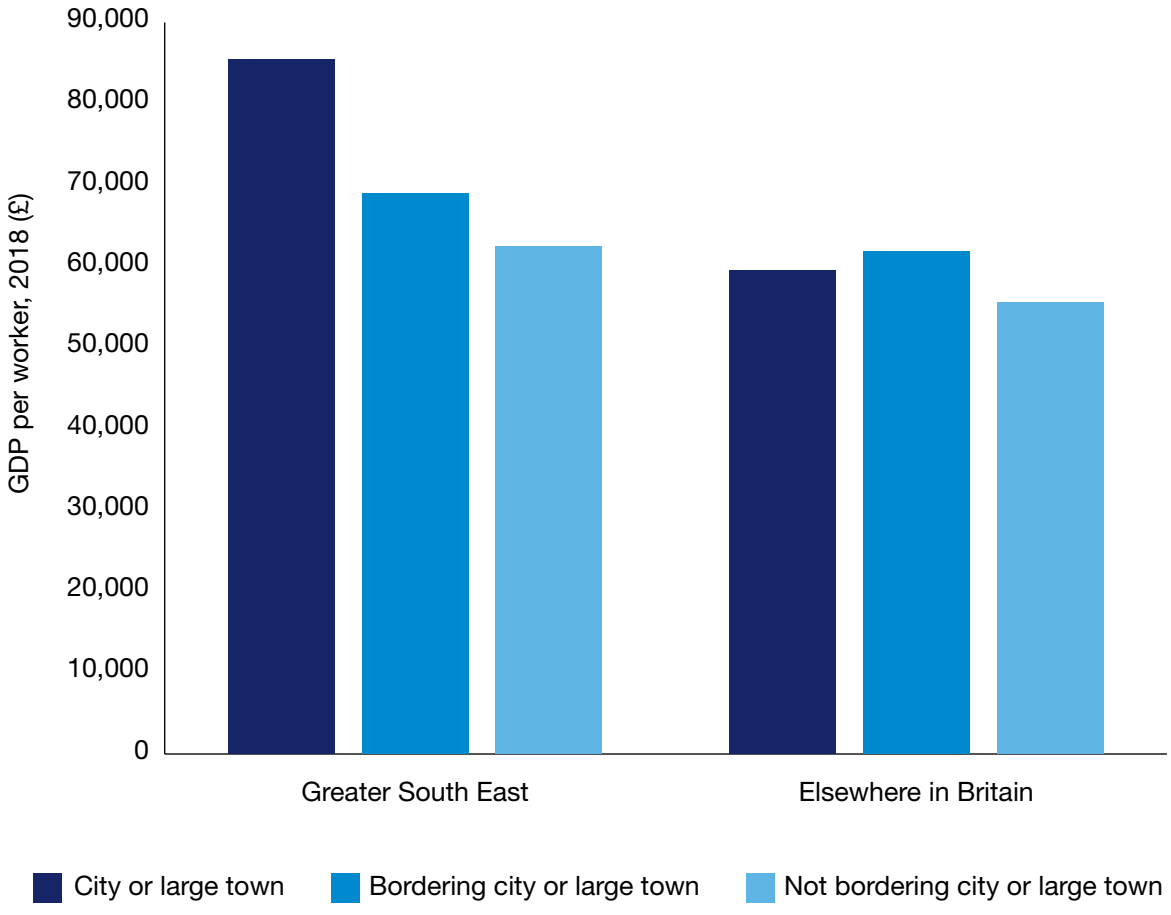
1.42 Regions rely on the strength of their cities to drive growth and productivity across smaller towns and rural areas. Cities are the engines of the economy and with metropolitan areas comprising 72% of the UK's GDP in 2019.[15] Increasing specialisation in knowledge-based activities, and the continued importance of face-to-face interaction for these industries, mean they will have an important role in the performance of the UK economy as it recovers and rebuilds.

1.43 The North West region already relies heavily on Greater Manchester as the engine of its economy. Greater Manchester is a thriving city and despite poor productivity when compared to London, produces a higher GDP output per head than any other city region in the North West.[16] The city centre, as the main driver of productivity, hosts over 140,000 jobs,[17] and is dominated by key growth sectors, including professional and financial services, cultural, creative and digital industries, and research, science and biosciences. Manchester already has a skilled labour force and clusters of productive industries, making it a great place to target transport investment to encourage growth. For example, Greater Manchester has the largest digital and creative sector outside of the South East, centred around Media City in Salford, with further potential to create an internationally significant cluster of businesses around areas such as broadcasting, content creation and media.[18]

[14] Office for National Statistics, 2021. Estimates of the population for the UK, England and Wales, Scotland and Northern Ireland.
[15] OECD, 2022. Metropolitan areas.
[16] Office for National Statistics, 2021. Regional gross domestic product: city regions.
[17] Greater Manchester Combined Authority, HS2 and NPR Growth Strategy.
[18] GOV.UK, 2019. Greater Manchester Local Industrial Strategy.

1.44 Therefore, the importance of economic growth in Manchester is critical to supporting smaller cities and towns in the North West. Towns geographically closer to successful cities, on average, have better employment outcomes, stronger economies, with larger shares of high-skilled exporting businesses in their economies. To strengthen regional towns in the North West, it is essential that Manchester's status as a successful city is further reinforced. The importance of cities in elevating the economies of surrounding towns is highlighted in Figure 1.4. This figure, based on ONS data, compares the GDP output of towns surrounding cities or other large towns with those not bordering a city or large town for both the South East and elsewhere in Britain. It demonstrates that towns are stronger when they have close links with a city, with this being especially true of those surrounding London.

Figure 1.4: Productivity across Great Britain



Intercity connectivity must be improved to achieve UK-wide growth

1.45 Good transport infrastructure provides the capacity needed to meet current and future passenger demand, and supplies the fast and direct connections needed between important destinations and economic clusters, creating agglomeration economies by effectively shrinking the distance between them.

1.46 Current journey times, crowded trains and reliability of services means that connectivity between Britain's major cities, in particular between cities in the Midlands and the North, is poor. The result is that passengers are disincentivised to travel between these places, restricting access to labour supply for businesses and resulting in fewer businesses trading with each other. Reducing journey times allows workers to travel further within the same time, increasing job opportunities for individuals and widening the labour market supply for businesses.

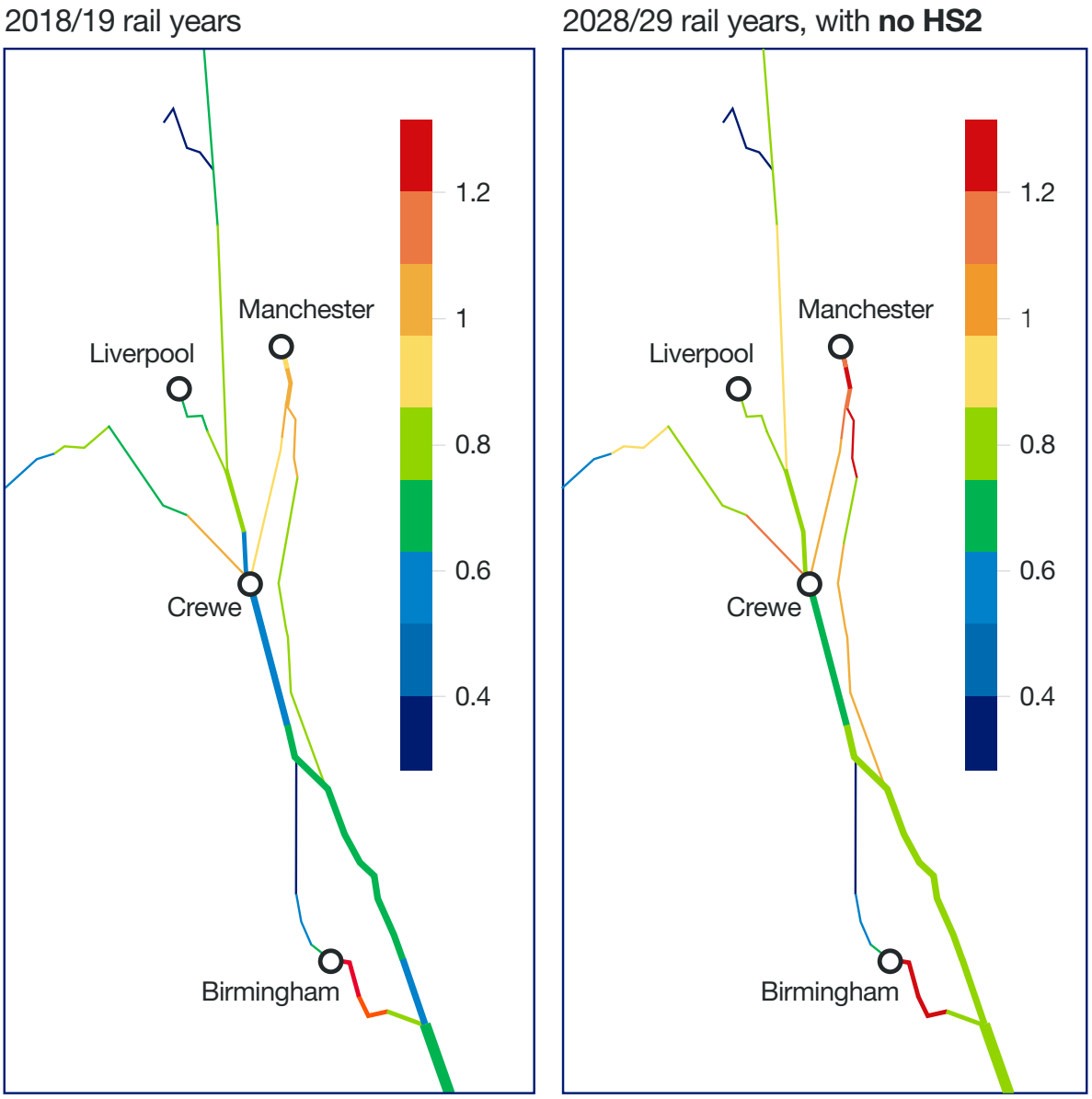
1.47 The WCML is the UK's key strategic rail corridor that connects the UK's biggest economic regions, the North West, the Midlands, the South East and Scotland. It carries a mix of passengers for business, leisure and commuting, and freight traffic for nearly 20 hours per day. Over 40% of all national rail freight uses the WCML.[19]

1.48 Capacity constraints on the route have resulted in years of overcrowding, with many passengers forced to travel in uncomfortable conditions and many commuter passengers having to stand on services in and out of Britain's major cities each day.

1.49 Between 1998 and 2008, Britain invested £14bn to upgrade the existing WCML. The upgrade was designed to increase peak service levels on the fast lines into Euston, from nine trains per hour (tph) to 13-14tph, and reduce journey times, such as those between London and Manchester, by around 20%. This work demonstrated the ability of improvements to the network to bring about increases in demand; since the upgrade was completed, the WCML has seen a period of extraordinary growth and this has continued every year since, up until the pandemic – including during the economic downturn from 2008. In total, passenger journeys grew from 13.2m in 1996/97 to 39.5m in 2018/19, representing growth of 199% since 1996/97, compared to 119% on the wider rail network. This growth has, however, also created a system that is again at risk of reaching capacity, with further infrastructure investment required to accommodate future growth. An ORR report, published February 2020, on WCML Capacity concluded that there is no available capacity on the WCML without significantly impacting performance and causing a reduction in timetable resilience.[20]

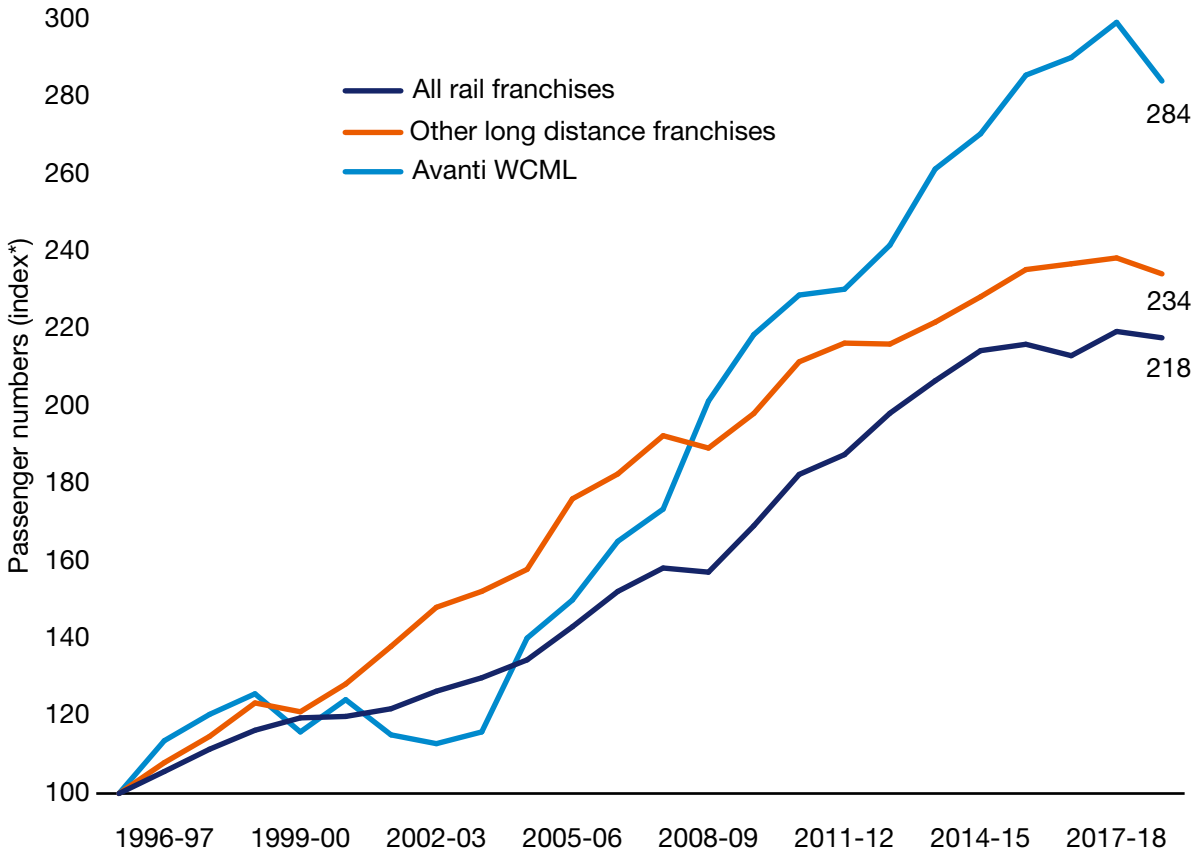
[19] Department for Transport, 2015. Demand and Capacity Pressures on the West Coast Main Line.
[20] ORR, 2020. West Coast Main Line Capacity Assessment.

Figure 1.5: Passenger Crowding on Avanti West Coast Trains: 1 hour AM peak



Colour of the line illustrates the loading factor. A loading factor of 1 means all seats are taken, above 1 means some passengers have to stand. Thickness of the line illustrates the capacity (number of seats). The thicker the line, the more seats on a given link. The growth rate assumed in the graphs does not include COVID-19 impacts beyond its effect on employment and GDP (i.e. no behavioural changes). Source: Interpolated MOIRA 2.2 loading report data; 2018/19 base year grown using December 2020 DDG vintage.

Figure 1.6: ORR data showing rail passenger growth since 1996 for Avanti WCML services, other long distances operators and all rail franchises



*The index represents growth of each series as a proportion of its 1997/1998 base year, to show growth rate.

1.50 HS2 Phase One will provide a step-change increase in capacity between London and Birmingham. However, the poor capacity, connectivity and reliability of the rail network into Manchester has the potential to continue to isolate labour markets. This will mean less economic interaction between our biggest economic centres, resulting in a loss of agglomeration benefit, impacts to business productivity, and a reduced ability to compete for individuals and firms deciding where to locate.

Local and regional capacity and connectivity issues exacerbate issues created by poor national connectivity

1.51 Greater Manchester and the North have seen significant rail passenger growth in recent years; ORR data shows that daily passenger journeys within the North West have quadrupled from just over 25,000 in 1995/96 to over 100,000 in 2019/20, leading to poor performance and crowding.

1.52 Outside of London, Manchester is consistently within the top 5 UK cities for rail crowding in the morning peak. 2019 Data shows that 10.2% of passengers were standing arriving into Manchester in the morning peak.[21]

1.53 Physical capacity to run more trains on the network is constrained in the North West and particularly on the approaches to Manchester, with a bottleneck in the Stockport area. This creates reliability issues, and also means that many local stations in the South Manchester and Cheshire East area have a poor frequency of service due to lack of capacity on this corridor, which is used by 6 different train operating companies (Avanti West Coast, Cross Country, Northern, Transpennine Express, East Midlands Railway and Transport for Wales). Data published by Transport Focus, based on surveys of passengers using all Network Rail stations, has found that respondents were more likely to have experienced delays or cancellations at Manchester Piccadilly when compared to the average across all major stations, reflecting the line capacity issues that the Manchester area currently experiences.[22]

1.54 Solving capacity issues for local services moving through the Stockport area is important for residents in the Places for Everyone Plan area (Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Tameside, Trafford and Wigan), with the Greater Manchester Independent Prosperity Review concluding that Greater Manchester's future growth, prosperity and sustainability will be restricted unless ambitious and long term infrastructure solutions are found.

1.55 Capacity issues also exist at Manchester's stations. Manchester Piccadilly is the city's largest station, serving over 30 million passengers per year. It was built in the 1900s and despite it being the third busiest station outside of London[23] much-needed investment has been minimal. ORR data shows that annual passenger numbers at the station have risen over 58% in the 10 year period 2009 to 2019, with an additional 20 million passengers annually.[24] The station suffers from overcrowding and limitations to its infrastructure, impacting network performance and passenger experience. Crowding problems are concentrated on Platforms 13 and 14, which currently serve Manchester Airport as well as a wider range of destinations.[25]

1.56 There are also wider access issues to Manchester Airport, with rail access limited by the fact that it sits on a short branch line, with no direct services from London or Birmingham. Enhanced connectivity would help the airport to utilise its capacity fully (55 million passengers per annum),[26] open up new routes and increase services to key growth markets in line with the National Aviation Strategy.

[21] GOV.UK, 2019. Rail Passenger Numbers and Crowding on weekdays in major cities in England and Wales.
[22] Transport Focus, 2019. National Rail Passenger Survey.
[23] GOV.UK, 2020. Estimates of Station Usage.
[24] GOV.UK, 2020. Estimates of Station Usage.
[25] Northern Railway, 2020. New team tasked to tackle crowding on Piccadilly platforms 13 and 14.
[26] Parliament.UK, 2012. Transport Committee.

New infrastructure will drive regeneration and encourage inward investment

1.57 Experience from the Kings Cross area in London and the area around Curzon Street Station in Birmingham demonstrates the ability of new high-quality rail infrastructure to bring in local private sector investment as construction starts. The transformation at Kings Cross is now almost complete with an underused industrial wasteland transformed into a new part of the city with homes, shops, offices, galleries, bars, restaurants, schools, a university and high profile businesses and organisations including Google and The Crick Institute.

1.58 The positive impact of HS2 can already be seen in Birmingham. Birmingham City Council (BCC) is integrating HS2 into its local plans for economic regeneration, such as the Enterprise Zone (EZ), which is a 113ha area across 39 sites created in 2011, to maximise early opportunities from HS2. HS2 Ltd is working with BCC to accommodate scope enhancements to facilitate and support the Big City Masterplan.

1.59 Furthermore, the latest systematic review of evaluation evidence on the impact of high-speed rail investment from across Europe, US and Japan on economic geography shows that investment in high-speed rail has often changed the distribution of businesses to create more highly productive areas in the vicinity of stations (summary of evidence is given in Annex 3).

1.60 The area around Manchester Piccadilly is a natural area for central Manchester to expand into in the next 20 years – as set out in Manchester City Council's Strategic Regeneration Framework (SRF). Much of the area is currently underdeveloped industrial land. There is substantial opportunity for development of commercial space, housing and public realm on this land, creating a sense of place and vibrancy which is currently lacking in the area around the station. HS2 investment along with NPR would make Manchester the best-connected city outside of London, bringing forward regeneration plans and creating a unique place to invest.

1.61 There is also opportunity for significant growth around Manchester Airport. Manchester is the UK's largest airport outside of London. It serves 28.2 million passengers annually, more than some of the world's major aviation hubs. Its role in providing access to international markets means that the airport is central to the delivery of a successful Northern Powerhouse economy. Over 300 businesses are based on the airport sites and there are 22,000 direct on-site jobs and a further 45,000 jobs in the wider economy that rely on the airport.

Transport is essential in maintaining and growing the tourism industry in the North

1.62 The visitor economy sector is a significant provider of employment in the North, directly supporting 39,000 businesses and 579,000 jobs, while also supporting many more jobs indirectly through the supply chain.[27]

1.63 The visitor economy is an important feature of urban, rural and coastal communities across the North, and in many places accounts for a significant share of local economic activity. For example, Cumbria and North Yorkshire have some of the highest shares of overall economic output which is attributable to tourism in comparison to all other UK sub-regions.

1.64 Transport is a key enabler for the visitor economy. A study by Transport for the North has identified that the North's transport network supports significant flows of visitors, particularly from the North's urban areas to other urban areas, rural and coastal areas within the North, as well as from other urban areas in Britain to the North.

Sustainable intercity travel for a net zero future

1.65 As well as the legislative requirement to reach a net zero target by 2050, taking forward measures to decarbonise transport and clean the air around us will save lives and improve health. Domestic transport has the largest share of UK greenhouse gas (GHG) emissions of any sector across the economy, at 27% in 2019.[28] While other industries, such as the power sector, have taken substantial steps in decarbonising over recent years, transport has been unable to make the same level of progress and remained broadly level in overall national emissions. In addition, the transport sector remains one of the largest sources of air pollution in the UK, and Public Health England estimate that poor air quality could cost health and social care services in England £5.3 bn by 2035.[29] Furthermore, the Royal College of Physicians has estimated that 40,000 deaths a year in the UK can be linked to air pollution.[30]

1.66 In its Transport Decarbonisation Plan, DfT has outlined that the electrification of road vehicles and the increased efficiency of domestic air travel alone will not be enough to achieve the Government's 2050 target. To achieve its emission reduction targets, the UK must work to decarbonise the movement of people and goods. This can only be achieved through behaviour change, modal shift and the development and implementation of new low-emission technologies and fuels. Boosting the number of journeys made by public transport and active travel forms is a key priority in delivering significant transport decarbonisation.

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[27] Transport for the North, 2021. Improving transport to support sustainable growth of the North's visitor economy.
[28] GOV.UK, 2021 Transport and environment statistics: Autumn 2021 - GOV.UK.
[29] GOV.UK, 2018 Nitrogen dioxide: effects on mortality
[30] Royal College of Physicians, 2016. The lifelong impact of air pollution.

1.67 Shifting trips to rail can reduce emissions, even as the number of low and zero tailpipe emission vehicles on the roads increases. Rail is already the greenest form of motorised transport and currently represents the most sustainable form of intercity travel, with almost 38% of the network electrified, and much more planned. Through seamless integration with local and regional transport networks we can make many more door-to-door journeys using rail as the main leg quicker, and by improving reliability and capacity on the network, travellers will feel able to make the decision to move to rail as the preferred form of travel. However, as demonstrated on upgrades to the WCML, despite significant recent investment in the existing network, the strong demand growth seen pre-pandemic has meant that additional capacity that was previously created is already being used up, limiting the potential for further growth of long distance rail journeys, and effecting passenger decisions on using the network. The scheme is forecast to reduce the number of road journeys by 30 million and domestic aviation journeys by 25 million.

1.68 The environmental challenge for the UK's transport network is exacerbated further by the fact that the conventional railway, originally built in the Victorian age, was not originally designed to withstand the scale of change in environmental conditions that future generations are likely to be exposed to (such as more frequent and more severe flooding events or higher weather temperatures). Designing and constructing a new railway, rather than simply upgrading existing lines, provides additional resilience for the whole railway network by designing and building the new infrastructure to mitigate the risks presented by these future challenges. Whilst no single weather event can definitively be assigned as due to climate change, the flooding on the rail network in the Greater Manchester area in January 2021 as a result of Storm Christoph is a good example of the challenges currently faced.

Improving the wider environment

1.69 Carbon reduction, whilst critically important in limiting the impact of climate change, is only one part of wider efforts required to address the environmental damage that has occurred worldwide largely as a consequence of rapid economic development. We are also experiencing a biodiversity crisis, with the impacts of climate change increasing the rate of decline in biodiversity.

1.70 Globally, there is an unprecedented decline in nature with the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) reporting that there are over one million species at risk of extinction without 'transformative changes'. The Environment Act 2021 mandates that new developments, including Nationally Significant Infrastructure Projects, will need to deliver biodiversity net gain, ensuring biodiversity is left in a better state post-construction compared to pre-construction.

1.71 The pandemic has shown us all the difference nature makes to peoples lives. As the independent Dasgupta Review: The Economics of Biodiversity has highlighted, access to nature can also help empower citizens to make informed choices and demand the environmental change that is needed. On Phase One and Phase 2a HS2 Ltd has been assessing the challenges and benefits of agreeing with land

owners better public access along new maintenance access tracks or legacy construction roads along the new railway. In some cases these might be joined up with existing or diverted rights of way to provide alternatives to the car between rural communities while also providing easier access to appreciate nature.

Building the UK's skills capability

1.72 High quality education and skills training play a vital role in sustaining productivity growth and our international competitiveness: improvements in skills accounted for 20% of the UK's productivity growth before the financial crisis.[31]

1.73 The OECD Skills for Jobs database (2019) reveals several skill pressures in the UK, including shortages of technical skills in technology, engineering and science, and it is acknowledged that the UK's skills system is less competitive internationally in areas such as technical skills and basic adult skills. A particular challenge is the pipeline of technical skills: the UK has persistent technical skills shortages in key sectors such as construction and manufacturing. Only 4% of young people achieve a higher technical qualification by the age of 25, compared to 33% who get a degree or above.[32] Since the 2000s, the number of people in higher technical education as a whole has fallen.

1.74 HS2 presents a huge beneficial opportunity to address this short fall in technical skills skills and leave a legacy of deepening the UK based talent pool in construction and rail engineering. The project has a dedicated Skills, Employment and Education workstream and in August 2021 HS2 Ltd published its report 'Building the Skills to Deliver HS2' in which it sets out how it will both address the technical skills shortage and support increased diversity within the workforce. Whilst detail on the exact benefits of Phase 2b WL is not yet available due to the maturity of the scheme, work around skills, employment and education will reflect the measures already in place for Phases One and 2a, with the project offering direct support through apprenticeships, workless jobs starts, professional status attainment, support for further education, schools engagement and work placements.

1.75 To date the project has been able to offer 650 apprenticeships with the ambition to create at least 2,000 over the entire programme (including Phase 2b WL). HS2 Phase One is currently supporting over 20,000 jobs and estimates for Phase 2b WL suggest a peak workforce of 17,500, offering employment opportunities in both construction and railway engineering.[33]

[31] GOV.UK, 2021. Build Back Better: our plan for growth.
[32] GOV.UK, 2018. Post-16 education: highest level of achievement by age 25
[33] HS2. Building Skills To Deliver HS2.

Strategic Goals and Scheme Objectives

1.76 From the outset of the HS2 Programme, it has been recognised that HS2 has the power to be more than a railway, and in order to meet this ambition, seven HS2 strategic goals as set out in the HS2 Corporate Plan have developed to reflect the potential of the full scheme to be a platform for transformative change within the UK.

1.77 Each of the HS2 strategic goals is supported by a number of scheme-wide strategic objectives covering the build, delivery and operation of the full HS2 programme. These objectives have been developed as part of a wider benefits framework to ensure that the full HS2 Programme is actively managed to enable it to deliver on its overarching goals.

1.78 Phase 2b WL has a further set of objectives, which relate specifically to the aims of this phase. These objectives are to:

Connect the largest economic regions and cities across the UK, through the provision of a step-change in connectivity and capacity

Enable significant enhancements to the conventional rail network across the North West and the North, freeing up much needed capacity on key bottlenecks as well as providing critical infrastructure to allow the delivery of NPR and new Metrolink routes.

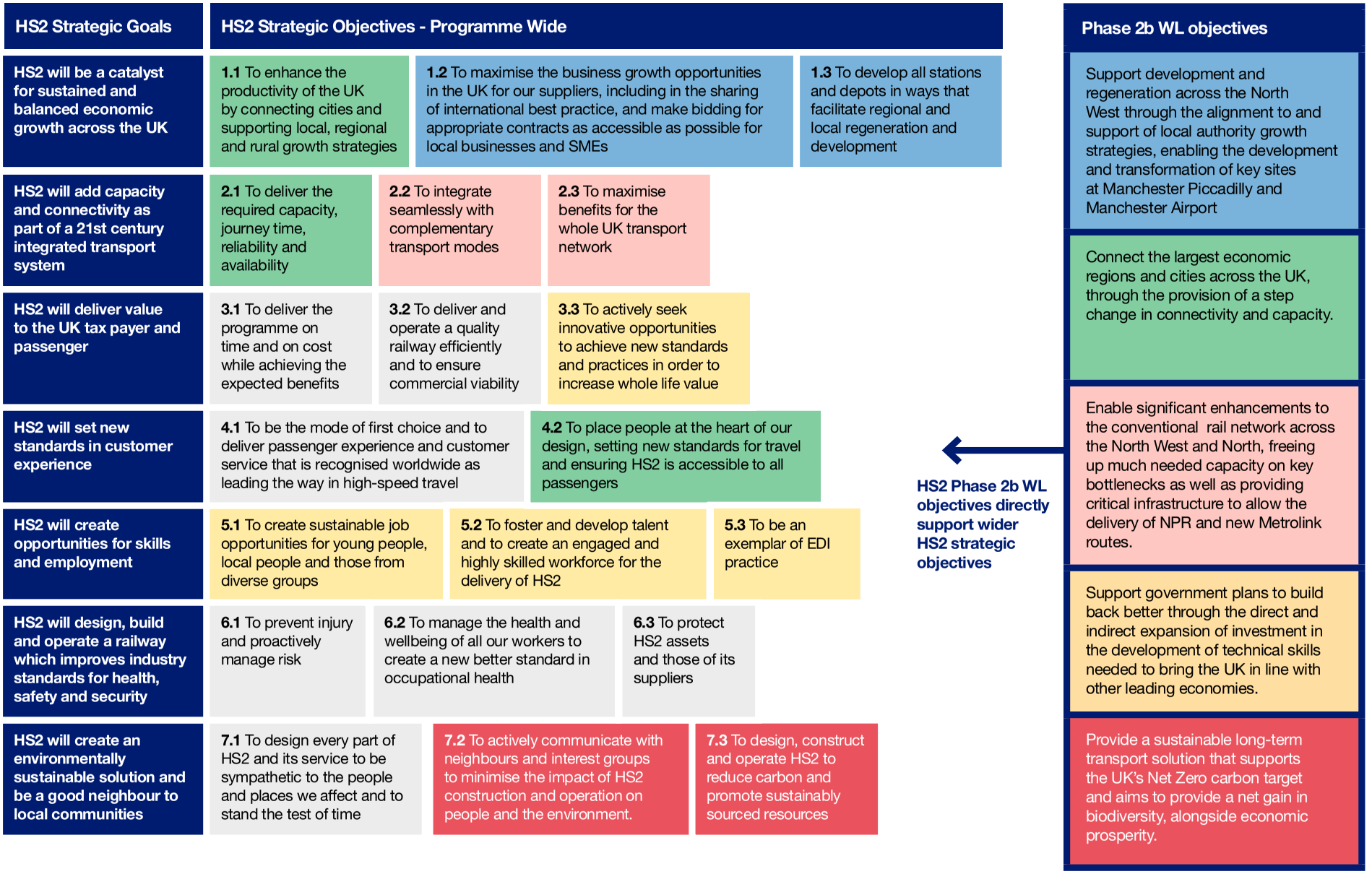
Support development and regeneration across the North-West through the alignment to and support of local authority growth strategies, enabling the development and transformation of key sites at Manchester Piccadilly and Manchester Airport.

Support government plans to build back better through the direct and indirect **expansion of investment in the development of technical skills** needed to bring the UK in line with other leading economies.

Provide a **sustainable long-term transport solution that supports the UK's Net Zero carbon target** and aims to provide a net 10% gain in biodiversity, alongside economic prosperity.

1.79 Figure 1.7 demonstrates how the Phase 2b WL scheme objectives contribute to the seven strategic goals and objectives of the HS2 programme.

Figure 1.7: The HS2 Strategic Goals, HS2 Strategic Objectives and the Phase 2b WL Scheme Objectives



Benefits of the Phase 2b Western Leg

Assessing the full benefits of HS2

1.80 Transport schemes are rarely stand-alone schemes. Transport exists as an enabler, to facilitate access to businesses, markets, employment, education, leisure, health care and other services. The better the transport network, the wider the breadth of opportunity available, with transport improvements able to impact positively on multiple spheres of life.

1.81 The economic benefits which flow from investment in transport schemes can create a feedback loop in which the initial user and direct business benefits generated by the scheme, trigger further additional investment. This can create transformational changes to the use of land in relative proximity of the scheme, for example, using former brownfield sites for the creation of new housing or business developments near a new station. This in turn creates more demand for travel to and from the location and increases direct user and business benefits.

1.82 The core economic modelling, undertaken as part of the Economic Case for the Phase 2b WL indicates a BCR range of between 0.6 to 1.7. In economic terms this represents a return of between 60 pence and £1.70 for every pound spent on the scheme. The benefits within the BCR range are derived from direct transport user and business benefits and also capture a wider range of economic benefits, such as increased agglomeration. However, the BCR does not necessarily capture the full transformational change impact and additional resulting benefits that are expected to be realised from the Phase 2b WL.

Wider Economic Impacts

1.83 In 2019, the independent HS2 review, led by Sir Douglas Oakervee, set out several conclusions relating to the economic assessment of HS2. It concluded that previously published evidence on HS2 "has considered the impacts of the full HS2 network in line with the HM Treasury Green Book and DfT's Transport Appraisal Guidance (TAG)," but went on to state that there are "wider economic impacts that have not been quantified as part of the HS2 Phase One Business Case".

1.84 Furthermore HM Treasury's Green Book guidance has now been refreshed and additional emphasis has been placed on the increased importance of place-based analysis to help drive the 'levelling-up' agenda, with the core BCR only forming one part of the decision making process, including the value for money assessment.

1.85 In response to the findings, DfT has worked to capture these wider economic impacts (WEIs) through both the Strategic Case and in monetary terms, with additional economic analysis being undertaken to estimate the potential range of these benefits. The details of this analysis can be found in the Economic Case and in Annex 3. Estimating these 'transformational impacts' is challenging and cannot currently be done with a high degree of precision or certainty. However current estimates, taking into account the full macroeconomic equilibrium changes in markets and allowing for changes in land use, place the per annum GDP impacts from the scheme as c£0.8bn in 2051.

1.86 In order to fully realise these wider transformational changes, complementary investment to ensure adequate availability of land, a workforce with suitable skills, and the willingness of economic actors to invest, is required. A figure demonstrating this theory of change is presented in Figure 1.8.

Figure 1.8: Theory of Change – From inputs to impacts

Inputs

- **Direct investment in HS2 infrastructure**
  - Track, rolling stock and Manchester stations
  - Enabling works for complementary schemes
  - Biodiversity improvements
- **Investment in skills**
- **Complementary Schemes**
  - Eg Northern Powerhouse Rail
- **Wider public and private investment**

Outputs

- High-speed infrastructure between Crewe and Manchester
- New link to West Coast Mainline
- Additional rolling stock
- New stations at Manchester Piccadilly and Manchester Airport
- Passive provision for NPR and Metrolink
- Improvements to Strategic Road Network
- Net gain in biodiversity
- More carbon efficient way of inter city travel
- Increase in technical skills within UK

Impacts and Outcomes

Transport and Environmental Outcomes

- Reduced journey times (average minutes)
- Increased capacity (seats)
- Improved train frequency (number of trains)
- Improved reliability on conventional network as a result of removing traffic from bottlenecks
- Environmentally friendly transport (more carbon efficient)
- Enables further transport schemes (NPR and Metrolink expansion)
- Reduced congestion on the strategic road network around Manchester Airport

Economic Impacts

These can be defined as 3 different 'orders' which create a feedback loop

1st order impacts

- Reduced costs of face to face service provision
- Easier interaction for staff and customers of existing businesses supporting growth.
- Business productivity benefits from agglomeration
- Increased output of goods and services
- Reduced commuting times widening labour pool

2nd order impacts:

- Local growth
- Regeneration and private sector investment

3rd order impacts:

- Further induced investment
- Dynamic land use change

Together these impacts can support a move towards a unified, well connected UK economy which enables levelling up, supporting regeneration in Manchester and the wider North West

Environmental Impacts

- Reduced level of CO_2 emissions from transport
- Increased level of CO_2 emissions during construction (largely from steel and concrete production with strategies in place to minimise)
- A more biodiverse landscape

Social Impacts

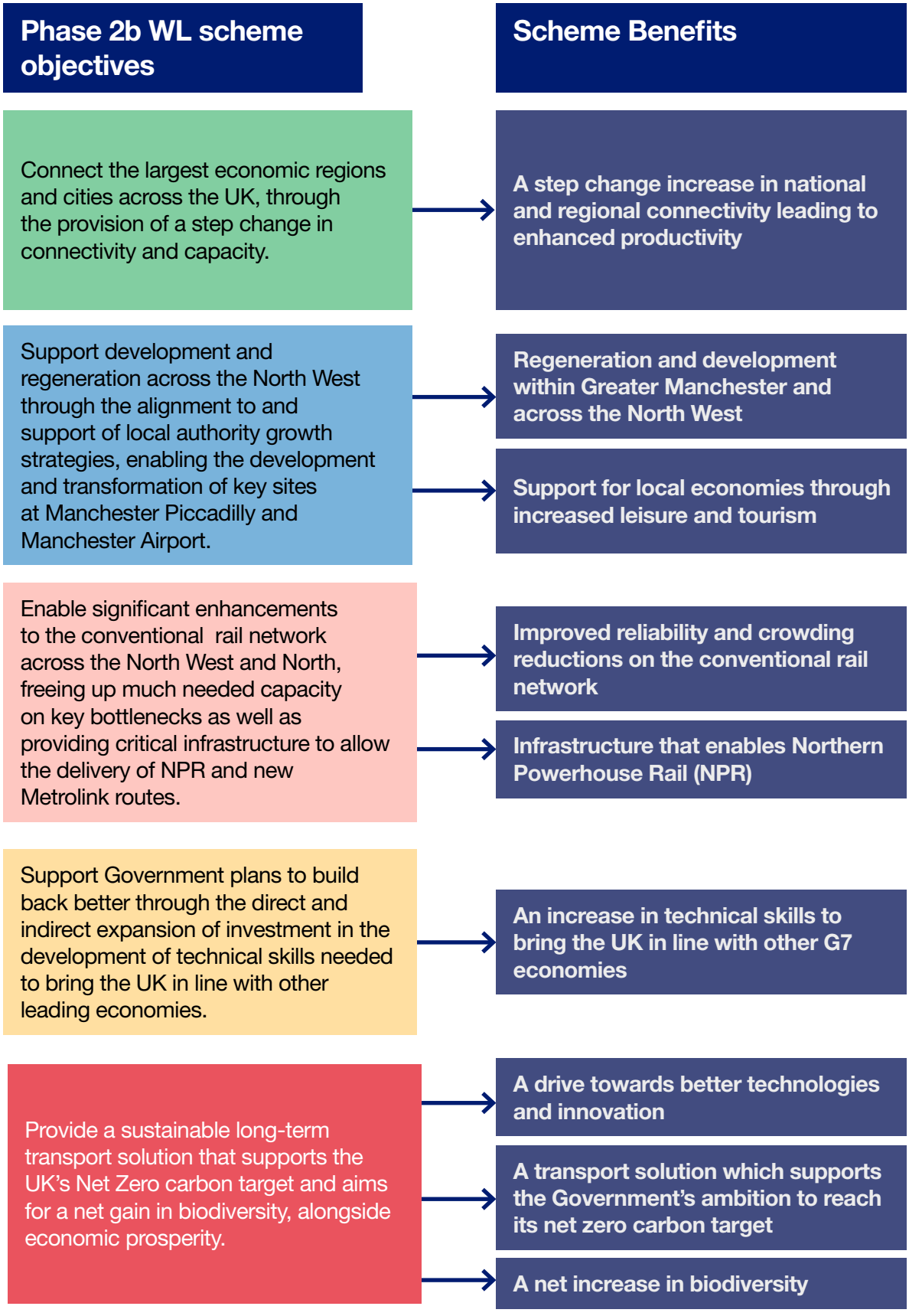
- People are able to make more trips for leisure and social purposes
- Improved standard of living

Phase 2b Western Leg benefits

1.87 In order to demonstrate how the scheme will advantage the UK and contribute to the Government's goal to level up, the benefits are explored under the following headings which relate directly to the phase-specific objectives for the scheme.

- A step change increase in national and regional connectivity leading to enhanced productivity
- Improved reliability and crowding reductions on the conventional rail network
- Infrastructure that enables NPR
- Regeneration and development within Greater Manchester
- Alignment with and support of North West Local Authorities' Growth Strategies
- Support for local economies through increased leisure and tourism
- A transport solution which supports the Government's ambition to reach its net zero carbon target
- A net gain in biodiversity
- An increase in technical skills to bring the UK in line with other G7 economies
- A drive towards better technologies and innovation

Figure 1.9: Linking scheme benefits to scheme objectives



A step change in national and regional connectivity leading to enhanced productivity

1.88 As the first major north-south railway line built in Britain in over 120 years, HS2 symbolises a transformational investment in Great Britain's rail network and will form the backbone of a revitalised integrated transport system. HS2 Phase 2b WL will deliver the critical high-speed infrastructure to directly link the North to the Midlands and London – better connecting the UK's largest economic centres (London, Manchester and Birmingham, Edinburgh and Glasgow) and bringing in the capacity and connectivity improvements that will trigger transformational change, supporting the North to realise its full potential and enhancing Union Connectivity.

1.89 Once complete, journey times between London Old Oak Common (OOC) and Manchester will be around an hour, with Euston just 1 hour 11 minutes (currently 2 hours 5 minutes) from Manchester Piccadilly. The capacity of the London-Manchester route will also be enhanced with the Proposed Scheme creating the ability to run much longer 400 metre trains on the captive high-speed network.

1.90 Furthermore, the Proposed Scheme creates capacity for direct high-speed services between Manchester and Birmingham. With a journey time of just 41 minutes, these services will more than halve current journey times between Manchester and Birmingham, the two biggest economic centres outside of London. When combined with existing services on the conventional network, the scheme also doubles the number of trains running between the two cities each hour.

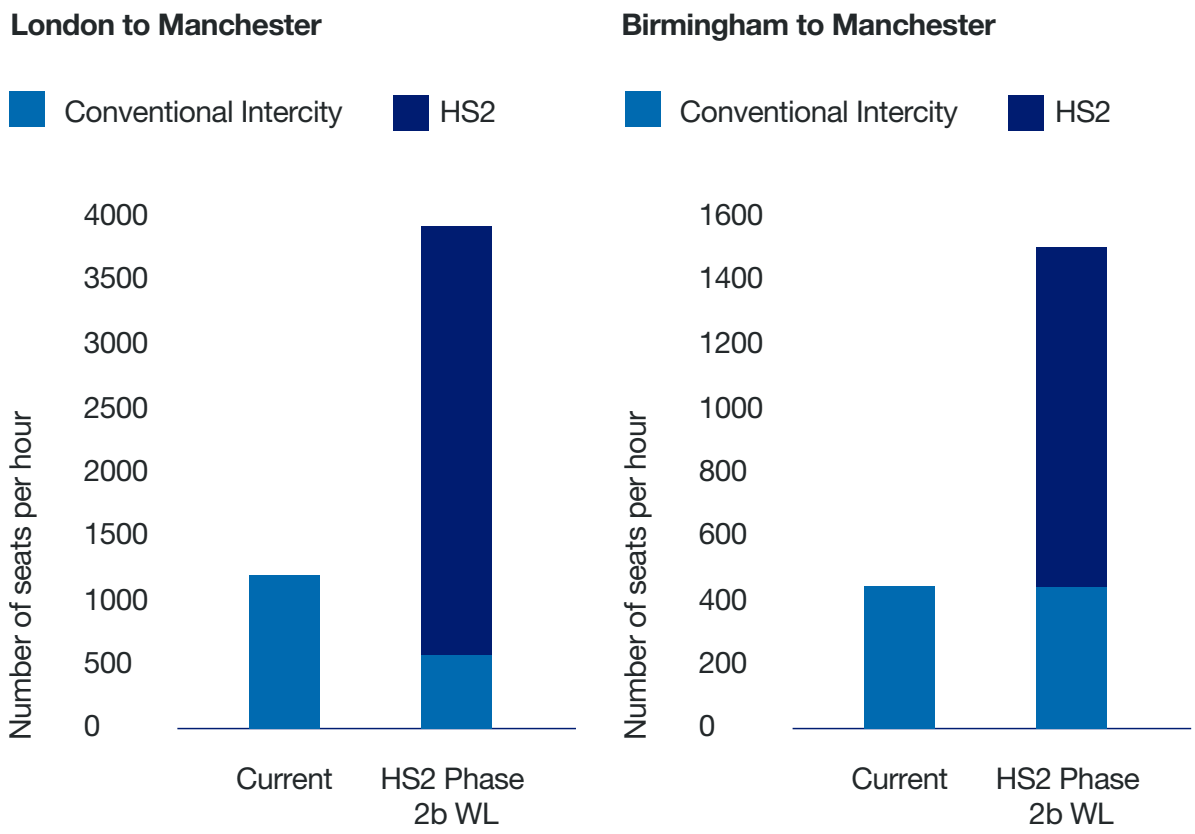
1.91 HS2 Phase 2b WL also further builds upon the improvements to Union Connectivity that Phase 2a will bring, bringing the capacity requirements that are highlighted in the November 2021 Union Connectivity Review. The additional paths created as a result of the Proposed Scheme represent a step change in high-speed capacity to Scotland. HS2 Phase 2b WL enables a quadrupling of high-speed capacity on trains to Scotland when compared with Phases One and 2a. Furthermore journey times to Scotland from Birmingham are significantly shortened saving at least 42 minutes on the current fastest time to Edinburgh using the conventional rail network. Based on current timetabling assumptions, the Proposed Scheme will allow for three high-speed services each hour, two of which will start from London and serve both Edinburgh and Glasgow, the third beginning at Birmingham Curzon Street serving Glasgow and Edinburgh on alternate hours.

Figure 1.10: Journey time savings from the Proposed Scheme in comparison to 2019

1.92 Seating capacity between key destinations across the UK will see a substantial increase as a consequence of the scheme. It could more than double capacity between Manchester and London, from around c.1800 (in 2019) to 3900 seats per hour in each direction, and more than treble capacity between Manchester and Birmingham (from 450 to 1,500 seats per hour).

1.93 Figure 1.10 above sets out key journey time savings with HS2 Phase 2b WL against the 2019 journey times on the conventional rail network and Figure 1.11 sets out the increase in additional seats into Manchester from Birmingham and London when compared with today.

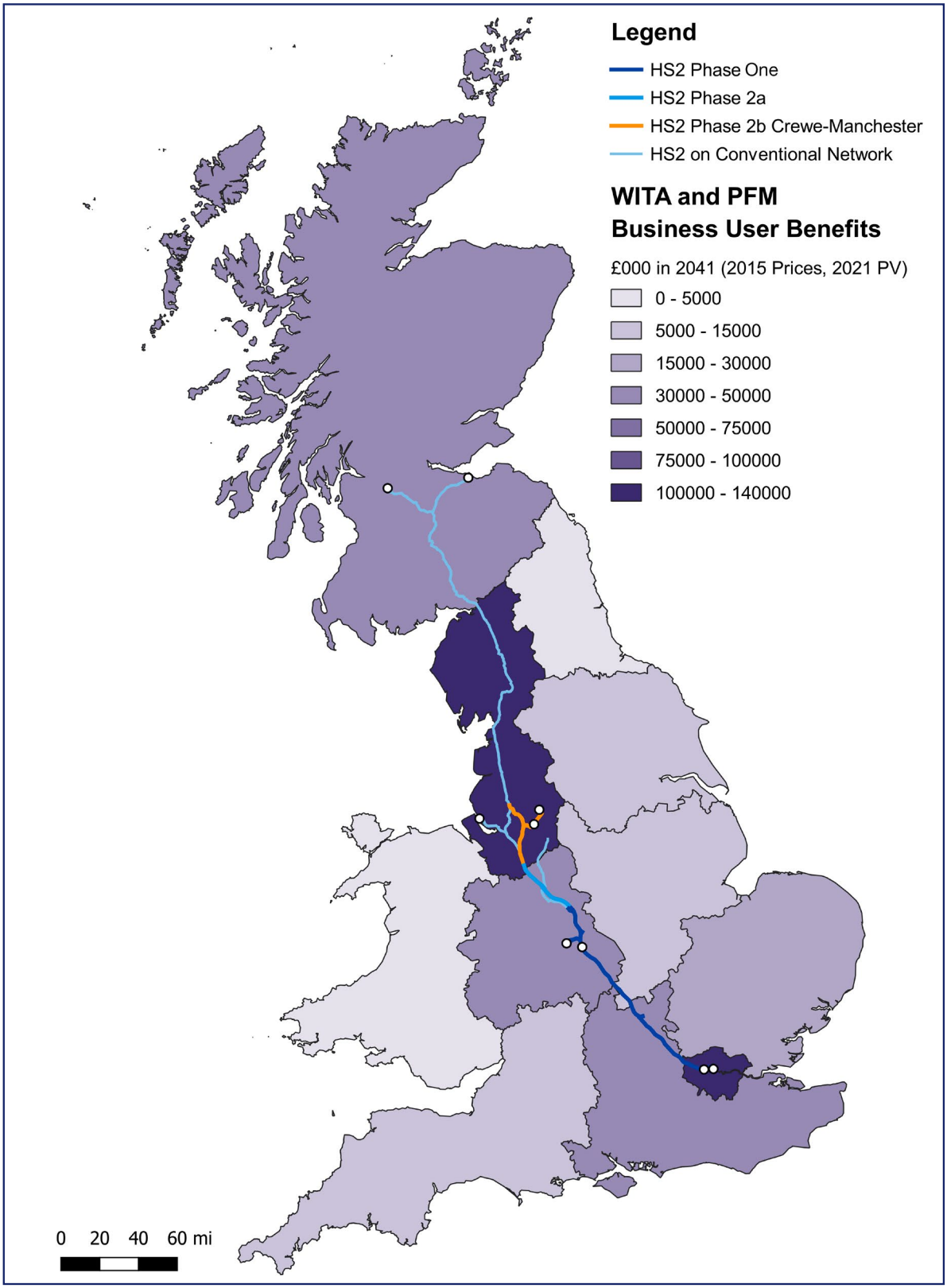
Figure 1.11: Additional seating capacity into Manchester with HS2 Phase 2b WL (current as of Nov 2021)



1.94 By increasing connectivity and capacity between the UK's largest economic centres, the scheme incentivises business and industry to take advantage of opportunities by relocating and expanding in the Midlands and the North, generating wider positive economic impacts on local economies. The scheme also broadens access to jobs for workers across the region and increases the skilled labour market of the region. The positive impact of increased access and connectivity will also fall to existing businesses in the region as the size of regional economy and labour markets increases and encourages further dynamic agglomeration impacts.

1.95 Overall, the Proposed Scheme will support productivity and fuel economic growth, as set out in the Economic Case. Modelling of the distribution of GDP benefits (assuming fixed land usage) shows that the regional allocation of benefits falls predominantly along the line of the route, including within the North West.

Figure 1.12: Business User Benefits and Level 2 Wider Economic Impacts of HS2 Phase 2b WL split by region for 2041 (2015 prices)



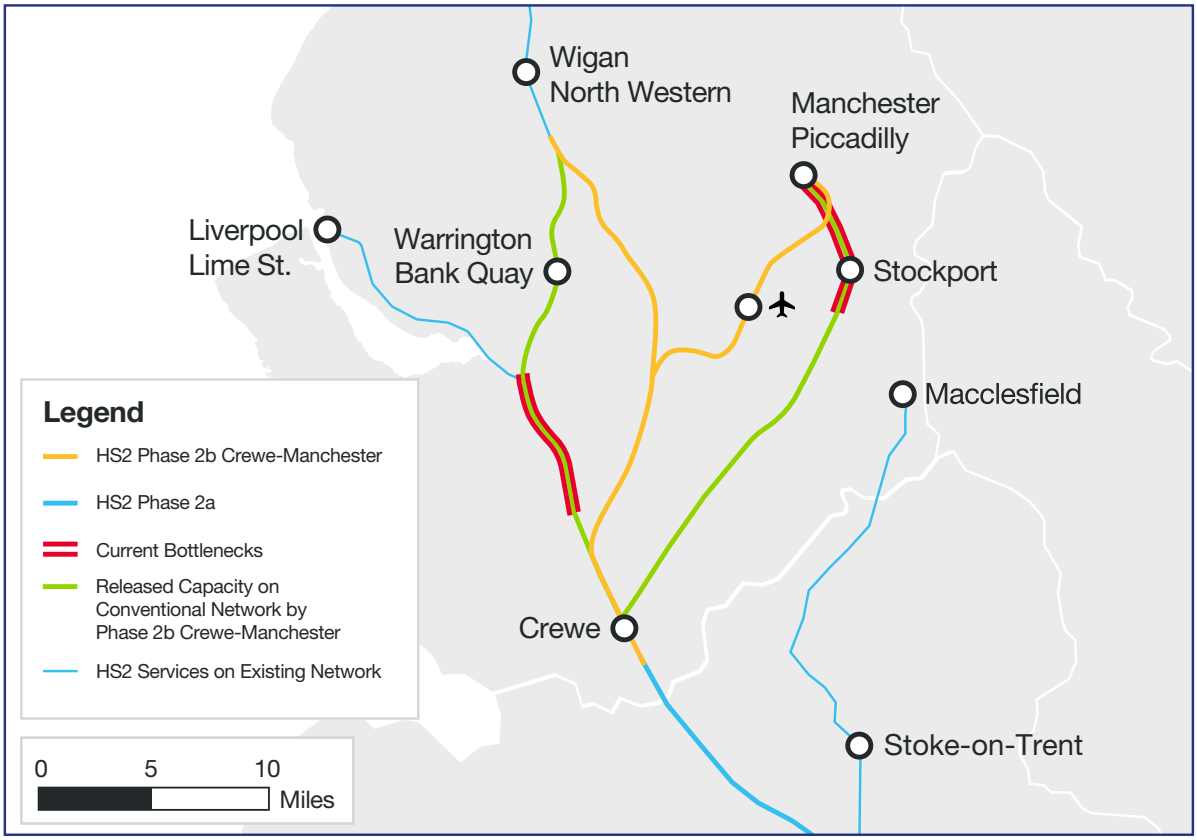
Data taken from Planet Long Distance Model. Values average of Origin and Destination Benefits in both directions. Map is based on discounted 2041 Benefits in 2015 prices.

Improved reliability and crowding reductions on the conventional rail network

1.96 A principal driver of delivering HS2 Phase 2b WL and expanding the high-speed network beyond Phases One and 2a, is the released capacity provided on the conventional network that will create new journey opportunities across the region. Moving longer distance inter-city services onto dedicated high-speed tracks will alleviate line crowding, resolve network bottlenecks and improve reliability and frequency of services on the conventional network. Phase 2b WL is particularly beneficial in relieving congestion both on the approach to Manchester from Stockport and on the WCML north of Crewe.

1.97 Figure 1.13 below sets out the existing bottlenecks on the network and the lines where the different phases of HS2 will create additional capacity.

Figure 1.13: West Coast Mainline and HS2 Capacity Map



1.98 HS2 Phase 2b WL opens three new train paths per hour between Crewe and Manchester via Stockport, on the existing conventional railway route into Manchester Piccadilly. This change will offer the opportunity to reorganise and enhance local and regional services in South Manchester and combined with NPR will address the reliability issues highlighted within the Case for Change.

1.99 The overall increase capacity and connectivity using both the high-speed and conventional network coupled with new HS2 trains will represent a step change in the betterment of the passenger experience for residents of towns and cities across the North West, providing better access across the region and supporting further economic growth.

Infrastructure that enables Northern Powerhouse Rail (NPR)

1.100 NPR aims to radically improve connectivity between major towns and cities from West to East in the North. It is a crucial part of the Government's plans to bring greater levels of economic growth to the North through the provision of significant journey time, frequency and capacity enhancements and a better user experience for rail passengers in the North. The Government has committed to delivering the NPR core network between Liverpool, Manchester and Leeds to York, with intermediate stops at Warrington and Huddersfield. Further investment in the wider network could be provided, dependent on future affordability, sustained demand and successful delivery of the NPR core network.

1.101 HS2 Phase 2b WL is fundamental to the delivery of NPR, and provides infrastructure at six key points, as well as providing the high-speed Line that NPR will use between Manchester Piccadilly and Hoo Green Junction. To avoid the double counting of benefits, these benefits have not been assessed within the Phase 2b WL Economic Case, and instead will be accounted for in the NPR business case. However, it must be acknowledged that without HS2 Phase 2b WL NPR could not be realised, and any decision to delay Phase 2b WL would have a knock-on impact on the Government's ambitions for NPR. Furthermore, the strategic alternatives to HS2 Phase 2b WL which have been assessed, are incompatible with plans for NPR and would require a complete redesign of the NPR scheme.

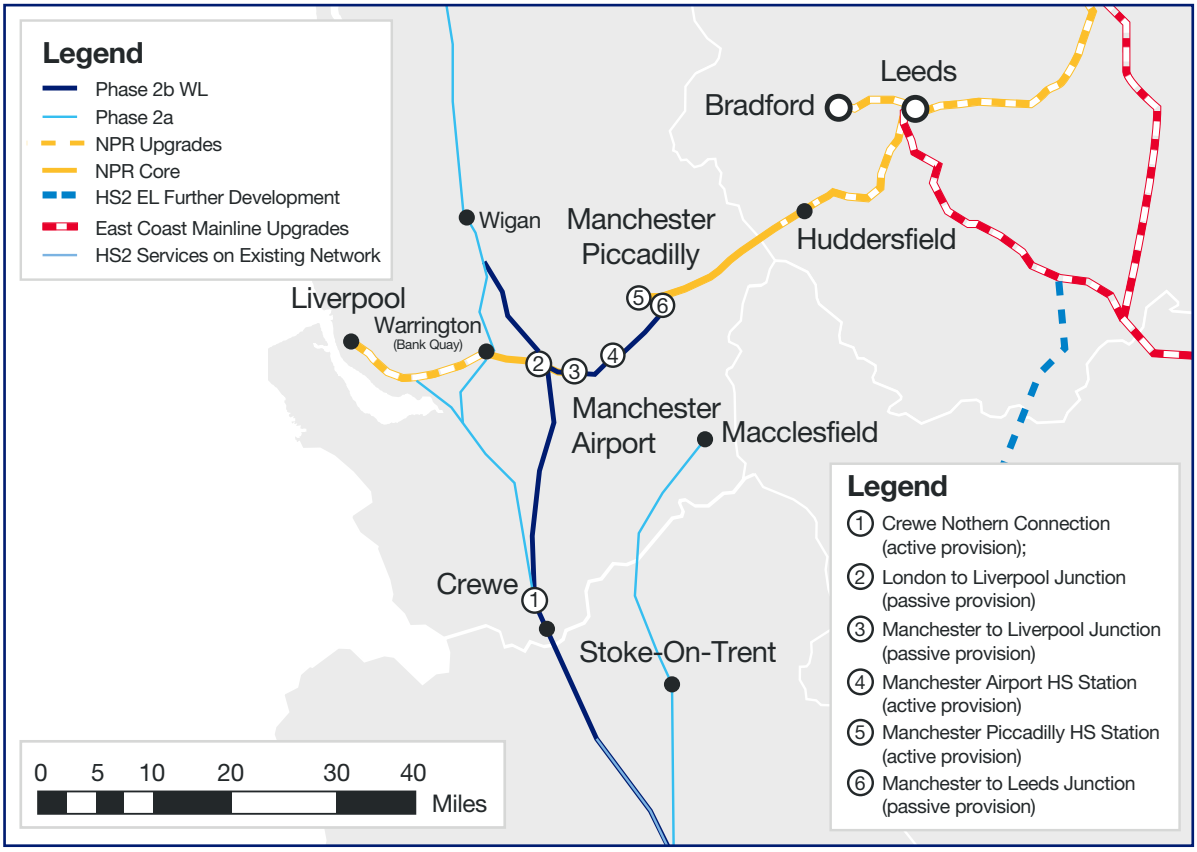
1.102 NPR will extend the high-speed network from the west of Manchester to Warrington, and to the east of Manchester as far as Standedge tunnels, allowing NPR to make use of HS2 services starting from London and Birmingham, as well as creating new east-west routes.

1.103 HS2 Phase 2b WL directly enables NPR through the delivery of:

- **The Crewe Northern Connection** – this will enable HS2 services from London to re-join the HS2 network after serving Crewe, potentially allowing HS2 services to stop at Crewe and run to Manchester and vice versa
- **London to Liverpool Junction** (passive provision) – this junction would enable high-speed services on the HS2 main line north of Crewe to connect to the future high-speed line to Warrington and by-pass the WCML, improving journey times between London, Crewe and Liverpool
- **Manchester to Liverpool Junction** (passive provision) – this junction would enable high-speed services on the HS2 main line from Manchester to connect to the future NPR high-speed line to Warrington and by-pass the WCML, improving journey times between Manchester, Warrington and Liverpool
- **Manchester Airport NPR Platforms** – the HS2 station at Manchester airport will provide four platforms, two of which will be used by future NPR services. Additional capacity within the station design and car parking space is also to be provided under the HS2 Phase 2b (Crewe-Manchester) hybrid Bill for predicted future NPR need
- **Manchester Piccadilly NPR platforms** – at Manchester Piccadilly station, a total of 6 high-speed platforms will be provided (rather than the original 4 proposed) in order to accommodate NPR as well as HS2 services. The design and layout of the approach tracks to Manchester Piccadilly high-speed station provide for operational flexibility and capacity for future service growth
- **Manchester to Leeds Junction** (passive provision) – HS2 Phase 2b WL will provide passive provision for a grade separated junction for a Manchester to Leeds connection to HS2 Phase 2b WL in the Ardwick area. This will allow NPR services to/from the Leeds direction to move in and out of Manchester Piccadilly using the Phase 2b WL infrastructure

1.104 Up to date analysis on the benefits that HS2 Phase 2b WL will bring to plans for NPR is not yet available. However, preliminary analysis shows that beyond the immediate benefit of providing critical infrastructure to enable the NPR scheme, the presence of HS2 will enhance the benefits of NPR through its integration with high connectivity links to the south. Further information is provided within the Economic Case.

Figure 1.14: HS2 and NPR Map



Regeneration and development within Greater Manchester

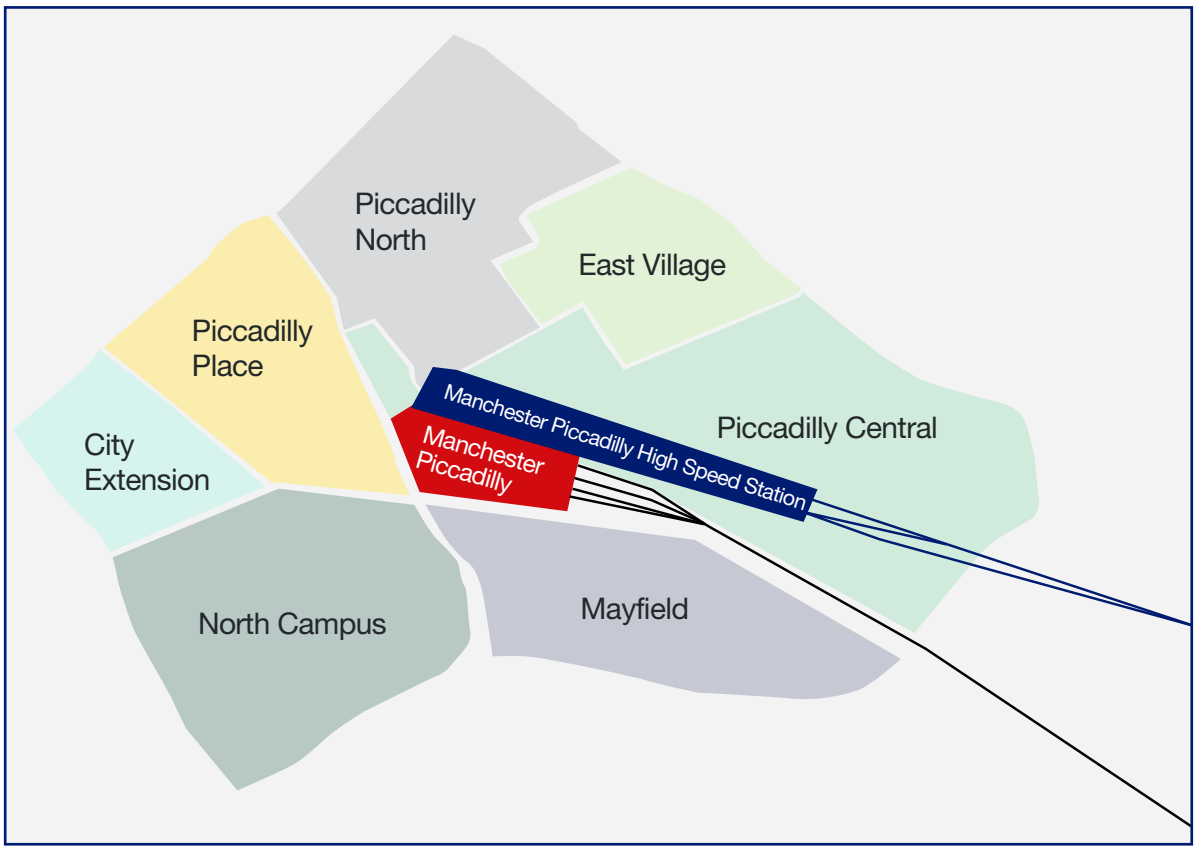
1.105 The scheme will directly enable key areas of regeneration identified by GMCA within Manchester City and Manchester Airport, as well as supporting regeneration of the wider area. The Greater Manchester HS2 and Northern Powerhouse Rail Growth Strategy – The Stops Are Just The Start sets out the proposals for local infrastructure investment that will ensure the full benefits from HS2 services at Manchester can be realised.

1.106 The growth strategy recognises that the introduction of HS2 to Manchester Piccadilly represents a once in a century opportunity to regenerate the area around the station, which will become, as a result of HS2 and NPR, one of the best-connected stations in the North of England. A fully integrated station, along with the wider development, infrastructure, and public realm proposals, will act as a magnet for development, attracting new businesses in key sectors and providing significant job opportunities for the area.

1.107 The IRP has restated the intention for a 6-platform surface level station at Piccadilly that will additionally be able to accommodate future NPR services. The scheme could also allow for provision of a Metrolink "subway" stop in central Manchester, taking a major bottleneck out of the street-level city-centre tram system that now carries 44 million passengers a year. This would allow for future development of the Manchester tram system to reach new towns such as Hyde, Marple or Glossop.

1.108 The Greater Manchester Growth Strategy predicts that up to 820,000m^2 of new commercial development will be delivered in and around Piccadilly, generating 40,000 additional jobs and creating 13,000 total dwellings, with further benefits extending beyond the immediate surroundings, through agglomeration.[34] The HS2 station at Piccadilly will sit alongside the conventional station, at the heart of the 6 distinct districts where redevelopment and regeneration will be focused. These districts are set out in Figure 1.15 below.

Figure 1.15: Redevelopment plans for Manchester City Centre



[34] GMCA, HS2 and Northern Powerhouse Rail Growth Strategy. It should be noted that in the calculation of these figures it is assumed that an underground HS2 station would be provided at Manchester Piccadilly. It is now assumed that a surface level station will be provided which may impact on these figures.

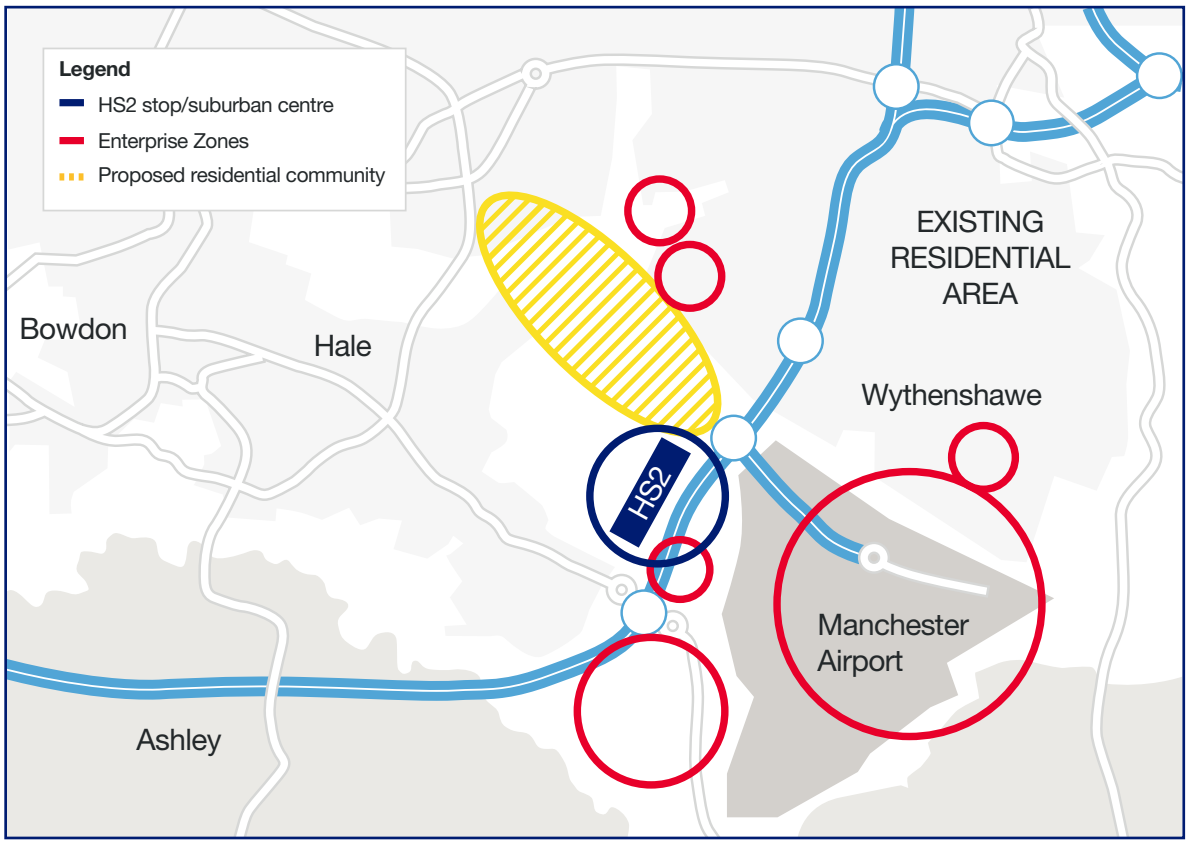
1.109 Manchester will additionally see a huge benefit to the development of the area around Manchester airport, as well as creating a step change in airport accessibility. At the airport, the Proposed Scheme directly provides for:

- A new 4 platform station that will be easy to reach from a range of destinations, including directly from London and Birmingham and which will provide a travel time between the airport station and Manchester City Centre of just 7 minutes
- Passive provision for a new Metrolink stop at the airport, further improving the connectivity potential of the airport
- Improved access to the Strategic Road Network (SRN) around Manchester Airport. These capacity enhancements will mitigate against increases in traffic and will improve access to the airport, HS2 and NPR station, making the high-speed network accessible to those not in easy reach of Manchester City Centre by public transport

1.110 More widely, the station at Manchester Airport will provide opportunity to accommodate businesses that will benefit from high levels of connectivity provided by proximity to an international airport and fast connections to major cities across the country. Greater Manchester's growth strategy identifies offices, global logistics, advanced manufacturing, complementary hospitality, and commercial development. Additionally there is strong potential for residential growth to the north of the airport station.

1.111 Around the airport station itself, a brand new suburban centre has been envisioned. A new distinctive and diverse neighbourhood will contain homes, offices and hotels, with the station acting as a focal point to the development. Work is currently ongoing to identify the value and scale of development. The commitment to deliver the HS2 Phase 2b WL will ensure that GMCA can accelerate the delivery of private sector led development linked with the station in advance of completion of HS2 Phase 2b WL, as well as supporting the expansion of further development within proximity of the airport. Investment is already being accelerated at the site driven forward by a £0.8bn joint venture arrangement between Manchester Airport Group and other investment partners.

Figure 1.16: Major development opportunity in and around Manchester Airport



1.112 The improvement in connectivity with other regions in the UK will significantly increase the airport's catchment area providing more people and businesses with much faster access to the airport. This will increase the airport's ability to attract new inter-continental routes and further increase the North's ability to trade internationally and develop new global leisure and tourism markets. A study for Transport for the North by the Independent International Connectivity Commission highlighted the value of international connectivity to the North's economy. It found that improving surface access to the North's international gateways could deliver improved global connectivity in two ways:

- Directly, by shortening end to end international journeys
- By increasing demand for international services to/from these gateways, which would translate into higher international service frequencies across a wider range of destinations, and thereby delivering potentially much greater indirect improvements in connectivity

Align with and support North West Local Authorities' Growth Strategies

1.113 Whilst Manchester is the obvious beneficiary of HS2 Phase 2b WL, the benefits will be far wider reaching, especially when combined with plans for NPR. This is recognised within the growth strategies prepared by local authorities across the North West (as set out in the strategic context), who predict that the wider connectivity that HS2 brings will stimulate regeneration within their local areas.

1.114 A number of towns within the North West are likely to see an increase in their high-speed service frequency as a direct result of HS2 Phase 2b WL. Under the latest assumptions around the timetable service specification, Preston will see its London HS2 service move from 2tph to 3tph and will additionally see a direct HS2 service from Birmingham. Wigan will see the introduction of a high-speed service from Birmingham, and Carlisle will see its number of high-speed services rise from 1tph to 3tph. These increases in frequency and fast connections to the UK's major economic centres will increase the attractiveness of travel to and from these towns, helping to support local economies.

1.115 At the southern end of the Proposed Scheme, Crewe is set to become a vital 'super-hub', connecting high-speed services and the existing railway network. The Crewe-Manchester Hybrid Bill provides powers for a new Crewe Northern Connection (CNC) to be constructed, a junction north of Crewe that could allow trains to serve Crewe station and then re-join the HS2 network. As part of NPR services, this would allow between five and seven high-speed trains to call at Crewe station each hour, potentially offering better connectivity (with a change of trains at Crewe) from Chester and North Wales to Birmingham, and from Shrewsbury to Manchester. Combined with other commitments set out in the IRP, the CNC could facilitate faster London to Liverpool journeys and release capacity on a crowded section of the WCML north of Crewe. The additional services have not been considered within the economic analysis of this business case, and the specifics of the train timetable will be reviewed as the plans develop further.

1.116 Based on an estimate included within the Crewe Station Hub Area Plan, the expanded high-speed offer at Crewe, including plans for NPR and the Crewe Northern Connection, could enable 7,000 new homes and 37,000 new jobs by 2043. Whilst these benefits have not been directly assessed through the Economic Case to avoid the double counting of benefits, the Proposed Scheme is an enabler for these works, and future plans for the Northern Connection and HS2 trains between Crewe and Manchester are dependent on the Proposed Scheme going ahead. Work is currently being undertaken at local authority level to prepare an SOBC to ensure that opportunities that HS2 and NPR bring to Crewe and the wider Cheshire area are maximised.

1.117 More widely across the North, a wider breadth of towns and cities are set to benefit from the infrastructure that HS2 Phase 2b WL provides for NPR. As with the Crewe Northern Connection, the economic case makes no attempt to quantify the benefits that NPR services using HS2 infrastructure will create. However, as outlined in paragraph 1.101 it must be acknowledged that without HS2, current plans for NPR would not be viable, thereby limiting opportunities to improve east-west connectivity and growth within key cities and towns such as Liverpool and Warrington to the west and Leeds, Bradford, York and Newcastle to the east.

Support for local economies through increased leisure and tourism

1.118 Travel for leisure and tourism already forms a large market share of demand on the WCML, with HS2 Phase 2b WL set to make leisure journeys to the North West even more attractive through faster journey times and an enhanced passenger experience.

1.119 The high-speed TGV network in France has supported growth in the number of French tourist and visitor destinations. In Marseille there has been a significant change in tourist behaviours and types of tourism forms, with a significant evolution of visitor volumes. That is, an increase in short-stay travel and visits by young adults, seniors, certain socio-economic groups and international visitors.

1.120 Manchester leads the way after London and Edinburgh as the UK's top city visitor destination. In the year 2018/2019 there were 4.8m staying visits and 59 million day visits, securing an estimated £4.5bn to Manchester's economy and supporting 50,000 jobs across the city.[35] The significant improvements brought about by HS2 Phase 2b WL in the transport infrastructure will allow this industry to blossom further, as well as supporting other towns and cities in the region. Modelling carried out on behalf of Transport for the North has demonstrated how the combined impact of HS2 and NPR will bring Manchester Airport into closer reach of the North West, offering more opportunity for tourism and leisure journeys.[36]

1.121 Birmingham tourism hit an all-time high in 2017, with 41.8 million visitors. The number of full-time equivalent jobs supported by the visitor economy has risen by 7.2% since 2016, from 70,635 to 75,748.[37] Improving connectivity with Manchester and towns and cities in the North will further increase the attractiveness of Birmingham as a destination for domestic and overseas visitors.

A transport solution which supports the Government's ambition to reach its net-zero carbon target

1.122 At a national level HS2 will create a new spine to the rail network across the country that will support public transport and active travel as a natural first choice for people's daily activities. Building upon the north-south capacity and enhanced journey times HS2 will facilitate an increased rail mode share for long distance inter-city travel, while its construction will also facilitate local transport schemes, such as NPR and an extension to the Manchester Metrolink, and free up capacity on the existing lines that will increase modal shift for intra-regional journeys.

1.123 The HS2 Phase 2b WL scheme will be an environmentally sustainable form of transport, offering significantly lower carbon emissions per passenger kilometre than cars (including electric vehicles) and domestic air travel. Once operational HS2 journeys will generate 2g CO_2e per passenger kilometre by 2030, compared

[35] Manchester City Council,2019. Economic Scrutiny Committee.
[36] Transport for the North, 2021. Visitor Economy and Transport in the North of England.
[37] Greater Birmingham Chambers of Commerce, 2018. Birmingham tourism sector enjoys record year.

to intercity rail (22g),[38] inter-urban car (average for petrol/diesel 88g, electric 4g) and domestic aviation (95g)[39]. The substantial passenger capacity of HS2 services, combined with the ability to draw power from an increasingly decarbonised national grid, means that it will be an effective and efficient low carbon transport solution for journeys across the country. By reducing journey times and increasing capacity between city centres across the UK, including Scotland, it has the potential to reduce carbon emissions by encouraging mode switch from road and domestic air travel.

1.124 When comparing the cabon impact of journeys themselves (not including the building of new trains and railways, new cars and roads, or new planes and airports) over the 60-year appraisal period, the Proposed Scheme is forecast to reduce the number of journeys on GB roads by 30 million, reducing emissions by 240,000 tonnes CO_2e; and the number of domestic aviation journeys by 25 million, reducing emissions by 1,750,000 tonnes CO_2e. The Proposed Scheme is also forecast to generate 225 million new passenger trips in net terms supporting growth while still producing a net reduction in operational CO_2 emissions of 750,000 tonnes.

A net gain in biodiversity

1.125 The Government and HS2 Ltd have committed to seek to deliver a 10% net gain in biodiversity for replacable habitats on Phase 2b WL, resulting in more biodiversity than existed before construction. Biodiversity has a twofold value; its intrinsic value that it holds for the health of the planet, and the benefits it provides to people. For example, a green space can support rare species but also contribute to improving the health and wellbeing of the people who use it.

1.126 The commitment on biodiversity comes in addition to existing habitat mitigation and compensation schemes designed to reduce the impact of construction of the railway on local ecosystems. HS2 Ltd's forthcoming Biodiversity Action Plan will set out the actions, outcomes and milestones of how the challenge of delivering a net gain in biodiversity on the Proposed Scheme can be achieved.

1.127 The Government and HS2 Ltd recognise that ancient woodland is irreplaceable, and therefore is not included in this commitment to aim to deliver a net gain in biodiversity. All ancient woodlands affected by HS2 and the associated compensation are considered by a separate Ancient Woodlands Strategy. In addition, HS2 Ltd is undertaking innovative research with experts to further knowledge of efficacy of ancient woodland soil translocations which will be shared with the wider industry.

[38] It should be noted that the intercity rail forecast is for the entire conventional rail network, including the predicted mix of both diesel and electric trains in 2038, as well as decarbonisation of the grid for the electrified portion of the network.
[39] This analysis has not taken into account new operational targets announced in HS2's Net Zero Carbon Plan on 11 January 2022. This includes using 100% zero carbon electricity generation to power its trains from 'day one' and cutting emissions from concrete and steel by 50% (tCO2e/t) by 2030 compared with 2021 levels.

1.128 Lessons from Phases One and 2a of HS2 on environmental reporting and strategies for mitigating environmental impacts will be applied to HS2 Phase 2b WL. The first HS2 Environmental Sustainability Progress Report was published in January 2022. The approach and content of the report is informed by Global Reporting Initiative methodology and has been shaped by seeking input from Natural England, The Forestry Commission, HS2 design panel and members of HS2 Ltd's Ecology Review Group. HS2 Ltd launched its Green Corridor Prospectus last year, providing information to the public on projects along the route that are being introduced to mitigate and compensate for the environmental impact of HS2's construction. The Green Corridor is the largest single environmental project in the UK and HS2 is already working in partnership with individuals and organisations to create a network of bigger, better-connected and climate resilient habitats along the HS2 route to support the natural environment and for the wider public to enjoy. The work already established as part of Phase One and 2a will be continued through to Phase 2b WL.

An increase in technical skills to bring the UK in line with other G7 economies

1.129 HS2 is also playing a pivotal role in the Government's Plan for Jobs, creating and supporting thousands of construction jobs and benefiting small and medium enterprises (SMEs) up and down the country. As of summer 2021 there were already 20,000 FTE jobs supported by the HS2 project, with 2,200 UK registered companies given HS2 contracts. Given the current stage of development of the HS2 Phase 2b WL, it is not possible to state the exact number of jobs that will generated, but HS2 estimate that the HS2 workforce is expected to peak at 34,000 in 2027/28 when parts of Phase One, Phase 2a and Phase 2b WL are concurrently under construction.

1.130 Engagement is taking place with relevant stakeholders along the line of route for the Proposed Scheme, to build skills capacity for the scheme by taking best practice from Phase One and Phase 2a and adapting to the labour market of HS2 Phase 2b WL..

1.131 HS2 will also make sure that employers throughout the supply chain need to invest in skills. The COVID-19 Pandemic and economic downturn has had a profound impact on the livelihoods of many people, strengthening the need to invest in skills. The 2021 Budget and the Government's Plan for Jobs set out clear priorities to Build Back Better, create and sustain jobs, and address skills gaps. HS2 is well-placed to support these priorities with the project committed to creating at least 2,000 apprenticeships during construction. New skills created as a direct consequence of HS2 can in turn be exported around the world, strengthening the UK's global trade.

1.132 The National College for Advanced Transport & Infrastructure is supported by HS2 Ltd and was created to directly addresses this shortfall in high-level, technical expertise. Delivered to its full potential, it will transform the future of the rail industry and of skills-based vocational training in the United Kingdom. Based in Doncaster and Birmingham, it should spread socio-economic benefits around the country, and also bring them to the communities of which it is a part.

1.133 To level up the UK economy, high productivity jobs need to move from London to the regions, and particularly to the UK's major cities. Rail remains the best transport option for getting people into city centres. London's success as a global city has been driven in part by the effectiveness of its transport system which allows the easy flow of skills, services and products into and around the city, as well as to wider domestic and international markets. HS2 will assist in the replication of the success of London's transport network in the regions, improving connectivity between the cities of the Midlands and the North as well as improving connectivity in and out of these city regions.

A drive towards new technology and innovation

1.134 HS2 is the UK's most ambitious transport infrastructure project. Its construction and operation presents a significant opportunity for the railway industry to drive innovation through the supply chain and to leave a legacy of increased innovation in the UK rail and construction sectors. HS2 Ltd aims to demonstrate an exemplar approach to innovation and has developed a dedicated 'Innovation Strategy'. This strategy focusses on facilitating an increased uptake in innovation across the programme, working directly with the supply chain, the Government and other key external stakeholders. HS2 Ltd's innovation programme has three key objectives:

- To support the creation of capability to enable innovation throughout the lifetime of the railway
- To create a collaborative culture internally and externally that ensures innovation can thrive
- To direct innovation capacity to where it will have the greatest impact

1.135 Specific examples of technological improvements over the existing conventional rail network that HS2 Ltd. is pursuing include:

- Semi-Automatic train operation – where starting and stopping is automated, but a driver operates the doors, drives the train if needed and handles emergencies. Automatic control of stopping and starting will reduce energy consumption in operation and improve capacity and reliability
- In-cab digital signalling – removing the need for line side equipment, which reduces cost and improves both capacity and reliability
- Enhanced remote asset condition monitoring using trackside and train-borne equipment – to improve maintenance efficiency and therefore performance and reliability
- An integrated data platform that combines passenger and operational data for improved customer experience

Strategic Alternatives

1.136 The Phase 2b Strategic Outline Business Case published in November 2016 considered a range of rail alternatives to the previously planned 'Y' shaped network. This updated previous work on alternatives published in 2013 to consider recent developments in the rail industry. The 2016 analysis found no alternative to HS2 that could deliver the strategic objectives, including provision of the same level of capacity, connectivity and service or generating the wider benefits to the UK, including the scale of regeneration and economic growth.

1.137 A further assessment of the interventions making use of upgrades to the existing line instead of building new lines have been considered for both the WCML and Manchester spurs. DfT consultants, Mott MacDonald, were commissioned to update and assess alternative options to the planned Phase 2b WL scheme to support the development of the business case. These alternatives covered options which would enable 400 metre trains into Manchester Piccadilly and an increase in HS2 services to Scotland over Phase 2a.

1.138 The assessment considered upgrades to the WCML, which included track widening and freight interventions, between Crewe and Weaver Junction (where the WCML Spur to Liverpool diverges) as an alternative to the planned WCML link near Golborne. The assessment also considered upgrades to the WCML from Crewe to Manchester Piccadilly conventional station. This included junction upgrades, track widening and a significant upgrade to the existing Manchester Piccadilly station to accommodate 400 metre HS2 services.

1.139 Figure 1.17 provides a comparison between the Proposed Scheme with the optimised combination of the alternatives.

1.140 The assessment concluded that the alternatives failed to fully meet the strategic objectives:

- They do not provide the level of enhanced connectivity nor the transformational change. For example, journey times into Manchester would be around 20 minutes slower than with Phase 2b WL, whilst journey times from London and Birmingham to Preston and to Scotland would be around 10 minutes slower
- The alternatives provide limited flexibility for additional rail services and significantly lower performance and reliability. This is especially true for the WCML into Manchester Piccadilly where the alternatives provide no capacity release and would do little to address long standing performance issues given the complexity of the network via Stockport
- Network Rail also has significant concerns around the ability to introduce an extra hourly HS2 service on the WCML north of Crewe between London and Scotland, without compromising existing rail services or performance. This extra service would be expected to support wider decarbonisation targets
- The alternatives would provide no capacity to deliver NPR proposals, which rely on the Proposed Scheme route into Manchester Piccadilly, including platform capacity at the new station. NPR is a manifesto commitment of this government and its scope confirmed as part of the IRP

- The alternatives would be significantly more disruptive to existing railway compared to the Proposed Scheme, leading to long periods of disruption for rail passengers and freight, particularly when these interventions are delivered as a combined package. This is especially true for routes into Manchester Piccadilly where there is the potential for significant disruption and/or closure for durations spread out over several years. This disruption could badly damage the markets intended to be served by the new infrastructure
- The alternatives do not align with and support delivery of local authority growth strategies across the North West, enabling the regeneration and transformation of key sites at Manchester Piccadilly and Manchester Airport (which is bypassed in the alternatives)
- The alternatives would represent a significantly smaller infrastructure interventions, and so would be likely to lead to less direct and indirect expansion of investment in the development of technical skills
- The alternatives do have the potential to be compatible with the commitments and targets set in the DfT's decarbonisation plan

1.141 Overall, the assessment of the alternatives demonstrates that only Phase 2b WL can fully meet the objectives set for both Phase 2b WL and the HS2 scheme up to and including the Proposed Scheme to Manchester.

Figure 1.17: A comparison of the Proposed Scheme with the strategic alternatives[40]

		Do minimum HS2 2a only	Strategic Alternative A4 & B2	HS2 full Western Leg as planned
Total Cost[41]		N/A	c. £9bn	c. £21bn
BCR[42]		N/A	1.1	0.9
HS2 Phase 2B WL Crewe to Manchester Objectives				
Connect the largest economic regions and cities across the UK, including those in Scotland, through the provision of a step-change in connectivity and capacity		Baseline	Low positive impact	High positive impact
Enable significant enhancements to the conventional rail network across the North West and the North, freeing up much needed capacity on key bottlenecks as well as providing critical infrastructure to allow the delivery of NPR and new Metrolink routes.			High Negative Impact	High positive impact
Support development and regeneration across the North West through the alignment to and support of local authority growth strategies. Investment pivoted around the new stations and services, enabling the development and transformation of key sites at Manchester Piccadilly and Manchester Airport			Low positive impact	High positive impact
Support Government plans to build back better through the direct and indirect expansion of investment in the development of technical skills needed to bring the UK in line with other leading economies			Low positive impact	High positive impact
Provide a sustainable long-term transport solution that supports the UK's Net Zero carbon target and provides a net gain in biodiversity, alongside economic prosperity.			Low positive impact	High positive impact
Delivery and Performance				
Schedule		Baseline	2035-2040	2035-40
Delivery disruption to existing network			High negative impact	Low negative impact
Train service outputs				
Percentage reduction in journey time against the baseline **Colour Coding** Journey time improvement over 25% dark green Journey time improvement up to 25% - light green No change in journey times - grey Journey time increase up to 20% - light orange Journey time increase over 20% - dark orange	London to Manchester Piccadilly	Baseline	6%	26%
	London to Manchester Airport		0%	58%
	Birmingham to Manchester Piccadilly		32%	53%
	Birmingham to Manchester Airport		0%	70%
	London to Edinburgh		12%	16%
	London to Glasgow		-2%	2%
	Birmingham to Edinburgh		24%	28%
	Birmingham to Glasgow		27%	31%
Capacity - % increase in all seats **Colour Coding:** Capacity increase of 100% or more – dark green Capacity of increase up to 100% - light green	London to Manchester*		57%	63%
	London to Edinburgh		1%	3%
	London to Glasgow		28%	28%
	Birmingham to Manchester*		211%	211%
	Birmingham to Edinburgh		168%	168%
	Birmingham to Glasgow		168%	168%

*Piccadilly only as strategic alternative does not serve Manchester airport Capacity increase of less than 100% light green

[40] Note that there are minor variations in the journey times used in these calculations to those presented elsewhere in this strategic case. This is as a result of updated assumptions in the period since the Strategic Altenatives report was completed by Mott MacDonald.
[41] Total costs include Capital costs, Operational costs and Rolling Stock and Renewals costs.
[42] The Benefit Cost Ratio assesses Level 1 and 2 benefits only. A full VfM assessment of Phase 2b WL is provided in the Economic Case.

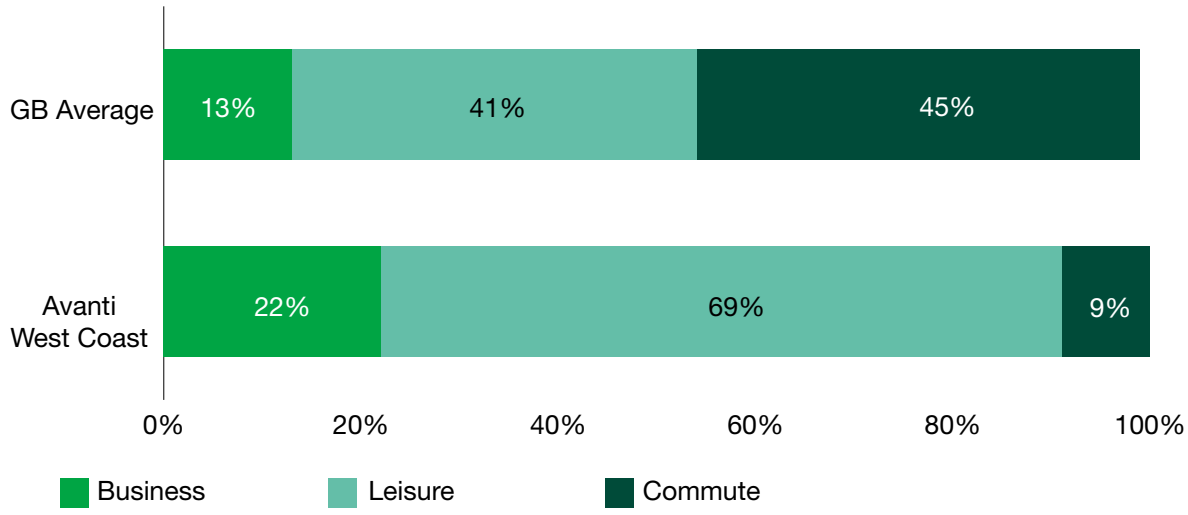
Strategic Risks and Uncertainties

COVID-19 – The impact on passenger demand

1.142 The underlying case for investment in the rail network in the North remains strong, and essential if the UK is to grow and level up. Phase 2b WL is a long-term investment that will take a decade or more to deliver. The results of historic 'stop-start' approaches to investment are still being felt, both in terms of inefficient delivery in the supply chain and in delayed outputs. The impacts of the pandemic make the Government's commitment to levelling up more, not less urgent; to ensure our major cities are the driving force for economic growth and future prosperity

1.143 The impact of COVID-19 on the wider economy as currently understood is reflected in the central scenario that has been modelled in the economic analysis, based on Office for Budget Responsibility (OBR) forecasts in November 2020. As a predominantly long-distance business and leisure service (on WCML commuting makes up only 10% of all trips, and leisure and business travel make up 90%), demand on HS2 is expected to be less influenced by a potential increase in 'working from home' than commuter routes. Although short journey times and high frequencies may encourage use as a commuter railway, the move towards an increased level of working from home may also potentially impact on the economic geography of the country with more people traveling further distances when they do commute to a workplace.

Figure 1.18: Passenger Market Splits by journey purpose on the WCML Autumn 2019 Passenger Survey



1.144 The evidence around how the pandemic will affect the long-term trend in demand for long distance travel is still evolving and it will be some time before it is fully understood. However, the patterns emerging as a result of the pandemic are not a new phenomenon. Over the last 50 years the time people spend travelling has remained relatively constant, though distances travelled have increased.[43] The number of days that people commute to the office has also reduced.[44] Overall, people have taken the benefits of better transport links as the ability to access a wider range of jobs, business and leisure opportunities, rather than to reduce total time spent travelling.

1.145 To capture longer term impacts of behavioural change around commuting/ business travel the Economic Case evaluates three behavioural change sensitivities for the scheme. The scenarios range from a 'low impact scenario', where demand recovers quickly to pre-pandemic levels but with a small permanent reduction, to a `high impact' scenario, where rail demand remains significantly and permanently lower than pre-COVID-19 level, even after the pandemic has ended. Since these scenarios were developed, the vaccination programme has been rolled out and the emerging evidence suggests a stronger recovery in travel markets than initially anticipated. Data from autumn 2021 shows rail demand at 69% of pre-pandemic levels with and road traffic at 98% of pre-pandemic levels.[45]

1.146 Recent work commissioned by DfT 'The Business Travel During COVID-19 Survey' also suggests a positive outlook for future levels of business travel with 13% of companies expecting to use long distance rail post pandemic (compared to 15% pre-pandemic), and only small reductions in the frequency of business trips made overall (34% of companies expect staff to travel at least weekly, compared with 40% before the pandemic).

Scope

The West Coast Mainline link

1.147 The HS2 Crewe-Manchester Bill provides for a high-speed rail link from the core HS2 line at Hoo Green to the WCML at Bamfurlong, near Golborne. The Union Connectivity Review, undertaken by Sir Peter Hendy, identified that there could be opportunities to further improve capacity and journey times to Scotland with an alternative HS2 connection to the WCML, and recommended that the Government should review alternative options. The Government is considering its response to UCR recommendations, that it review options for alternative northerly connections between HS2 and the WCML. It is the Government's intention to deliver the right infrastructure for long term benefits to the rail network, to the North and to Scotland.

[43] GOV.UK, 2013. Average number of trips made and distance travelled
[44] GOV.UK, 2013. When people travel
[45] GOV.UK, 2021. Transport use during the coronavirus (COVID-19) pandemic

1.148 The Economic Case includes the WCML Link from Hoo Green to Bamfurlong. A sensitivity test has been carried out as part of the economic assessment to understand the impact of removing the link. This is set out in Annex 1.

Manchester Piccadilly Station

1.149 The Bill provision is for a station at Piccadilly that is shared between HS2, NPR and Metrolink tram. The additional costs associated with an underground, future-proofed Metrolink stop are to be funded by third parties. Discussion on design, cost estimates, sources and models for third party funding contributions are underway with Greater Manchester stakeholders.

Manchester Airport

1.150 Additional scope has been included in the hybrid Bill to cover Manchester Airport and support Manchester stakeholders' plans for a strategic transport hub for the region. Construction of this station and its inclusion in the final scheme remains subject to agreeing an appropriate local funding contribution. DfT continue to collaborate positively with Greater Manchester local authorities and Manchester Airport Group on this matter.

M56 Junction Improvements

1.151 HS2 Phase 2b WL will provide enhancements to the strategic road network to improve access to the new HS2 (and NPR) stations in Manchester and to mitigate the increases in traffic due to background growth and the high-speed station. As part of these works, there is ongoing engagement between DfT, HS2 Ltd, and National Highways to ensure that the final solution is the best solution representing the optimum outcome for all users.

Delivery of Benefits – HS2 as a catalyst for local regeneration and growth

1.152 HS2 offers a major opportunity to catalyse local regeneration. Whilst, much of the regeneration is expected to be delivered by private sector investment, Central and Local Government have a role in creating and maintaining the conditions for the private sector to have the confidence to invest. Central Government has taken a devolved approach to regeneration at HS2 station places, with Local Government leading and Central Government in support.

1.153 The Government has already provided funding to a number local authorities with HS2 stations, to produce growth strategies which set out places' vision and strategy for using HS2 to drive local development, jobs and housing.

1.154 The Government will continue working with places to determine how we can help them make the most of HS2. Its aim is to develop a HS2 Local Growth Action Plan this year, setting out how Phase One and 2a station places will be supported to realise their local growth ambitions and how lessons learned from these phases will be applied to the Phase 2b Western Leg.

Environment – Decarbonisation and Sustainability

1.155 Alongside the long-term environmental benefits of the Proposed Scheme in terms of low carbon journeys and net gains in biodiversity, it must be acknowledged that the potential carbon emissions associated with the construction and operation of the Proposed Scheme are substantial.

1.156 Assessed on a reasonable worst case basis, the construction carbon emissions for the baseline scheme are estimated to be 5 million tonnes of CO_2 equivalent (million tCO_2e), with the majority (62%) coming from product manufacturing with steel and concrete materials which account for 44% and 37% of manufacturing emissions respectively. However, this scenario assumes conservative values for the decarbonisation of the steel and concrete sectors, which can be considered pessimistic based on the high levels of innovation which are already taking place in these sectors to minimise carbon emissions, in part driven by the HS2 Phase One construction currently underway. For example, British Steel launched their low carbon roadmap in autumn 2021 to deliver net zero steel by 2050 and significantly reduce CO_2 intensity by 2030.[46] In the concrete sector, Hanson have just delivered their first low-carbon concrete rail project[47] and HS2 is already actively undertaking trials using lower carbon concrete[48] with a target to reduce the CO_2 content of steel and concrete used on the project by 50% by 2030. Analysis undertaken within the Economic Case demonstrates that based on a linear decarbonisation to net zero by 2050, emissions from construction for Phase 2b WL fall by 40% to 3 million tCO_2e.

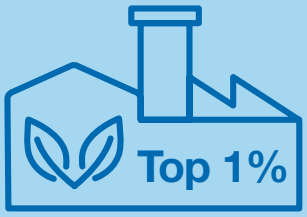
1.157 There also exist opportunities to reduce carbon through the refinement of designs and innovation in construction techniques, with HS2 Phase One having already achieved significant carbon savings against its baseline design.

[46] British Steel, 2021, Low Carbon Roadmap
[47] Hanson UK, 2021, Europe's largest Cemfree concrete pour, Chatham Station.
[48] HS2, 2020 HS2 uses new pioneering low carbon concrete to reduce carbon emissions in construction

HS2 Phase One Stations Case Study: Construction and Operational Carbon Reductions

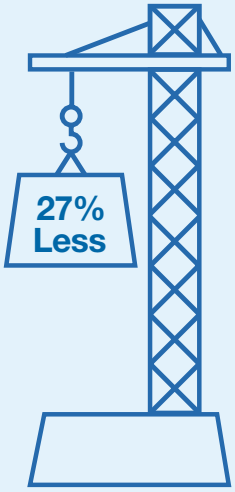
Interchange Station

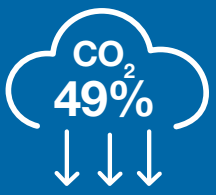
HS2's Interchange station, to be built in Solihull and near the NEC in the West Midlands, has become the first railway station globally to achieve the BREEAM 'Outstanding' certification – a measure of sustainability for new and refurbished buildings – putting it in the **top 1% of buildings in the UK** for **eco-friendly** credentials.



Old Oak Common

At Old Oak Common designers have achieved a **27% reduction** in the structural steel required to build the station roof. Following the results from wind tunnel tests and a snow load review, the team of structural design engineers and architects, concluded that structural thicknesses and profiles in the station roof could be modified to allow for **27% less material** to be used, with a total steel reduction of over **1,000 tonnes**. This is equivalent to a **2,700 tonne reduction in carbon**.



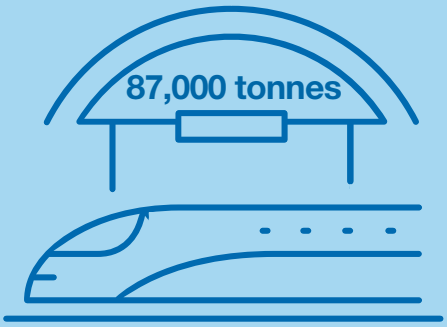


Euston

HS2's contractor at Euston has been able to reduce the amount of carbon by **49% (365,500 tonnes)** from the Baseline Design to the Scheme Design.

Curzon Street

The new HS2 Curzon Street station is set to reduce lifetime carbon emissions by an unprecedented **55%**. Through innovative design, there are over **40 opportunities** for **carbon reduction**, resulting in a reduction in the station's lifetime emissions by over **87,000 tonnes** of carbon dioxide equivalent.



1.158 Operational carbon emissions are measured in two ways:

- The operational emissions from the scheme including the operation, maintenance and renewals of HS2 rolling stock and infrastructure, based on a reasonable worst-case estimate, are calculated to be 3.2 million tCO_2e over the 60 year appraisal period. This includes electricity consumption to operate the rolling stock (51% of operational emissions). However, HS2 also delivers substantial carbon savings through mode shift from road and air to rail. This is estimated to be in excess of 2 million tCO_2e over the 60-year appraisal period. The current estimate of carbon saved from mode shift is also conservative. Finally, there are large carbon sequestration impacts (i.e. CO_2 removed from the atmosphere by addition trees planted and creation of other land uses included as mitigation within the scheme) which offset HS2 carbon emissions by a further 0.5 million tCO_2e over 60 years of operation. This suggests that HS2 could, in the worst-case scenario, produce less than 1 million tCO_2e over 60 years of operation.
- The operational emissions used to compare with other transport modes such as existing rail, car and air travel only measure the emissions associated with operating the HS2 trains, so as to provide a direct and equivalent comparison. On this basis the scheme produces a net reduction in operational CO_2e emissions of 750,000 tonnes. For more detail on this measure please refer to the Economic Case.

1.159 The wider decarbonisation of the UK presents opportunities for low carbon operation of HS2. Emerging analysis suggests that the proposals outlined in the Transport Decarbonisation Plan could nearly halve HS2's operational emissions over the 60 year appraisal period and HS2 Ltd has recently announced its target to power Britian's new high-speed trains with zero carbon energy, supporting the goal of making HS2 net zero from 2035. This will offer a cleaner alternative to long distance car journeys and domestic flights while continuing to support the Government's 2050 target to tackle climate change.

1.160 HS2 Ltd has made several other commitments through its Net Zero Carbon Plan with the aim of decarbonising its construction and operations. These commitments will help support the goal of making HS2 net zero from 2035 through a number of new targets. They include:

- Using 100% zero carbon electricity generation to power its trains - making journeys on HS2 zero carbon for emissions from `day one'
- Introducing the first diesel-free site in 2022 and stop using diesel on all sites by 2029
- Working with supply chain partners and industry peers to set ambitious new science-based targets in 2022 to tackle carbon emission `hotspots' year-on-year as HS2 is built
- Aiming to cut emissions from concrete and steel by 50% (tCO_2e/t) by 2030 compared with 2021 levels
- Investing in innovation and forming partnerships to speed up ways to cut emissions in HS2's supply chain
- Cutting emissions from sources HS2 owns or controls and indirect emissions from electricity production

- Offsetting residual carbon emissions that cannot be eliminated as HS2 is built, maintained and operated from 2035. This includes looking at ways to capture and store carbon emissions using nature-based interventions such as planting new trees to absorb carbon dioxide

1.161 There is also an opportunity for further carbon reductions from operational emissions which relate to the repair, maintenance and replacement of infrastructure and rolling stock. These processes are currently carbon intensive as they require a substantial amount of steel and concrete. Assuming the CCC's Decarbonisation Pathway is met, it's likely that there will be a corresponding decrease in carbon emissions associated with HS2 infrastructure.

1.162 It should be noted in the calculation of all baseline carbon estimates, that these assessments are expected to mature over time with assessments becoming more robust as more detail is known about the design.

Stakeholder Views

1.163 Stakeholder engagement is critical in ensuring that the Proposed Scheme maximises the opportunity for benefits realisation as well as ensuring that we work together to minimise any unwelcome impacts. In addition to wider consultations in which the general public and local communities have been able to provide feedback on scheme proposals, HS2 Ltd and DfT have been continuously engaging with key stakeholders. These include local authorities, businesses, environmental and heritage organisations, other governmental bodies, and organisations representing the interests of residents. Overall, the scheme has received a high level of support, with HS2 Ltd and DfT working closely with stakeholders to manage issues where they occur.

1.164 The local authorities within the Greater Manchester area have all voiced support for the scheme with a clear recognition that the scheme is key to realising strong economic growth and investment for the Greater Manchester area and to enable wider rail improvements across the North. There remain some issues relating to scope and funding, in which dialogue is ongoing. For example, Manchester City Council have been particularly vocal in calling for an underground station at Manchester Piccadilly. An underground station provides an alternative way for services to continue beyond Manchester towards Leeds to that proposed with the surface station, but it has been concluded as part of the IRP that it would result in prohibitively high costs, major additional construction impacts, and a significant delay to opening. The decision to proceed with a surface level station has now been confirmed through the Design Refinement Consultation 2 response report.

1.165 The scheme will interface with a number of other transport bodies and operators including Manchester Airports Group (MAG), Highways England (HE) and Network Rail (NR). All these organisations are supportive of the wider HS2 project, though they have voiced concerns around construction and operation, with ongoing discussions taking place on construction practices and maintenance of assets.

HE's primary concern relates to proposed changes at Junctions 5 and 6 of the M56 with further information on this highlighted within the risks section of this document. NR are very supportive of the scheme in terms of the paths it will free up on the conventional network and crowding relief it will bring to Manchester Piccadilly conventional station. However, they have raised concerns on the programme of works required on the conventional railway and issues on access created by HS2.

1.166 There are several environmental groups and bodies who have raised concerns around the impact of Phase 2b WL on the local environment and heritage, including The National Trust, the Royal Society for the Protection of Birds, the Royal Society of Wildlife Trusts and the Woodland Trust. However, these organisations have also been engaging collaboratively with HS2 and DfT on the earlier phases of the wider HS2 scheme to ensure that environmental impacts are minimised. For example, on Phase 2a the National Trust has been offered a package of assurances including a fund of up to £1.5m for new environmental measures and a review of the mitigation strategy for operational noise. Following engagement with the Woodland Trust, the scheme has committed to sourcing all saplings for new tree planting from within the UK, noting that some seeds will need to be derived from outside of the UK.

1.167 DfT and HS2 Ltd have been engaging closely with Cycling UK through the 'Cycling and Walking Infrastructure Group', which is held quarterly. As the scheme progresses, HS2 Ltd and its contractors will engage with relevant stakeholders with an interest in active travel (including highway authorities) to ensure that due regard is given to the needs of people walking and cycling.

1.168 Landowners affected by the scheme are represented by The Compulsory Purchase Association and are also supported by the HS2 Construction Commissioner, Sir Mark Worthington and the HS2 Resident's Commissioner, Deborah Fazen. They all act to support those directly affected by the scheme by challenging HS2 Ltd on their decisions. In November 2020, DfT published the HS2 Land and Property Review, documenting lessons learnt on earlier phases with work ongoing to adopt this learning as part of the Phase 2b WL scheme.

1.169 In addition to the stakeholders outlined above, DfT continue to engage with a wide range of interest groups, dealing with concerns as they arise. Alongside these engagement activities targeted towards specific interest groups or subject areas, the scheme has had extensive engagement with directly affected residents and the general public. Route-wide update events were held in 2019, 2020 and 2021, both in-person and virtually via webinars. These events gave local residents the opportunity to ask questions about the scheme's design in their area and learn more about the next steps in building HS2.

1.170 Community events are based on the key principles of: informing local residents about changes that affect them; involving communities as HS2 is built; responding to questions and concerns as they arise; and consulting on route changes where necessary to ensure the best possible route option is built. Building HS2 causes disruption to local residents, communities and businesses. Early engagement with local residents, communities and businesses helps to reduce this disruption as much as reasonably possible.

2 Economic Case

Purpose of the Economic Case

2.1 The Economic Case builds on the Strategic Case in the previous chapter, and sets out expected economic impact of investment in HS2 Phase 2b Western Leg (WL).

2.2 HS2 will provide direct, high-speed connectivity between the UK's biggest economic centres – London, the Midlands, and the North West – and in so doing will act as a catalyst for growth and regeneration in Manchester and the wider North West in particular.

2.3 Economic theory has long hypothesised the positive link between transport investment and economic growth.[49] This chapter quantifies the economic and societal impacts of HS2 Phase 2b WL and comprises:

- a **Summary of the findings** of the economic assessment undertaken by the Department for Transport (DfT), with advice from HS2 Ltd
- an explanation of the **Appraisal Methodology** used for the assessment and its alignment with DfT's Transport Analysis Guidance (TAG)
- the **Benefit Cost Assessment**, which estimates the benefits and costs of the Proposed Scheme. This is informed by a reference case with additional modelling scenarios undertaken that reflect the inherent levels of economic uncertainty when delivering a long-term infrastructure project
- the approach to assessing the **Wider Economic Impacts (WEI)** generated by the scheme, which are over and above the direct transport user and static agglomeration benefits quantified within the benefit-cost ratio (BCR) range provided
- the description and rationale for the **Modelling Sensitivities** that have been undertaken as part of the assessment and have been used to inform the BCR range. This includes testing a number of different macro-economic growth and passenger demand scenarios, as well as refinements on costs, appraisal methodology, and passenger behavioural changes as a consequence of the COVID-19 pandemic
- a consideration of the **Interdependencies** of HS2 Phase 2b WL with wider rail schemes to which the Government has committed, with a focus on the Northern Powerhouse Rail (NPR) network
- an assessment of the **Carbon, Environmental, and other Non-Monetised Benefits** of the scheme that are not directly captured in the BCR calculations
- a **Distribution Impacts Assessment**, on different social groups, particularly assessing vulnerable groups
- an assessment of **DfT's Value for Money (VfM)** categorisation of the HS2 Phase 2b WL and the economic rationale for proceeding with scheme

[49] For example, Classical location theory, New Economic Geography theory.

2.4 Unlike the Strategic Outline Business Case for Phase 2b, published in 2017, which was based on an assessment that included Eastern and Western Legs of HS2, this assessment considers the HS2 Phase 2b WL increment in its own right in order to determine the value for money of the scheme.

2.5 Separate to this assessment, a BCR calculation for Phase One, 2a and Phase 2b WL together, and a refresh of the BCR for Phase One and 2a only, which corresponds to the "Statement of Intent" option from the 2020 Phase One Full Business Case (FBC), have also been undertaken, with the results provided within the chapter.

Summary of findings

Key findings:

- The Economic Case assesses the Value for Money (VfM) of the HS2 Phase 2b WL and is informed by a reference case BCR, a range of BCR sensitivities to reflect economic uncertainty, non-monetised benefits, and additional economic analysis on wider economic impacts.
- The Level 1 and 2 BCR range for the scheme, under several different economic scenarios, has been assessed as between 0.6 to 1.7. The range is wide and primarily driven by uncertainty in long term population and economic growth forecasts. This range does not include additional dynamic economic impacts covered by the Level 3 analysis.
- The initial modelling to assess Transport Analysis Guidance Level 1 (transport user) and Level 2 (static economic benefits) benefits, without a consideration of the wider dynamic impacts, indicates a BCR of 0.9.
- This increases to 1.2 if benefits are appraised over 100 years, rather than 60 years, to reflect long design life and the scale of new infrastructure being delivered, although this should be placed in the context of increased uncertainty given challenges of forecasting so far into the future.
- When taking into consideration the work on demand uncertainty and wider economic impacts, the balance of probabilities would support a BCR for HS2 Phase 2b WL between 1.0 and 1.5. As a result, the benefits of the scheme are assessed as outweighing the costs, providing long-term economic value for the taxpayer.

Supplementary findings:

- A number of scenarios have been explored to assess potential changes in travel behaviour from the COVID-19 pandemic. Evidence suggests that over summer and autumn 2021 there was a strong recovery in rail leisure and long-distance business markets. However, it is noted that in the short term at least, there are likely to be further impacts on travel markets, dependent on the future trajectory of the pandemic.

- The reference case demand growth forecasts represent more conservative growth than was observed on the West Coast Main Line (WCML) pre-pandemic. Assuming stronger growth on the West Coast corridor would suggest a BCR at the upper end of the range.
- There may be opportunities for cost efficiencies on both high-speed and conventional services by changing the rate at which train services ramp-up at the beginning of operations, the capacity of HS2 trains, the frequency of HS2 services between cities, and the level of complementary non-HS2 services. These changes could lead to improvements in the VfM for the Proposed Scheme.
- Evidence on wider dynamic impacts (Level 3 benefits) that result from land use change and which are expected to flow from an investment of the scale of HS2 Phase 2b WL, has been drawn from transport scheme evaluations, regeneration plans and complex economic modelling. The output of this work suggests that there could be additional GDP impacts from the scheme that range from £2.0bn to £5.5bn.[50]
- In addition to the VfM assessment of HS2 Phase 2b WL, an updated assessment of the Level 1 and 2 benefits was undertaken on Phases One and 2a only which indicated a BCR of 1.3, and a calculation of Phases One, 2a and the 2b Western Leg together, which indicated a BCR of 1.2.

[50] The bottom end of the range is based on meta-analysis of evaluation evidence. The upper end of the range is based on CGE modelling, with a sensitivity scenario that estimates the impact during the appraisal period, over and above the level 1 and 2 GDP impacts, that would occur if the long-term GDP multiplier was 1.8.

The Appraisal Methodology

2.6 This is the first economic assessment of any phase of the HS2 programme since the Government's decision to approve the Phase One Full Business Case and the start of Main Works construction in April 2020.

2.7 This economic analysis has been developed in line with DfT's TAG. It also reflects updated recommendations from Her Majesty's Treasury's (HMT) Green Book review, including considerations around theory of change, levelling-up and place-based impacts.

2.8 The Economic Case draws on advice from HS2 Ltd, which has undertaken the modelling and economic analysis for use by DfT. This modelling and analysis follows the same principles and approach used in previous business cases and has received the appropriate level of assurance for the level of maturity of the Proposed Scheme's design and development.

2.9 DfT guidance sets out three levels of analysis for quantifying the impacts of transport schemes and these impacts are differentiated based on the maturity of the techniques. The BCR is calculated based on the first two levels associated with transport user benefits and wider economic impacts, assuming fixed land use. The third category of benefits is associated with variable and dynamic changes in land use as a consequence of introducing new infrastructure. This third category is not included within the reference case BCR calculation, because the techniques for forecasting these impacts are subject to a high degree of uncertainty. However, the modelling and analysis is used to support the overall VfM assessment of the Proposed Scheme, alongside other non-monetised benefits.

The levels of economic impacts are outlined in the Transport Analysis Guidance (TAG) and can be summarised as follows:

- **Level 1:** direct transport user benefits
- **Level 2:** static wider economic benefits
- **Level 3:** dynamic wider economic benefits

2.10 More detail on the Level 3 benefits and its use in the VfM assessment is provided in the approach to estimating dynamic economic impacts section. Further details on the evaluation evidence supporting the section are provided in Annex 3.

Assessment of TAG Level 1 and 2 Benefits and Costs

2.11 The VfM assessment of HS2 Phase 2b WL quantifies TAG Level 1, 2 and 3 benefits. The following section sets out the 'reference case BCR', which includes an assessment of Level 1 and Level 2 benefits only and represents the basis from which other scenarios and sensitivities pivot. The assessment of TAG Level 3 benefits is set out subsequently and this is then combined with the Level 1 and 2 benefit estimates to inform the final VfM assessment.

Reference Case Core Assumptions

2.12 The following assumptions have been used to inform the reference case:

- to allow for easy comparison with the 2017 HS2 Phase 2b SOBC and 2020 HS2 Phase One FBC, the Economic Case has used Q1 2015 prices, which are presented in Present Value terms (PV)
- capital cost estimates originate from HS2 Ltd's latest baseline (Baseline 2.1W) the details of which are described in the Financial Case. The Proposed Scheme's undiscounted point estimate is £13.3bn in 2015 prices, which translated into £14.0bn in net present values including optimism bias (2015 prices). The risk and uncertainty around capital costs applies Reference Class Forecasting (RCF) at the arithmetic mean of all risk levels on the RCF curve as a measure to include optimism bias, consistent with TAG. This results in an uplift of 37.9% on the capital cost estimates
- the BCR includes the cost of core scope (including for these purposes a two-platform Manchester Airport High-Speed station) but excludes any costs associated with NPR (e.g. additional platforms at Piccadilly and Airport stations) and non-core scope (e.g. costs associated with Metrolink), which will be justified separately. In line with these assumptions about costs, the benefits of NPR are also not counted in this business case
- the 'do minimum' train service specification and the HS2 Phase 2b WL indicative Train Service Specification (iTSS) which has been used to support this assessment can be found in Annex 2
- it is assumed that Phases One and 2a are already in operation once HS2 Phase 2b WL services commence, details of the assumptions used for Phase One and 2a are provided in Annex 1
- the infrastructure authorised by the Phase 2b WL hybrid Bill includes the core scope needed to deliver high-speed services between Crewe and Manchester and also some infrastructure that delivers both active and passive provision for NPR

- for the purposes of this assessment, services in the indicative Train Service Specification (iTSS) which travel between Manchester and Birmingham will not call at Crewe. The expectation is for more stops at Crewe to be included in services in due course. However, these stops are included in the NPR business case, and so the exclusion of those benefits here avoids double counting[51]
- the remaining assumptions underpinning the analysis are contained at Annex 1

Reference Case BCR results

2.13 Figure 2.1 below sets out the the benefits, revenues and costs of the Proposed Scheme's reference case, excluding Level 3 WEIs.[52]

Figure 2.1: BCR Components for the Proposed Scheme reference case

Present Value (£bn, 2015 prices)	The reference case: Phase 2b WL (Crewe to Manchester)
(1) Net Transport Benefits	10.0
(2) Net Transport Benefits (including WEIs)[53]	13.7
(3) Capital Costs	14.0
(4) Operating Costs (including Non-Ticket Revenue)	5.9
(5) Rolling Stock & Infrastructure Renewal Costs	1.0
(6) Total Costs = (3) + (4) + (5)	20.8
(7) Revenues	5.9
(8) Net Costs to Government = (6) – (7)	15.0
(9) BCR1 (excluding WEIs) = (1) / (8)	0.7
(10) BCR2 (including WEIs) = (2) / (8)	0.9

[51] Though to this effect, these services would be included in the Bill iTSS diagrams.
[52] A more detailed breakdown of the benefits, assumptions and changes to methodology are described in Annex 1.
[53] The Wider Economic impacts included only assume fixed land use (Level 2 impacts).

2.14 The Proposed Scheme reference case is shown to have a central BCR of 0.9 before the inclusion of dynamic economic (Level 3) benefits and is expected to generate £13.7bn of welfare benefits over an appraisal period of 60 years (present value, 2015 prices).

2.15 The key driver of benefits are the transport user benefits that derive from the improved connectivity that the new high-speed network will deliver. The WEIs (static Level 2 WEIs only) for HS2 Phase 2b WL account for around £3.8bn (27%) of benefits. These benefits can be mainly attributed to agglomeration.

Phase 2b WL as catalyst for wider economic change

2.16 As outlined in the previous chapters the BCR captures static benefits (Level 1 and 2 impacts) which assume that land-use is fixed and that HS2 will have no impact on the number or location of homes, businesses or jobs. However, there is now strong evidence to suggest that major transport schemes can result in wider dynamic benefits (also referred to as Level 3 impacts) which are not accounted for within the core BCR.

2.17 The 2020 Oakervee review into HS2 determined that the 2017 SOBC for Phase 2b failed to sufficiently capture these dynamic economic impacts, noting an imbalance between the benefits that were identified within the Strategic Case and those evidenced in the Economic Case. The review concluded that further work was required in the Economic Case to understand the potential impact of HS2 on the number and location of homes and jobs. Reflecting on Oakervee's recommendation, analysis was undertaken to understand the nature and magnitude of wider benefits, and to incorporate these into the VfM assessment.

2.18 HS2 Phase 2b WL is expected to catalyse dynamic economic impacts by changing the economic geography of the Greater Manchester and the wider North West region in particular. Direct impacts along with regeneration (including development of new businesses) are expected to induce further investment and encourage greater numbers of highly skilled workers to live and work in the North West due to more job opportunities. This will lead to dynamic agglomeration impacts i.e. further expansion of productive clusters of businesses consolidating in the area. The Proposed Scheme is expected to contribute to the formation of this transformation change, which will be supported by a 'feedback loop': sustained productivity improvements will attract further private sector investment, generating further agglomeration and positive spill over effects. This chain reaction of benefits is referred to as the economic theory of change, and is set out in more detail in the Strategic Case of this SOBC update.

2.19 Evidence to suggest that investment in Greater Manchester is likely to be sustained rests on the facts that:

- Manchester's central business district (CBD) already exists as a highly productive cluster with the potential for growth
- there are unique attributes and strong business sectors in Greater Manchester that make it an attractive place to invest. These include a strong base of university graduates, with four major universities within three miles of the expanded Piccadilly station, and the second-highest rate of graduates finding jobs in the location they studied
- Manchester has a strong health sector with teaching hospitals at Manchester Royal Infirmary, Wythenshawe and the specialist cancer centre at Christie Hospital
- Manchester has high number of amenities and is a strong leisure destination offering extensive retail, sport, museums, and entertainment options

2.20 These attributes combined with the region having the second largest airport outside London, which has a catchment across the North, and the city as a whole having extensive trunk road and motorway connections, creates a good environment for long term sustained private sector investment.

Approach to Estimating Dynamic Economic Impacts (Level 3)

2.21 International evidence shows that previous high-speed rail investments can and have changed the distribution of firms to create high productivity clusters (see Annex 3). However, estimating the magnitude of these dynamic or transformational economic impacts is challenging and is characterised by a high degree of uncertainty. In particular, it is not just a case of forecasting GDP but the effect that this has in turn on broader welfare and overall government income and spending.

2.22 Given these challenges, DfT has sought to estimate the potential size of transformational impacts using three different methodologies that are top-down and bottom-up, but all of which result in an estimate that can be used to support the VfM assessment. These methods are:

1. Estimates based on evaluation evidence from other transport schemes
2. Estimates based on regeneration land value uplift evidence
3. Spatial Computable General Equilibrium Modelling

2.23 Each approach along with the core findings is summarised below:

1. Estimates based on evaluation evidence from other transport schemes

2.24 New economic geography theories predict that, with increasing investment, economic activity will increasingly centralise to a 'core' but that, beyond a certain 'optimal' city size, increasing economic activity will spread to the periphery due to factors such as high land rents in the core. Cities like Manchester with strong urban and inter-urban transport networks allow this spill over to happen more seamlessly.

2.25 International evaluation evidence from a range of sources has been used to assess the impact of the Proposed Scheme on economic geography. The Transport Investment and Economic Performance (TIEP) report of 2014 identified that transport investment benefitted the economy through productivity effects and investment and employment effects. While there are important correlations between transport and local economic activity, establishing robust causality is difficult.

2.26 The latest systematic review of evaluation evidence on the impact of high-speed rail investment from across Europe, US and Japan on economic geography shows that investment in high-speed rail has often changed the distribution of businesses to create higher productive areas in the vicinity of stations (summary of evidence is given in Annex 3). Evidence is emerging on the positive investment impacts HS2 links have brought forward in Birmingham. However, in some cases economic activity is drawn towards more highly productive areas eg. HSR in France has been linked to managerial jobs relocating from regional to HQ offices.

2.27 Detailed meta-analysis of international empirical evidence (Melo et al 2013) considers quantitative evidence that links transport infrastructure investment to long run output (as measured by GDP). The authors conclude that the evidence suggests that for every 10% increase in the country's infrastructure capital stock, GDP would increase by 0.37% for rail investments. This provides a high-level, broad-brush indication of the size of the effect of transport investment on GDP.

2.28 Taking the outputs from Melo et al (2013) meta-analysis and applying to HS2 Phase 2b WL suggest that the Proposed Scheme could generate up to £8bn of GDP benefits over a 60-year appraisal period.[54] This is in addition to the £11.2bn already included as direct economic impacts.[55]

2. Estimates based on regeneration land value uplift evidence

2.29 Although Manchester's CBD has grown northwards and into Salford, there are still large areas to the east (including the area around the HS2 station) in need of regeneration with a high proportion of vacant sites. Regeneration is critical to creating a bigger and more productive CBD that will support its sustainability for the long term.

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[54] The estimate range varies due to assumptions around the definition of capital stock and asset life of capital stock. There is uncertainty around this estimate, as the empirical evidence includes a number of assumptions and draws on international evidence that may not all be directly applicable to the UK. Further detail is provided at Annex 3.

[55] Direct economic impacts are described as Business User benefits and static WEIs, with a 2.5x adjustment to labour supply benefits to reflect the GDP value of these.

2.30 Based on the Greater Manchester Growth Strategy, estimates of gross development values (GDV) from new developments around Manchester Piccadilly and Manchester Airport, and delivery of both HS2 Phase 2b WL and NPR, provides an upper-bound estimate for the increase in land values in the immediate vicinity of the stations, with some of these benefits likely to be additional to TAG Level 1 and 2 benefits set out above. It is an upper end local estimate because there will be other dis-benefits (e.g. transport external costs) that are not captured in a GDV metric, that should be quantified in order to arrive at a net social value. The Proposed Scheme will provide an incentive for developers to invest in areas around Manchester Piccadilly and Manchester Airport. Some of this will be development that may have happened without HS2 and NPR, but most is expected to be the direct consequence of HS2, as set out in Transport for Greater Manchester (TfGM's) plans. Some will in effect transfer development from other areas of the country (i.e. is not `additional'). The figures set out in Figure 2.2 provide an indicative scale of the value of additional benefit of these investments, based on work done pre-COVID-19.[56]

2.31 The Strategic Case provides further detail on the areas of land in which The Greater Manchester Combined Authority (GMCA) expect to see investment as a result of both HS2 and NPR.

Figure 2.2: GDV of new developments arising from for the Proposed Scheme and regeneration plans around Manchester

Area	GDV of new developments arising from HS2, NPR, and regeneration plans (£bn, 2015 prices, time period up to 2051, PV)[57]
Manchester Piccadilly	3.30
Manchester Airport	1.16

3. Spatial Computable General Equilibrium model

2.32 To further support the economic analysis and assessment of TAG Level 3 economic impacts, HS2 Ltd commissioned a Spatial Computable General Equilibrium (CGE) model to estimate the macroeconomic impacts of the Proposed Scheme.

What is a CGE model?

CGE modelling is part of a suite of supplementary economic models (see Transport Analysis Guidance Unit M5.3) TAG Unit M5-3 supplementary economic modelling - GOV.UK (www.gov.uk) A CGE model simulates economic interactions between economic agents (consumers, producers, and government) with data from official statistics and international trade datasets. CGE models are used as policy impact simulation tools by national governments, the EU, and international agencies such as the World Bank and the IMF.

[56] It should be noted that estimating these changes in land value is challenging and it cannot be done with a high degree of precision.
[57] See Greater Manchester Combined Authority Growth Strategy

The key benefit of CGE modelling is that it can capture all of the impacts that lead to GDP change within a general equilibrium framework, providing an estimation of the long-term result once all of the various interactions in the economy have been worked through. The model forecasts the way in which the balance of factors of production, and their locations, would be expected to alter following a significant transport improvement. Accessibility improvements encourage investment around stations as, in effect, the economic reach of service businesses increases. As well as encouraging existing businesses to expand, such improvement in turn stimulates new businesses to set up and people to move jobs and homes to take advantage of the new opportunities. The CGE model forecasts these changes as they promulgate through all sectors of the economy and thus it also makes allowance for the displacement of economic activity from one part of the economy to another. This allows it to forecast net growth.

Although CGE modelling captures the main channels through which the Proposed Scheme is theorised to affect the economy, there is a substantial amount of uncertainty related to estimating transformational impacts. CGE modelling is not routinely applied to the transport sector, making it difficult to compare the modelling with traditional transport models. There are also key areas where the model differs from the assumptions set out in Transport Analysis Guidance. Although CGE modelling is a useful part of the evidence on wider impacts, the outputs are innovative and subject to a high degree of uncertainty.

2.33 Using the CGE model GDP output estimates referenced in the Strategic Case and applying adjustments (including discounting them over the 60-year appraisal period (2038-2098) and excluding pre-appraisal period GDP impacts), we estimate the additional GDP impact, above those included in Level 1 and 2 and used as inputs to the CGE model (valued at £11.2bn), of the Proposed Scheme could be £3.2bn (2015 prices, PV).[58] There are wider uncertainties and complexity in attempting to estimate dynamic impacts. The spatial pattern of re-allocation of economic activity geographically is especially uncertain, and the evidence base is not unanimous on the expected direction of travel. However, there is anecdotal evidence of increased economic activity along the line of route of HS2. Given these challenges, we take a conservative approach when including these estimates in the VfM assessment set out below.

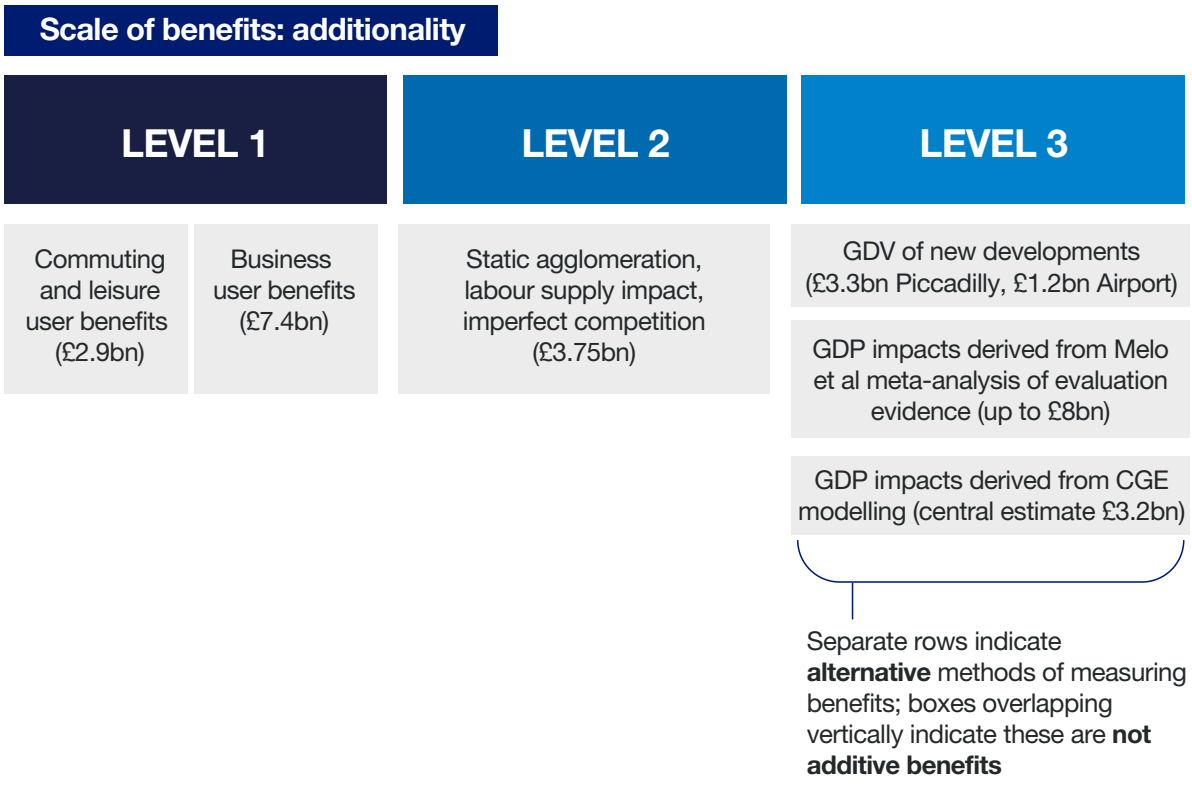
2.34 Figure 2.3 below illustrates the different sources of benefits and their relationship to each other. The benefits estimated using evaluation evidence and the CGE estimates of benefits are additional to the Level 1 and 2 benefits but the estimates based on GDV uplift will overlap to some degree with the Level 2 estimates.

2.35 In line with HMT Green Book guidance on assessing VfM, Level 1 and 2 benefits are estimates of welfare impacts on society. However, the Level 3 benefit estimates are estimates of economic or GDP impacts. There is not necessarily a direct relationship between welfare and GDP. However, international evidence shows that higher GDP is associated with higher social welfare.[59] Further work is needed

[58] Based in CGE modelling
[59] IMF, Working Paper 17/271: Welfare v Income Convergence and Environmental Externalities

to better align GDP and welfare estimates but for simplicity, here we assume that welfare and the increase in productivity (GVA) are closely related and are of similar magnitude.

Figure 2.3: Economic benefits of the HS2 Phase 2b WL scheme split by Level 1, Level 2 and Level 3 benefits



Bringing together the estimates of dynamic impacts

2.36 The evidence presented above suggests that the economic impacts captured in TAG Level 1 and 2 benefits are highly likely to underestimate the full economic impact of the Proposed Scheme. As Figure 2.3 suggests, benefits could be significantly above those identified by the core analysis, their scale being increased by the delivery of complementary investments triggered by the Proposed Scheme. We estimate the likely range of additional GDP benefits as between £2 – 5.5bn.[60]

[60] The bottom end of the range is based on meta-analysis of evaluation evidence. The upper end of the range is based on CGE modelling, with a sensitivity scenario that estimates the impact during the appraisal period, over and above level 1 and 2 GDP impacts, that would occur if the long-term GDP multiplier was 1.8.

Sensitivities for the Proposed Scheme

2.37 Modelling of the economic benefits of the Phase 2b WL Scheme is subject to a number of core assumptions which are subject to change. This is not unusual, especially for projects that will be delivered some years into the future, and to this end it is standard practice to consider a range of sensitivities. These sensitivities allow the impact of changing assumptions on the value for money of the scheme to be assessed.

2.38 Sensitivies can be grouped under the following headings:

- changes to the appraisal period
- changes to cost
- changes in passenger demand, including high and low economy and population forecasts, behavioural changes as a result of COVID-19, and different regional growth assumption
- changes to assumptions on mode shift
- other methodological sensitivities

2.39 It should be noted that all of these sensitivities are given in relation to the reference case BCR of 0.9 and do not take into account the Level 3 dynamic WEIs quantified through the methods outlined in the previous section.

Extended appraisal period

2.40 In line with DfT TAG guidance, the reference case appraisal period for the impacts of the scheme is 60 years from scheme opening (assumed 2038). A sensitivity test using a 100 year appraisal period, which more accurately reflects the expected life-time of the investment, provides an estimate of the long-term value of HS2. **Increasing the appraisal period to 100 years increases the Proposed Scheme's BCR to 1.2.**

2.41 The sensitivity test recognises the long asset life (up to 120 years) and new, long distance infrastructure that HS2 will provide, with transport infrastructure having previously determined where people locate for centuries. However, it should be stressed that growth forecasts this far into the future cannot take into account the impact of technological developments and wider changes to society which could have a significant impact on the demand for travel.

Cost sensitivities

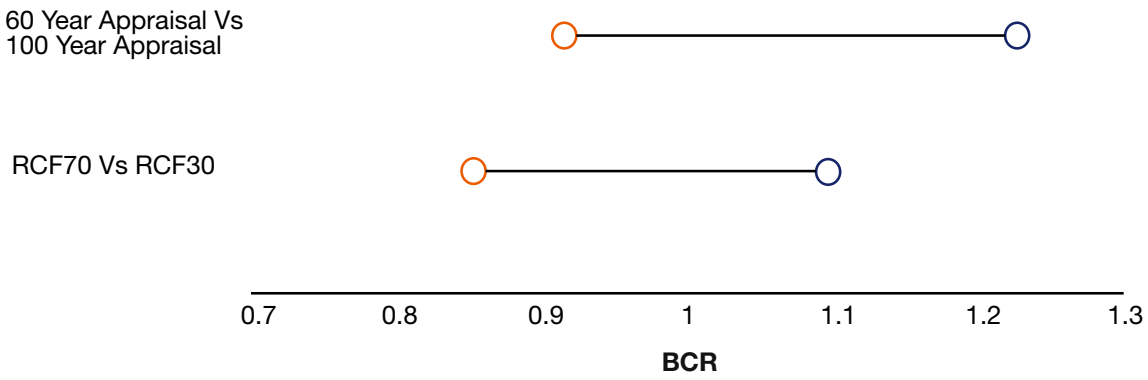
2.42 Cost sensitivities were undertaken using the TAG-compliant RCF approach in which the level of risk and optimism bias are adjusted. Changing the level of risk and optimism bias from RCF30 to RCF70, reflects different levels of risk and appropriate levels of contingency to the cost of the programme. The rationale for the use of RCF is provided in the Financial Case.

2.43 The impact this has on the BCR of the Proposed Scheme is shown in Figure 2.4. This results in a BCR, with level 2 WEIs, with a range of 0.9-1.1.

Figure 2.4: Benefit Cost Ratio with Wider Economic Impacts of the Proposed Scheme at different risk adjustment levels to the capital costs

	RCF30 (12% risk adjustment)	RCF mean (37.9% risk adjustment)	RCF70 (44.2% risk adjustment)
BCR with static (Level 2) WEIs	1.1	0.9	0.9

Figure 2.5: BCR with Level 2 Wider Economic Impacts Ranges of the Proposed Scheme under different cost and appraisal length scenarios



Passenger Demand Sensitivities

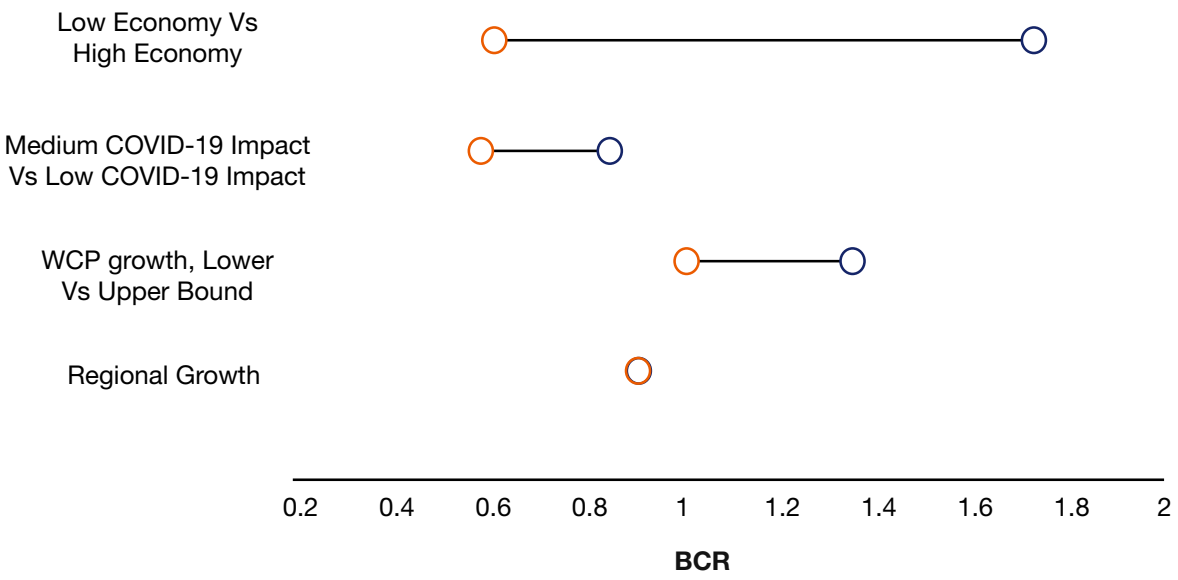
2.44 As outlined above in relation to the 100 year sensitivity test, there is significant uncertainty around the future demand for travel. Demand for travel is largely determined by population and economic growth which are difficult to forecast into the future. Demand for travel is also affected by travel behaviour, with the current COVID-19 pandemic causing a short-term impact on some types of travel, elements of which could continue on into the longer term, but with no certainty around this.

2.45 Following the TAG uncertainty toolkit, a series of different demand scenarios have been developed. These allow an exploration of the impact on benefits for HS2. Several of these scenarios reflect the TAG Common Analytical Scenarios, including:

- high and low economy and population forecasts
- behavioural changes as a result of COVID-19
- West Coast Partner growth assumptions
- different regional growth assumptions

2.46 Figure 2.6 summarises the BCRs for these sensitivities, which compare with the reference case BCR of 0.9. Further detail on each scenario is provided below:

Figure 2.6: BCR with Level 2 Wider Economic Impacts Ranges of the Proposed Scheme under different demand scenarios



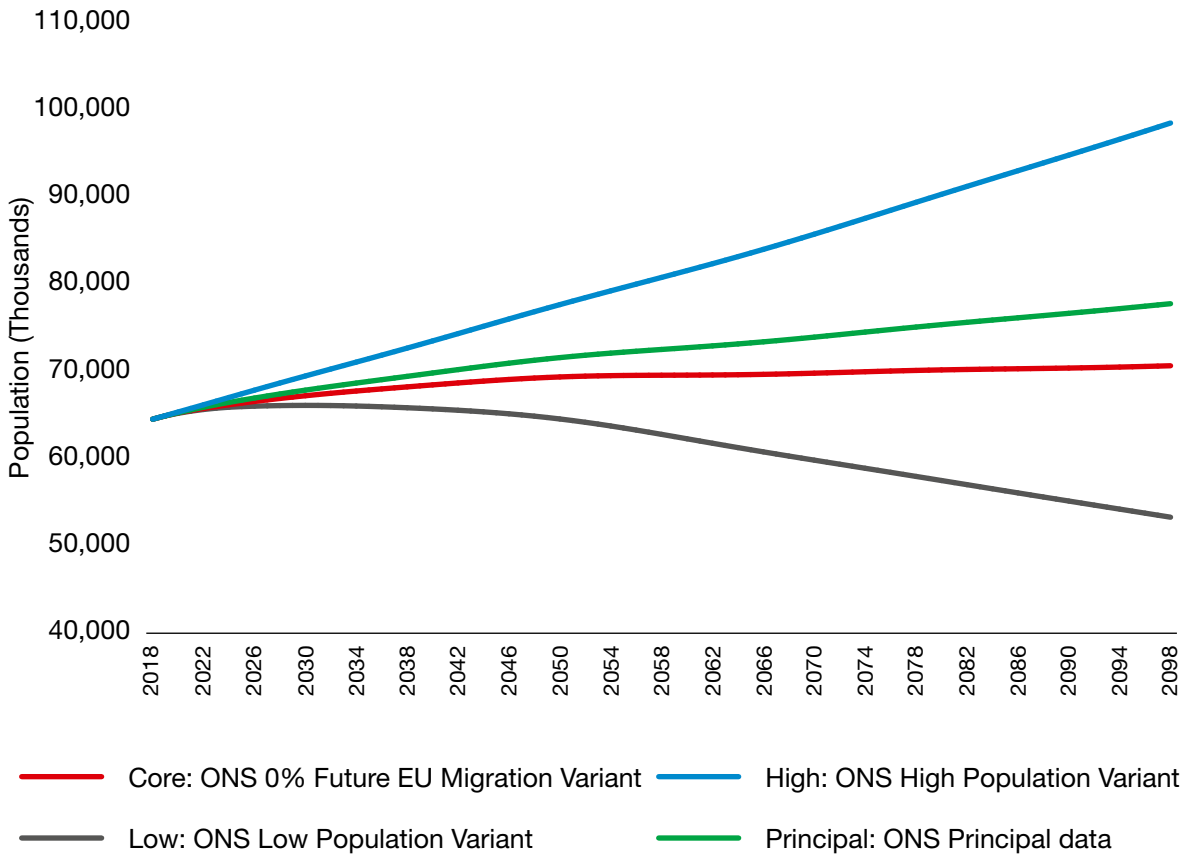
High and Low Economic, Population Growth and Employment sensitivities

2.47 HS2 is a long-term project and is significantly impacted by changes in long term economic and population forecasts. This is explored through both High and Low Economy scenarios which assume alternative projections for population, GDP per capita and employment, the key drivers of rail demand.

2.48 Population assumptions in the long run have a significant impact on the BCR, as beyond 2041, the final modelled year, demand is extrapolated in line with population growth.

2.49 Reference case population projections are assumed in line with the Office for Budget Responsibility (OBR) and the TAG data book, which assume 0% EU migration. This is compared against the Office for National Statistics (ONS) central "principal" population projection and high and low population variant projections (also published by the ONS). The reference case projection results in 2.2m fewer people forecasted than the ONS central "principal" forecast, as shown in Figure 2.7.

Figure 2.7: GB Population forecasts used for the core (reference case), high and low economy sensitivities against the principal ONS forecast



2.50 The GDP per capital assumptions for the High and Low Economy sensitivities apply a +/- 0.5 percentage point year-on-year growth rate from the reference case assumptions.

2.51 Employment is also a key driver of demand, and the employment assumptions for the High/Low Economy sensitivities increase at the same rate of central employment growth[61] uplifted by the ratio of growth in the scenario's working age population compared with the core working age population in that year.

2.52 The High and Low Economy sensitivities estimate the BCR, with (Level 2) WEIs, to be 1.7 and 0.6 respectively.

Sensitivities capturing Passenger behaviour changes due to the COVID-19 pandemic

2.53 The impact on the UK's wider economy from the COVID-19 pandemic and the subsequent restrictions that have been put in place is reflected in our reference case economic assumptions and based on the OBR forecasts in November 2020.

2.54 It is is possible that COVID-19 could also have a long-lasting impact on how people travel and work. However, we will not know the degree to which it may change travel behaviour for many years. There have been significant shocks to the economy that have occurred over the last 60 years that have changed travel patterns, such as the 1979 oil crisis and recessions. Conversely, there have been others, such as the internet revolution and widespread use of mobile devices that have not significantly changed how people travel. The strongest predictors of demand for travel in the long term remain economic and population growth. (The impact of uncertainty in these forecasts is discussed in the section above).

2.55 The economic analysis has explored the potential impact of COVID-19 on the demand for travel through three behavioural scenarios that have been based on regular surveying of the rail market. The work uses evidence gathered primarily from commuting and leisure markets, and the behavioural scenarios have assumed that business travellers will behave in a similar way to commuters.

2.56 The scenarios range from a 'low impact scenario', where demand recovers quickly to pre-pandemic levels but with a small permanent reduction, to a 'high impact' scenario, where rail demand remains significantly and permanently lower than pre-COVID-19 level, even after the pandemic has ended.

2.57 These scenarios are not predictions, but instead explore a range of possible impacts of the pandemic on future rail demand, including a worst-case scenario. These assumptions (see figure 2.8) result in a range of BCRs between 0.4 and 0.9.

[61] This rate is informed by OBR's March 2020 Economic and Fiscal Outlook release, which forecasts core workforce growth of 0.05% year-on-year.

Figure 2.8: COVID-19 behavioural impact scenario assumptions on commuting, business and leisure users relative to the reference case and resulting Level 2 BCR with Wider Economic Impacts

Assumption	Low impact resulting from COVID-19 Behavioural change	Medium impact resulting from COVID-19 Behavioural change	High impact resulting from COVID-19 Behavioural change
Working from home impacts (commuting and business travel)	5% reduction	26% reduction	47% reduction
Leisure travel[62]	No permanent impact	25% reduction	50% reduction
BCR with Level 2 WEIs	0.9	0.6	0.4

2.58 Since these scenarios were developed the vaccination programme has been rolled out and the emerging evidence suggests a strong recovery in travel markets. Data from autumn 2021 shows rail demand at 69%, bus use at 79% and road traffic at 98% of pre-pandemic levels.[63]

2.59 Furthermore, the HS2 travel market is dominated by business and leisure travel. With the importance of in-person meetings and growth in leisure travel, and emerging evidence suggesting a strong recovery in the business and leisure markets, it is likely that the HS2 market will be less impacted by behaviour change than other rail markets which are more heavily dominated by commuting trips.

2.60 A recent survey 'The Business Travel During Covid-19 Survey' commissioned by DfT (published August 2021), suggests a positive outlook for future levels of business travel with 13% of companies expecting to use Long Distance Rail post pandemic (compared to 15% pre-pandemic), and only small reductions in the frequency of business trips made overall (34% of companies expect staff to travel at least weekly, compared with 40% before the pandemic). This suggests the more extreme post-COVID-19 demand scenarios which model a decline in business (47%), commuting (47%) and some leisure travel (50%)[64] thus reasonable to assume that any long-term impact from behavioural change is more likely to fall within the 'low impact scenario' with the 'medium impact scenario' providing a reasonable worst case.

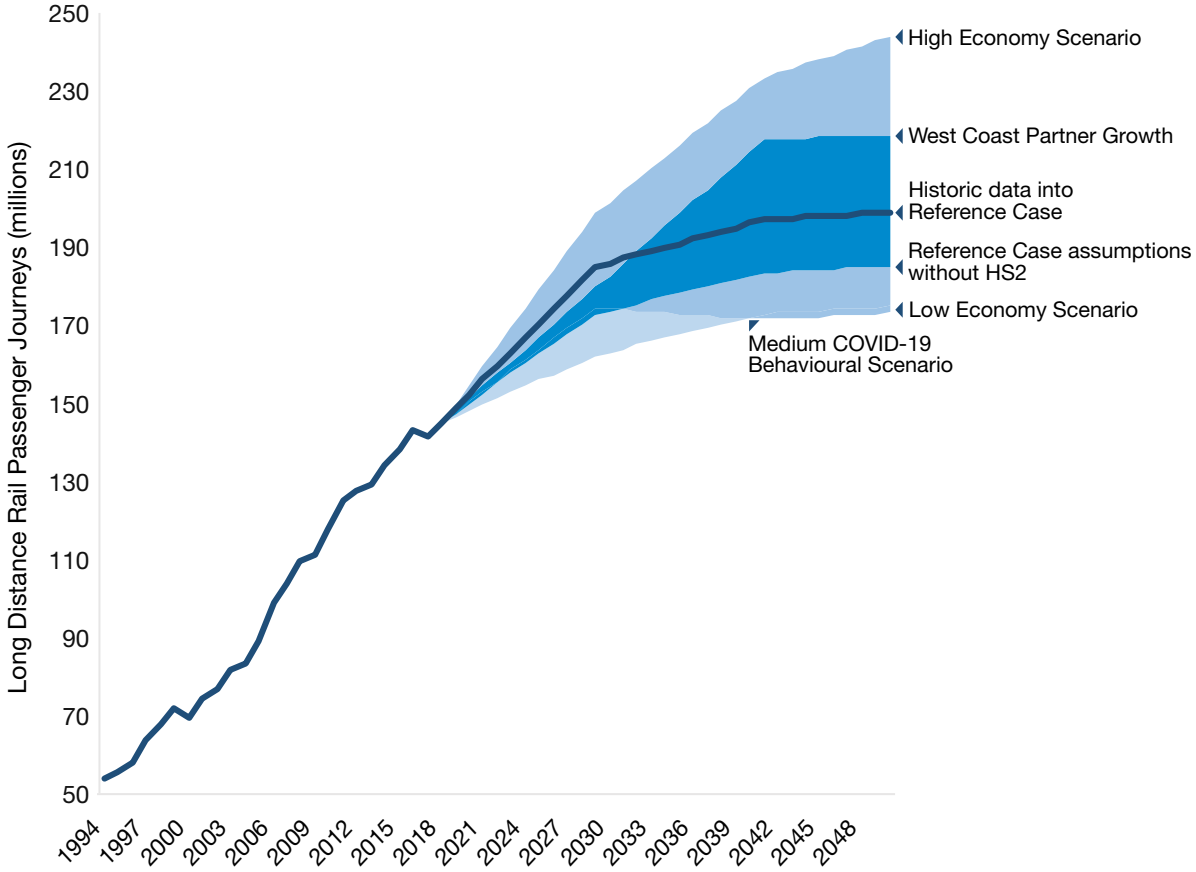
[62] This includes public events, eating out, day trips and cinema specifically. All other leisure trips are not affected. It results in a 3.25% and 6.5% reduction in leisure travel.
[63] GOV.UK, 2020. Transport use during the coronavirus (COVID-19) pandemic.
[64] This includes public events, eating out, day trips and cinema specifically. All other leisure trips are not affected. It results in a 3.25% and 6.5% reduction in leisure travel.

West Coast demand growth sensitivities

2.61 Phase One, Phase 2a and the Phase 2b WL will be delivered in a high growth corridor which is focussed primarily on long distance business and leisure travel markets. The WCML has experienced relatively strong demand growth, averaging 4.3% per annum between 2013/14- 2018/19, far above the network average growth. Demand modelling shows an implied growth of around 1.63% per annum. This means we may be under-forecasting demand on this corridor.

2.62 Commercial opportunities reflected in operators' yield management (pricing and ticketing, alternative configuration of seating and use of space, and other quality initiatives) have benefits recognised in previous research undertaken for the Passenger Demand Forecasting Council. Separate analysis has also been conducted by the West Coast Partnership Development (HS2 operations advisers) in this area. The emerging evidence from this analysis shows that the relative higher growth on the WCML corridor could be sustained into the future. If the recent historic growth on the WCML was sustained over a 10-year period following the introduction of HS2, this would bring demand growth more closely in line with the high economy scenario discussed above.

Figure 2.9: Long distance (>50miles) historic passenger demand and forecasted demand under different scenarios



Regional growth sensitivity

2.63 Forecasts of population and employment growth differ across regions in Great Britain. In the reference case these grow at a faster rate in London, the South East and East, than in the Midlands or the North. The regional growth sensitivity is designed to show how HS2 benefits and revenues would change when population and employment growth is spread more equally across the country. The sensitivity test shows that the changes to benefits and revenues are minor, with no effect on the BCR. This is largely explained by HS2 being a national programme and any disbenefits that occurs in London and the South are offset by larger benefits to the North and Scotland.

Positive mode shift sensitivity

2.64 In the reference case, 10% of HS2 demand comes from mode shift from car and aviation. This is on the London – Birmingham – Manchester –Scotland corridor which focusses on long-distance, inter-regional movements and already has a high rail mode share.

2.65 Based on international evidence, a positive mode shift scenario was developed to investigate the potential impact of additional mode shift from car and air to rail along this corridor.

2.66 Looking at the impact of four European high-speed line projects, a significant proportion of mode shift comes from the aviation sector. The evidence from these projects shows that comparing demand pre and post the introduction of high-speed lines, there are reductions in air travel on relevant corridors of between 24-27% Similarly, road share modes were reduced by around 8%.[65]

2.67 The reference case already assumes a reduction in aviation demand of 8% and road demand of less than 1%. If an additional increase in mode shift from air to rail of 15% is assumed, this results in an additional 3% rail demand uplift for high-speed rail. Assuming an increase in mode shift from road by a further 2% above the reference case produces a further high-speed rail demand uplift of approximately 3%.

2.68 Preliminary analysis shows that given the road and air share of the market is small, the additional demand from further mode shift will have a small but positive impact on BCR.

Other sensitivities

2.69 There are further sensitivities that may affect the benefits, costs and revenues derived from the Proposed Scheme, where appraisal assumptions are not identical to the reference case. These include adjusting:

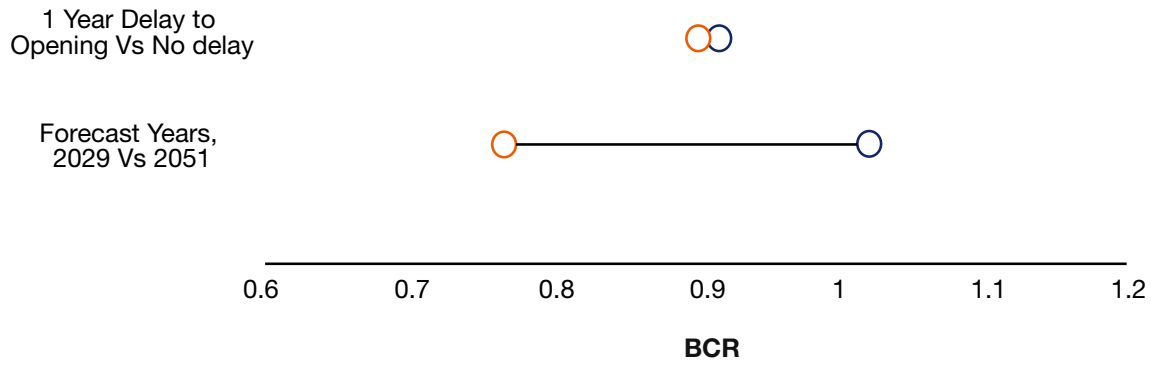
1. the demand forecast years to 2029 and 2051

[65] HS2 Ltd, March 2014. High Speed Rail: International Case Studies Review

2. the schedule by delaying the opening date by a year

2.70 These sensitivities will create BCRs different to the reference case. Figure 2.10 shows the BCRs for these sensitivities, which compare with the reference case (0.9).

Figure 2.10: BCR with Level 2 Wider Economic Impacts Ranges of the Proposed Scheme under different methodological scenarios



1. Demand forecasts/ final modelled year

2.71 The appraisal year is the year in which this appraisal was carried out which is 2021 for this business case. In line with TAG, the second forecast year is set at twenty years from the appraisal year (i.e. 2041 for the Proposed Scheme's reference case). As per TAG guidance, sensitivity tests with a forecast year of eight years after the appraisal year (i.e. 2029) and thirty years after the appraisal year (i.e. 2051) have been undertaken. These sensitivity tests show the impact of varying the time period over which exogenous demand drivers impact demand. Effectively, this tests the uncertainty around the validity of the time period over which the relationship between rail demand and its determinants is assumed to hold. The impact of BCR in the long run is driven more by population forecasts than other variables as demand is assumed to only grow in line with population after the last forecast year.

2.72 The first forecast year sensitivity caps passenger demand growth at 2029, and reduces the BCR including static WEIs to 0.8, whereas using a third forecast year and extending passenger demand growth by ten years to 2051 increases the BCR including static WEIs to 1.0.

2. Schedule

2.73 In the reference case, for the purposes of assessment, the Proposed Scheme is assumed to start operations in 2038. This schedule sensitivity assumes that this date is delayed by one year to 2039, based on the Baseline 2 RCF70 delivery into

service date.[66] The delayed opening sensitivity increases capital costs and reduces benefits, revenues and operating costs in present value terms due the effect of discounting. There is a slight decrease to the BCR, but no material impact on the reference case BCR (no change to 1 decimal place) as a consequence of the delay.

Interdependencies with other schemes

2.74 The Proposed Scheme acts as a spine that other services may use in the future, such as NPR. The integration of HS2 and NPR will potentially lead to additional demand and benefits attributable to HS2 which have not been captured in the current modelling, where NPR is assumed not to be in operation.

2.75 As set out in the Strategic Case, not only does HS2 Phase 2b WL provide critical infrastructure to enable NPR, the complementary nature of the two schemes works to maximise benefits.

2.76 Additional analysis has been undertaken to assess each scheme as an integrated package. This shows that the level of benefits in the integrated HS2/NPR scenario are greater than the sum of the benefits from each scheme in isolation. The analysis suggests that integration could generate an additional 15% of demand across the HS2/NPR network, on top of the demand resulting from HS2, and creates the potential to generate an additional 5% of benefits over and above the HS2 benefits set out in this Economic Case. These benefits are not included in the BCR or VfM assessment.

Carbon, environmental and non-monetised benefits

Carbon Impacts

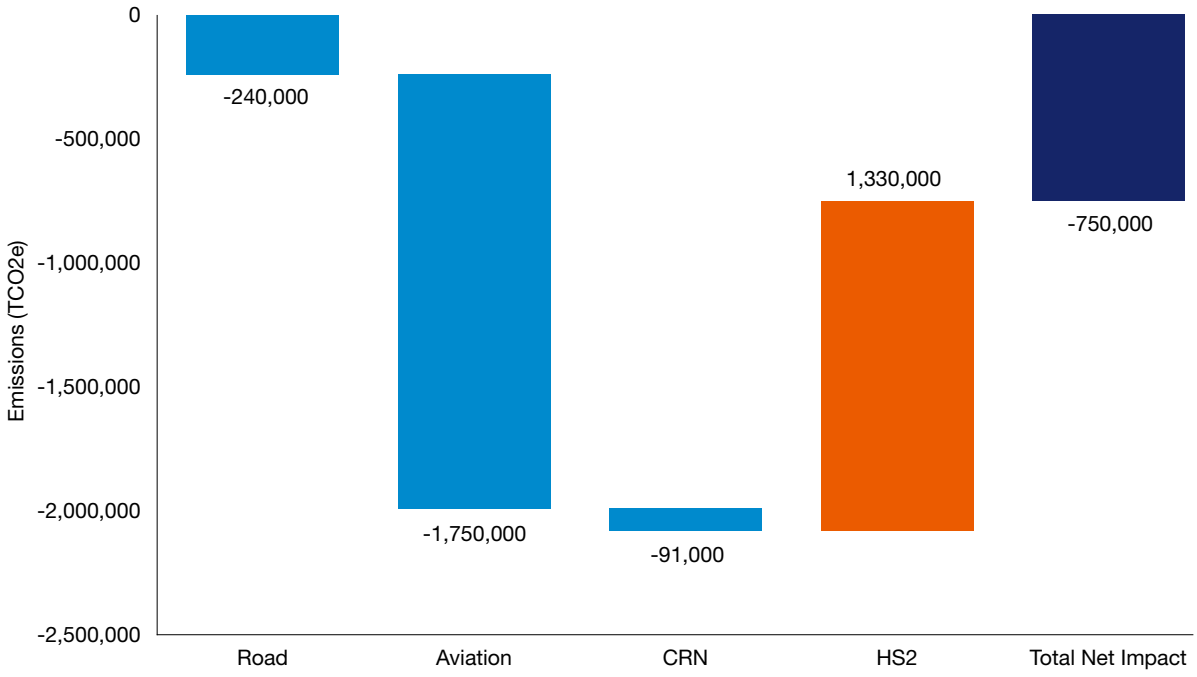
2.77 As highlighted in the Strategic Case, HS2 has the potential to significantly contribute to the UK's carbon net zero target.

[66] This date differs from the RCF70 schedule date quoted in the Financial Case, 2041, which uses a more up-to-date Baseline 2.1w to inform schedule risk. This report was not completed in time for use in the Economic Case sensitivity assumptions. However, off-model analysis indicates that there would still be no material impact to the BCR to 1 decimal place.

2.78 DfT's recently published Transport Decarbonisation Plan indicates that in order to achieve the ambitious target of net-zero carbon emissions by 2050, there will need to be a major change in people's travel habits, moving away from road and domestic air travel to less carbon-intensive modes of transport.

2.79 Over the 60-year appraisal period, the Proposed Scheme is forecast to reduce the number of journeys on GB roads by 30m, reducing emissions by 240,000 tonnes CO_2 equivalent (CO_2e); and the number of domestic aviation passengers by 25m, reducing emissions by 1,750,000 tonnes CO_2e. The Proposed Scheme is also forecast to generate 225m new passenger trips in net terms but produce a net reduction in operational CO_2 emissions of 750,000 tonnes. This includes both traded and non-traded carbon impacts, though only non-traded carbon emissions, 200,000 tonnes CO_2e, are currently monetised within the reference case, included in the breakdown of the benefits in Annex 1.

Figure 2.11: Impact of the Proposed Scheme on Operational Carbon emissions over the 60 year appraisal period



Environmental sensitivity (faster decarbonisation of transport modes and national grid)

2.80 To reflect the Government's commitment to achieving carbon neutrality for the UK by 2050, as published in the Transport Decarbonisation Plan, an environmental sensitivity test was performed which assumes a greater level of decarbonisation of the transport network than is currently assumed in TAG.

2.81 The sensitivity is based on faster decarbonisation of transport modes and the national grid based on evidence produced in the 6th Carbon Budget by the Committee on Climate Change (CCC), in collaboration with industry, on moving towards a balanced pathway to decarbonisation and achieving net zero by 2050.

It does not explicitly model how government policy will affect mode shift from road and air to rail. The number of passenger journeys on HS2, and the level of modal shift, remains unchanged from the Reference Case. The scenario has been developed based on assumptions similar to the Transport Decarbonisation Plan medium scenario which assume:

- reduced road transport emissions and higher update of electric vehicles: a net-zero Greenhouse gas (GHG) emissions transport decarbonisation scenario, which is consistent with the Department for Business, Energy & Industrial Strategy's (BEIS) Ten point plan for a green industrial revolution
- reduced rail emissions due to lower national grid emissions: a net-zero GHG emissions scenario consistent with the Traction Decarbonisation Network Strategy
- aviation: DfT's aviation model emissions baseline adjusted for 20% uptake of Sustainable Aviation Fuel by 2050

2.82 In this sensitivity, overall emission savings increase from 750,000 tCO_2e to 980,000 tCOe. This is driven largely by lower emissions from HS2 due to a darbonised national grid. There is no impact on the BCR to one decimal place.

2.83 Similarly, for carbon emissions from construction, the environmental sensitivity indicates a fall of around 2m tCO_2e compared to the Reference Case. This is a 40% decrease in emissions and is based on a linear decarbonisation toward net zero by 2050.

2.84 No assessment has been made of the impact decarbonised steel and concrete has on maintenance and renewal of infrastructure, a significant source of carbon. DfT is waiting for further advice from HS2 Ltd. A fuller analysis of the BCR impact will be included in time for the second reading of the HS2 Phase 2b WL Bill.

New Carbon values (Traded and Non Traded)[67]

2.85 Recently updated guidance from BEIS recommends extending appraisals to include traded carbon at the same value as non-traded carbon (net of the traded UK Emission Trading Scheme (ETS) price). As the guidance has only recently published, a full analysis on the size of impact is not available for this business case. However, high level calculations suggest applying these carbon values to all emissions from construction, operation and modal shift in the central case would imply a disbenefit of £0.7bn (PV, 2015 prices, £241/tonne in 2020, 5.4m tonnes CO_2e) with a range from £0.3bn to £1.2bn under low and high carbon values (£120/tonne and £361/tonne) respectively. A disbenefit of this scale could reduce the BCR by up to 0.1. A high-level sensitivity has been undertaken based on a decarbonised scenario, where HS2 Ltd would adopt decarbonised construction and operation, as set out in the Strategic Case. The sensitivity test results in a reduced disbenefit of £0.4bn (PV, 2015 prices,3.1m tCO_2e), with a range from £0.1bn to £0.7bn.

[67] The BEIS pubication 'Valuation of greenhouse gas emissions: for policy appraisal and evaluation' provides detail on traded and non-traded emissions.

Freight Impacts

2.86 Freight impacts are not included in the core BCR. However, modelling and analysis undertaken for the Proposed Scheme (as an increment to Phase One and 2a) shows a neutral or negative impact on rail freight traffic. This is because the introduction of additional passenger services when compared to Phase One and Phase 2a create wider constraints on freight through-traffic. However, given the infrastructure improvements due Phase 2a investment, the HS2 programme as a whole is likely to deliver freight benefits.

2.87 By flexing the capacity at key junctions on the network, and therefore assuming a less constrained future freight demand on the rail network, some significant benefits could be realised from the Proposed Scheme. Whether, and the extent to which, this occurs depends on additional (currently unfunded) investment at the key junctions. These are initial emerging results and they will be updated as part of the Phase 2a FBC where the full potential for freight benefits will be captured.

Landscape impacts

2.88 The landscape impacts of the Proposed Scheme have been monetised in line with the latest DfT landscape appraisal guidance. This assessment involved utilising a quantitative approach that uses monetised values for each different type of landscape that will be impacted by the route of the Proposed Scheme, and does not consider any additional policies being considered to minimise the impacts.

2.89 The landscape impacts were appraised differently in a central, low and high scenario. The central scenario assessed the impacts over a 100-year appraisal, while the low and high scenarios considered 60 and 250 years respectively. Each scenario used land type value estimates that were low, medium and high, relative to one another and using DfT estimates.

2.90 The analysis indicates that the Proposed Scheme will generate a disbenefit to the associated landscape of £0.5bn (PV, 2015 prices). This estimate accounts for the value of the land that will be used to build the scheme, as well as the lost ecosystem services that would have been derived from carbon sequestration and air quality impacts. While the low and high scenario results suggest that the Proposed Scheme will produce a dis-benefit of £0.3bn and £0.9bn respectively (PV, 2015 prices). Landscape impacts are not included in the core BCR but are used to inform the overall VfM assessment. However, inclusion of the monetised landscape impacts would reduce the BCR by up to 0.1.

Non-monetised Impacts

2.91 As set out in DfT's TAG, impacts that cannot be translated into monetary values have been considered as part of the VfM. This requires a qualitative appraisal based on the inputs of experts from the relevant fields.

2.92 The results of this appraisal for the Proposed Scheme are summarised in Figure 2.12. The appraisal considers the permanent impacts arising from the scheme's construction and operation on the natural and social environment around the proposed route and on passenger experience – beyond the already monetised benefits. There are also likely to be temporary impacts on noise and air quality that occur during construction of the route. These have not been appraised at this stage of scheme design.

2.93 The non-monetised appraisal is based on the Environmental Impact Assessment (EIA) prepared to support the hybrid Bill that will enable construction. The appraisal is intended to complement the EIA rather than be seen as an alternative or replacement. Consideration of the additional environmental and social impacts is not believed to alter the VfM category of HS2. We will continue to review our appraisal of non-monetised impacts as the HS2 scheme design progresses.

Figure 2.12: Non-monetised Impacts Summary of the Proposed Scheme

Impact	Assessment	Comments
Landscape	Moderate Adverse	Ten sections of the route have been recognised as having major impacts on landscape character and qualities of the wider countryside.
Townscape	Neutral	Inherent uncertainty at this stage to assess but overall changes to townscape through urban development both from primary impact of scheme and secondary effects expected.
Heritage	Slight adverse	One Grade II listed building will be demolished. Five Grade II listed buildings and one Grade II* listed building within the land required for construction will be affected but not demolished.
Biodiversity	Slight adverse[68]	16 ancient woodlands have some impact, though no ancient trees will be lost. The land required for construction will include approximately 53.5ha of semi-natural broadleaved woodland; 27.8ha of grassland; 313 ponds; and 7.5ha of fen, marsh and swamp habitats. Construction will lead to the permanent loss of approximately 5.7ha of ancient woodland. However, the scheme's design includes habitat creation, including the creation of new hedgerows. A total of approximately 240ha of habitats will be created, mainly lowland mixed deciduous woodland and lowland meadow with some wetland habitats. In addition, there will be further areas of landscape planting of native broadleaved woodland, which will also contribute to habitat creation.

[68] It should be noted that although the Proposed Scheme has committed to a net gain in biodiversity, the rating takes into account the loss of ancient woodland which cannot be directly replaced.

Impact	Assessment	Comments
Water Environment	Large adverse	One major waterway diverted, flood risk and minor potential ground water impact. 1.7 km of route through flood zone 3. 0.9km of station to be built within flood zone 3. 0.6 km of tunnelling through SPZ 1 or 2.
Security	Moderate beneficial	Around Piccadilly, the redevelopment of entrances and exits, alongside the development of the Boulevard will generally improve security, particularly for access on foot. At Manchester Airport, the provision of the network, alongside the Metrolink connection will increase the public transport capability for the region. Added to this is the reworking of Hasty Lane underpass which will increase safety for pedestrians and cyclists across the M56.
Severance	Slight adverse	Limited severance, due to the track bed being on viaduct/tunnel/parallel to M56 through majority of Manchester. Severance will be caused by higher volumes of traffic accessing the stations. However, this is slightly mitigated by the new boulevard and access to the north of Piccadilly, and improved Metrolink and M56 crossings at the airport.
Option Values	Slight beneficial	The Scheme offers an additional form of travel which does not currently exist, does not remove transport options, but adds a further option hence positive impact. Although the released capacity means that we are reducing some rail services on the conventional rail network, but this is balanced against major increases to capacity for most users.
Physical Fitness	Neutral	Unlikely to have a significant impact. People choosing to switch from car to rail because of HS2 could access the stations via bicycle with some benefit attached to this.
Journey Quality	Moderate beneficial	Improve the journey ambience for journeys as the rolling stock will be newer and the new track will be able to provide a smooth riding experience.

Distributional Impact Assessment

2.94 Distributional Impact Analysis (DIA) is a TAG mandated assessment of new transport interventions and their impacts on different social groups, particularly assessing vulnerable groupings.

2.95 The analysis focused on seven separate indicators (user benefits, noise, air quality, accidents, security, severance and accessibility) and produced an assessment of levels of both beneficial and non-beneficial distributional impacts and the social groups impacted.

2.96 The assessment indicated that while some demographics will suffer from negative impacts, such as increases in noise affecting younger and older people, overall, the Proposed Scheme provides potential benefits in several areas, including security, accidents, and user benefits.

2.97 Normally a major restrictive factor, negative severance impacts are limited due to scheme design, with the track being located either on a viaduct, in a tunnel, or running parallel to the M56 in the heavily populated Greater Manchester area. Severance is mostly caused by the increase to road traffic around the stations to serve the new scheme.

2.98 Significantly, the developments in and around Manchester Piccadilly station will provide benefits for security, accidents and accessibility, while the development of Manchester Airport High-Speed Station will have severance and accessibility benefits from providing new connections alongside HS2 (Manchester MetroLink, and M56 crossings).

2.99 The results of the DIA assessment are summarised in the tables below:

Figure 2.13: Assessment of User Benefits of the Proposed Scheme by country and income quintile

User benefits	Most deprived income quintile	Second most deprived income quintile	Third most deprived income quintile	Second least deprived income quintile	Least deprived income quintile
England	Moderate beneficial	Slight beneficial	Slight beneficial	Slight beneficial	Slight beneficial
Scotland	Slight beneficial	Slight beneficial	Slight beneficial	Slight beneficial	Slight beneficial
Wales	Slight beneficial	Slight beneficial	Slight beneficial	Slight beneficial	Slight beneficial

Figure 2.14: Impact of the Proposed Scheme on Social Groups by Transport Indicators – greyed out cell indicates that it has not been assessed.

	Young People (U16s)	Older People (O70s)	Income Distribution	Disabled	BAME	Carless Households	Women
Noise	Slight disbenefit	Large disbenefit	Slight benefit				
Air Quality	Neutral	Neutral					
Severance (Piccadilly)	Slight disbenefit	Slight disbenefit		Moderate disbenefit		Slight disbenefit	
Severance (Airport)	Slight disbenefit	Moderate disbenefit		Moderate disbenefit		Slight benefit	
Accidents	Moderate benefits	Moderate benefits					
Security	Moderate benefits	Moderate benefits		Moderate benefits	Moderate benefits		Moderate benefits
Accessibility	Moderate benefits	Slight benefit	Moderate benefits	Slight benefit	Slight benefit	Moderate benefits	

Switching Value Analysis

2.100 The switching value is the value at which the project VfM categorisation changes when cost or benefit estimates change. Figure 2.15 indicates that in our Reference Case scenario only £1.3bn additional benefits (9% of total benefits) would be required to move into a "low" VfM category. In the medium COVID-19 demand sensitivity, £6.7bn additional benefits would be required to move the BCR into the "Low" VfM Category and the High Economy Scenario sits firmly in the Medium VfM Category, with and implied BCR range of between 1.5 to 2.

2.101 On the balance of probabilities, having regard to the demand scenarios uncertainty work and the work on wider economic impacts would support a "Low" VfM Category. This implies the BCR is most likely to fall in the range between 1 and 1.5.

Figure 2.15: Switching values table showing the level 2 BCR of the scheme under four different scenarios and the additional benefit required to move into the Low and Medium VfM category

	Scenarios			
	Reference Case	**Medium COVID-19 Impact**	**100-year appraisal period**	**High Economy**
BCR with Level 2 WEIs	0.9	0.6	1.2	1.7
Additional benefit required to achieve 'Low' VfM category (implied BCR between 1 and 1.5) (£bn, 2015 prices, PV)	£1.3	£6.7	N/A	N/A
Additional benefit required to achieve 'Medium' VfM category (implied BCR between 1.5 and 2) (£bn, 2015 prices, PV)	£8.8	£14.8	£4.1	N/A

Value for Money Assessment

2.102 At various stages through a transport project's lifecycle, a conclusion must be reached on whether the scheme represents value for taxpayers' money. TAG specifies VfM categories within which schemes can be placed and specifies that both monetised and non-monetised impacts should be considered, and that final VfM category may be different to that implied soley by the BCR. Figure 2.16 below describes the categories.

Figure 2.16: DfT TAG Standard VfM Categories (where transport cost outlays exceed revenues of cost savings)

VfM Category	Implied by...*
Very High	BCR greater than or equal to 4
High	BCR between 2 and 4
Medium	BCR between 1.5 and 2
Low	BCR between 1 and 1.5
Poor	BCR between 0 and 1
Very Poor	BCR less than or equal to 0

** Relevant indicative monetised and/or non-monetised impacts must also be considered and may result in a final VfM category different to that which is implied solely by the BCR.*

2.103 The analysis in this economic dimension has quantified the impacts of the Phase 2b WL to assess the economic, social, environmental and public accounts impact of the intervention. This quantified analysis forms the basis of a VfM assessment. However, there are limits, not least because not all impacts currently be valued monetarily on the ability of a single BCR to generate informative conclusions on the scheme's value for money, particularly if it is still in relatively early stages of design and development. HMT Green Book advice has also recently been updated to reinforce the principle that wider considerations should be taken into account when making an assessment on the appropriate VfM category.

2.104 The long-term forecasting horizon for the Phase 2b WL, combined with its inherent scale and complexity, means it is appropriate to assess how robust the value for money of the scheme is across a particularly wide range of possible future scenarios, as illustrated through the different sensitivity tests that have been undertaken as part of this analysis.

2.105 The VfM assessment uses TAG consistent modelling and appraisal, assesses a wide range of sensitivity tests resulting from the uncertainty of demand, based on the principles of the TAG uncertainty toolkit. The VfM assessment, in addition to transport user benefits and wider economic benefits, also accounts for monetisable environmental benefits, including landscape impacts, and non-monetised benefits. Additionally, the assessment has also explored the strategic aims of the scheme including the scale of wider economic impacts that may result from changing economic geography, such as new housing, retail and industrial development that are expected as a result of the Proposed Scheme.

2.106 Wider modelling scenarios, accounting different economic and population growth projections, and COVID-19 impacts, indicates a BCR range between 0.6 to 1.7, with a central BCR of 0.9. For example, the central BCR rises to 1.2 when assessed over a 100-year appraisal period.

2.107 On the balance of probabilities, having regard to the uncertainty work and the work on wider economic impacts, it is concluded that the Proposed Scheme is in the low VfM category. This implies the BCR is likely to fall in the range between 1 and 1.5.

Updated analysis for Phase One and 2a Network

2.108 This section sets out updated economic analysis of Phase One and 2a for the high-speed network. The analysis here is separate and independent of the Phase 2b WL assessment provided above.

2.109 An assessment has been carried out which considers the impact of Phase One, 2a and Phase 2b WL together. A refresh of the Phase One and 2a assessment (without Phase 2b WL) has also been undertaken and this corresponds to the "Statement of Intent" option from the 2020 Phase One Full Business Case (FBC). Both assessments were performed against a "Do Minimum" option that assumed no HS2 services. Annex 1 sets out in detail the modelling and appraisal methodology used to determine the full costs and benefits, and methodological changes.

2.110 The Full Network assessment is not equal to the sum of the Phase One and 2a, and Western Leg increment. This is due to the differing opening dates and appraisal periods for each scenario. The results of the assessment are outlined below in Figure 2.17.

Figure 2.17: BCR Components for the Proposed Scheme reference case, Phase One + Phase 2a, and Phase One + Phase 2a +Phase 2b WL

Present Value (£bn, 2015 prices)	The reference case: Phase 2b WL (Crewe to Manchester)	Phase One + 2a	Phase One + Phase 2a + Phase 2b WL (Crewe to Manchester)
(1) Net Transport Benefits	10.0	29.2	40.6
(2) Net Transport Benefits (including WEIs)[69]	13.7	38.3	53.9
(3) Capital Costs	14.0	34.2	48.2

[69] The WEIs included here only assume fixed land use (level 2 impacts).

Present Value (£bn, 2015 prices)	The reference case: Phase 2b WL (Crewe to Manchester)	Phase One + 2a	Phase One + Phase 2a + Phase 2b WL (Crewe to Manchester)
(4) Operating Costs (including Non-Ticket Revenue)	5.9	8.3	14.4
(5) Rolling Stock & Infrastructure Renewal Costs	1.0	2.8	3.9
(6) Total Costs = (3) + (4) + (5)	20.8	45.2	66.5
(7) Revenues	5.9	15.6	21.9
(8) Net Costs to Government = (6) – (7)	15.0	29.6	44.5
(9) BCR1 (excluding WEIs) = (1) / (8)	0.7	1.0	0.9
(10) BCR2 (including WEIs) = (2) / (8)	0.9	1.3	1.2

Phases One and 2a

2.111 Compared to the Phase One FBC, there has been a £6bn reduction in total costs (2015 prices). This is mostly due to increased sunk costs and lower construction cost inflation assumptions. This has more than offset the decrease in net transport benefits and revenues of £1bn and £2.8bn respectively, that has occurred through weaker OBR forecasts. However, WEIs have increased due to an increase in agglomeration benefits due to reduced generalised travel costs.

2.112 Although the HS2 Phase 2b WL SOBC's purpose is not to establish the VfM of the Phase One and 2a schemes, the results presented above show that the Phase One and 2a BCR still demonstrates positive net benefits and aligns with the conclusions of the Phase One FBC.

COVID-19 Cost Sensitivity

2.113 HS2 Ltd have estimated that COVID-19 has increased the costs of constructing Phase One during 2021 and 2022 by circa £0.7bn (net present value, 2015 prices). Including these results in the assessment does not have an impact on the BCRs of Phases One + 2a or Phase One + Phase 2a + Phase 2b WL to one decimal place.

3 Financial Case

Purpose of the Financial Case

3.1 The Financial Case assesses the funding requirements for the construction of HS2 Phase 2b Western Leg (Phase 2b WL) and the longer-term affordability of the project. Cost estimates have satisfied the required level of internal and independent assurance. They are based on a higher level of design maturity and an improved understanding of cost estimation, gained from actual contractor costs on Phase One and Phase 2a, when compared with previous cost estimates.

3.2 The Financial Case sets out:

- The **Background** to the development of Phase 2b WL's costs and their presentation within this update on the Strategic Outline Business Case (SOBC)
- The development of an appropriate **Cost Range** for the Phase 2b WL. This has been informed by HS2 Ltd's most up-to-date Capital Cost Baseline and Reference Class Forecasting (RCF) analysis, which draws on the past performance of comparator projects at specific stages in their lifecycle to forecast future project costs
- The **Funding Estimates** for further design and development, informed by Government Spending Rounds 2020 and 2021, and the approach to securing third-party funding where elements of core scope remain unfunded
- The plan of activity being developed by Government and HS2 Ltd to **Challenge Costs and Maximise Opportunities** throughout the life of the project
- The development of the **Schedule Range** to reflect the anticipated Delivery into Service (DIS) and commencement of operations on Phase 2b WL
- Analysis of the **Ongoing Affordability** of Phase 2b WL once operational

Background

3.3 Maintaining an affordable programme for HS2 has been the subject of ongoing dialogue and scrutiny between HS2 Ltd, the Department for Transport (DfT) and HM Treasury throughout the development of the programme. The HS2 programme and its funding requirements have been revised at several key decision points since its inception in 2009, in response to changing sponsor requirements, finalising a preferred route, developing more robust cost estimates and reflecting the effects of inflation.

3.4 Following the Government's decision to proceed with HS2, DfT agreed a revised set of funding arrangements with HM Treasury for Phase One of the programme, in parallel with preparations to issue Notice to Proceed for the main construction works. This comprised a new cost range of £35bn to £45bn (2019 prices) with a target cost set at £40bn and a DIS date range of 2029 to 2033. The purpose of setting the target cost was to encourage cost control and tight management of contingency.

3.5 Last year the Government also set new cost and schedule ranges for Phase 2a of HS2. This comprised of a cost range of £5.2bn to £7.2bn (Q3 2019 prices) and a DIS date range of 2030 to 2034.

3.6 The last Financial Case for Phase Two of the scheme was published in July 2017. The case covered Phase 2a and both the Eastern and Western Legs of Phase 2b. The overall Phase 2b estimate was presented as a total funding estimate of £25.07bn (2015 prices).

3.7 As this current update only covers Phase 2b WL, and no disaggregation of this cost estimate was undertaken in 2017, direct comparisons with individual elements of the cost estimates from the previous case cannot be made. In addition, cost estimates for the Phase 2b WL have since matured, reflecting further development of the project's design and certainty on its scope.

3.8 In accordance with Infrastructure and Projects Authority (IPA) guidance and supported by the National Audit Office, the estimated costs and DIS date of the Phase 2b WL infrastructure are provided as ranges.

Cost Range

3.9 The estimated cost range for the Phase 2b WL is **£15bn to £22bn (Q3 2019 prices)**[70], and is primarily informed by the point estimate in HS2 Ltd's most recent cost baseline and RCF70. This range includes some costs that are to be funded by third parties.

3.10 DfT is confident that this range, supported by information on past projects, provides a realistic set of parameters within which it expects the project to be delivered. The Government expects this range to be narrowed down with further scheme development ahead of setting a target cost and a taut contingency budget.

Setting the lower end of the cost range

3.11 The HS2 Ltd baseline cost estimates are updated at regular intervals during development of all phases of the HS2 Programme and will continue to be developed by HS2 Ltd throughout the lifecycle of the Phase 2b WL, in order to support decision-making on the project and ensure effective cost management and control. Updating the baseline is an important part of HS2 Ltd's role and its evolution reflects increasing design maturity, supply chain information, stakeholder requirements and Ministerial priorities.

[70] The estimate used for IRP of £17bn excluded some costs, including those for NPR works and 3rd party scope

3.12 A full Phase 2b re-baselining exercise (Baseline 2) took place in 2019-20, and comprised both the Eastern and Western Legs of the scheme. Cost estimates for the Proposed Scheme were subsequently disaggregated from the full baseline and, with some further adjustments, led to the development of a new Phase 2b WL-only baseline (Baseline 2.1W), which was approved by DfT in 2021 and has been used to inform the point estimate.

3.13 The cost estimates also take into account an allowance for possible future development changes, which may occur during the Bill's passage through Parliament. The cost estimates include the following components:

- Construction Costs
- Land and Property Costs
- Indirect Costs
- Operating & Maintenance Costs up to DIS
- Rolling Stock Costs

3.14 The core scope of Baseline 2.1W has remained largely unchanged from that in Baseline 2 and the high-speed route is broadly consistent with the last published business case. The following non-HS2 scope has been incorporated into the cost estimates as part of the Bill scheme being presented to Parliament, with some elements to be funded through local and regional funding commitments.

- A four-platform station at Manchester Airport of which two platforms are provided to accommodate NPR services. With the exception of the NPR platforms the station is subject to a local funding commitment
- A six-platform station at Manchester Piccadilly of which two platforms are to be provided to accommodate NPR services
- Passive provision for a Metrolink stop at the Manchester Airport station
- Relocation of the Metrolink station beneath the Manchester Piccadilly HS2 station and provision for expansion of Metrolink, subject to a local funding commitment

3.15 The cost estimates in the baseline have been evidenced using a number of different methodologies and their reliability has been verified using HS2 Ltd's three lines of defence assurance process, which includes HS2 Ltd internal assurance and independent assurance provided by third party specialists, as well as Project Representatives, acting on behalf of the DfT. Further confidence is provided as the estimates draw on increased design outputs and lessons learnt from actual experienced costs on Phases One and 2a.

Setting the upper end of the cost range

3.16 The approach taken to present a range is in line with the DfT and IPA's Lessons from Transport for the Sponsorship of Major Projects. All major projects and programmes require an estimate of cost and schedule contingency. This allows the programme to account for unforeseen risks emerging and for potential changes to be managed and controlled in an effective way.

3.17 To develop this cost estimate range DfT has relied on RCF, benchmarking assessments against other similar programmes, and value engineering lessons from Phases One and 2a. The level of design maturity of the HS2 Phase 2b WL scheme relative to Phase One and Phase 2a, at the same point in their design developments, has also been considered.

3.18 RCF analysis assesses the historic outturn performance of a range of projects with similar characteristics to the project in question and considers what cost and schedule contingency would need to be applied to achieve a predicted outturn if the current project performed on average as well or badly as the range of projects in the reference class. The reference class used for the Phase 2b WL has been selected based on suitably similar project features.

3.19 The move to RCF provides a more robust approach at this stage of the project's development, compared to the blanket allocation of 40% optimism bias that was placed against the overall Phase 2b estimate in the 2017 SOBC.

3.20 RCF70 (adding about 44 per cent to the point estimate) has been used to inform the upper band of the cost range, leading to a figure of circa £22bn. This would provide confidence of a 70% likelihood of delivering the scheme within budget when compared with the reference class. Taking the same approach but using RCFmean, would instead return an upper band figure of about £21bn. Similarly, if RCF50 were to be applied this would return an upper band figure of around £19bn.

3.21 The application of an RCF70 level provides the best way to balance the realistic budgeting for a project that is at a stage where substantial risks remain to be retired, during the period of Parliamentary passage (where the scope will be set), and during the later stages of design (for example incorporating findings from ground investigations). A comparable RCF has also been used to help to determine the upper band of cost ranges for Phase One and Phase 2a of HS2.

3.22 As the design of the project matures, it is anticipated that the range between the lower and upper bands will reduce. In addition, the Government and HS2 Ltd anticipate that there will be opportunities to derive efficiencies within the cost range. Alongside the passage of the Bill in Parliament HS2 Ltd intends to develop advanced critical designs, a delivery and procurement strategy, and a Cost and Carbon Reduction Programme, all of which will be informed by an extensive programme of ground investigation works. It is expected that these combined works will identify cost and schedule efficiencies in the programme. Further details on these plans to challenge costs and maximise opportunities is set out below.

Operational finances

3.23 The estimates above are for the programme capital costs, and do not account for the operational stage of HS2.

3.24 Once the construction phase is complete and services are introduced, the operation of services on HS2 will generate revenues which are assumed to provide an income to HS2 Ltd and/or DfT. This will not affect the affordability of the programme during the construction phase.

Funding Estimates

Core funding

3.25 It is proposed that construction of the Phase 2b WL, barring the scope to be funded by third parties, will be funded by central Government.

3.26 The funding for the Proposed Scheme for the next three financial years has been provided through Capital Delegation (CDEL) and Resource Delegation (RDEL) settlements at Spending Rounds 2020 (SR20) and 2021 (SR21).

3.27 In SR20 Phase One, Phase 2a and Phase 2b WL all received multi-year capital settlements. Phase 2b WL received a CDEL settlement of £1,146m (2019 prices) for the period up to 2024/25 and an RDEL settlement for a single year of £133m for the period 2021/22. These settlements ensure that ongoing development of the scheme can continue and will enable design refinement and cost estimates to be further developed ahead of setting a funding estimate at the appropriate stage of the project lifecycle.

3.28 The project will be funded through RDEL up to the point of second reading of the hybrid Bill, expected later in 2022. This will then trigger the capitalisation point of the project, after which CDEL will then be utilised for spending.

3.29 The multi-year settlements were confirmed at SR21. A further £29m (2019 prices) of RDEL has also been forecast, and is expected to be confirmed as part of this budget.

Third Party Funding

3.30 Currently, the relocation of Metrolink and the construction of Manchester Airport station are subject to identifying third party funding. Funding options for these elements are under consideration. A number of potential sources have been identified, including contributions from local partners, and further work is underway to assess the viability of these options.

3.31 In addition, DfT and HS2 Ltd will continue to consider:

- opportunities and efficiencies to drive down the cost estimates for these items of scope
- options to share delivery and financial risk (for example for local partners to take on the role of delivery of some aspects of the scheme, bearing some risk themselves)
- opportunities for deals around land assembly and regeneration
- opportunities to descope elements of the scheme if funding cannot be secured

Challenging costs and maximising opportunities

3.32 Lessons learnt on risk management through the development of Phases One and 2a of HS2 will be adopted on Phase 2b WL. These lessons will be augmented with the application of principles set out in government policy and guidance, including the DfT Transport Infrastructure Efficiency Strategy (TIES), the IPA Transforming Infrastructure Performance (TIP) and the Government's Construction Playbook.

3.33 The lessons include processes for mitigating risks as the hybrid Bill progresses through Parliament, where knowledge and expertise from previous Bill teams has been retained to maintain the project's critical path. In addition, the project estimate is supported through a mature and tested Value Management process embedded in HS2 Ltd. This mature process facilitates greater opportunity to bear down on costs across all work disciplines such as design, procurement and wider commercial activity.

3.34 Throughout the life of the project HS2 Ltd will continue to strive to identify and deliver opportunities that will have a bearing in reducing the overall cost of the project. Using a developed assurance process, HS2 Ltd will set efficiency targets, working with its supply chain to utilise Value Management techniques, risk reduction methodologies and align potential efficiencies with the wider industry through the application of benchmarking costs. The management and oversight of costs on the project will continue to be the focus as the project passes through the Bill process.

3.35 The delivery of efficiency targets and the monitoring of trends along with opportunities to reduce costs will continue to be developed and will build upon lessons learnt from other HS2 Phases. Development opportunities will also continue to be sought, with a focus on increasing retail receipts at stations and the maximisation of over-site development opportunities.

3.36 A detailed assessment of benchmarking costs against international comparators including the Crossrail project has been applied to the project estimates. Further, embedded Value Management and Value Engineering techniques will also play a role in driving the delivery of cost opportunities throughout the life of the project with potential cost savings anticipated as the project matures through its design stages.

3.37 Any unexpected cost and/or affordability pressures created through the petitioning phase of Bill progress in Parliament will be managed though a well-developed strategy which builds on the experience of previous HS2 Phases. In some limited cases, this includes options for reducing scope without significantly impacting overall project benefits.

3.38 The construction sector has adapted well to the challenges presented by restrictive working practices due to COVID-19. Lessons and best practice will continue to be adopted to mitigate this risk to the successful delivery of the scheme.

3.39 There is a defined set of risks set out in the HS2 Development Agreement between HS2 Ltd and DfT, which are not accounted for in the baseline programme because they are outside of HS2 Ltd's control. These include risks related to excess inflation, changes in Government policy and major geopolitical events.

Schedule

3.40 The Department has set a schedule range for a DIS, which marks the start of operations on the Phase 2b WL, as between **2035 and 2041**.

3.41 HS2 Ltd's forecast base schedule has been used to inform the lower band of the schedule range. This 'deterministic' base forecast, which does not include risk or contingency, indicates a DIS for Phase 2b WL 11½ years after Royal Assent of the hybrid Bill (which currently has a target date of 2024 subject to Parliamentary process). This compares to a deterministic DIS forecast of 12 years for Phase One (Birmingham to Old Oak Common) and nine years for Phase 2a.

3.42 Opportunities to accelerate the construction programme for the scheme are in the process of being examined and potential mitigations include:

- Advancement of land access for critical path activities (Manchester Tunnel)
- Enabling works to de-risk and advance the tunnelling programme
- Optimisation of the trial operations duration (benchmarked to Phase One)

3.43 The delivery strategy that will drive construction to schedule is now under development and due for completion around the end of 2023. It will set out the construction approach for the line of route reflecting lessons to be learnt from the Phase One main works strategy and the approach for Phase 2a. It will also include the rail systems and rolling stock strategies, and the testing and commissioning strategy to integrate Phase 2b WL with the existing HS2 Phases and the conventional railway, depending on the finalised scope. The delivery strategy will also set out how efficiencies in scope and schedule will be developed in the delivery of the programme.

3.44 As with the cost estimates, DfT has employed RCF to inform the schedule range. To set the upper band of the range DfT has reflected RCF70, based on the performance of about 70% of comparable projects. This estimates six years of schedule contingency should be applied and results in an upper band set at **2041**.

3.45 DfT is confident that this range provides a realistic set of parameters within which it expects the project to be delivered.

Operational Expenditure and Income

Ongoing affordability

3.46 Financial analysis of the ongoing affordability of HS2 has previously shown that there will be an improvement in the financial position of Britain's railways, with HS2 generating an average annual surplus. When assessing HS2 operations for the Phase 2b WL scheme in isolation, the services are expected to yield a significant financial surplus once operational. When account is taken of assumptions for (a) abstraction of revenue from conventional services, and (b) released capacity being taken up with new conventional services, the net impact to the Great Britain (GB) rail industry finances is close to neutral. Compared to previous projections, the revenues extracted from the Conventional Rail Network (CRN) are no longer offset by revenues on HS2 services because of the reduction in passenger demand which has been forecast in the reference case. As discussed in the Economic Case, there remains considerable uncertainty associated with passenger demand forecasting.

3.47 When compared to previous analysis of HS2's impact on the CRN, this analysis reflects marginally lower operating costs on HS2 services while savings on the CRN operating costs have remained largely unchanged. The abstraction of revenue from CRN services is not estimated to be large enough to offset the forecast reduction in HS2 revenue that has been assumed due to reduced economic growth forecasts. This results in a deterioration to the net GB rail financial position. The assumptions on the conventional services that will be operational have not yet been optimised, and could result in further savings that are not currently realised.

3.48 Sensitivities and switching value tests have been undertaken to reflect the range of uncertainty associated with this analysis. These demonstrate that the impact on the GB rail industry finances, once Phase 2b WL is operational, ranges from an average annual surplus of approximately £40m to an annual average deficit of £250m. In particular, in the high demand scenario, we would expect an improvement in the net GB financial position of £36m annually on average.

3.49 Since the Phase One Full Business Case (FBC), there have been updates to the operating cost modelling suite used to produce this assessment. This includes data maturity updates and some aspects of work undertaken by the West Coast Partnership to better reflect the train operating companies' operating costs. Updates to the revenue modelling suite are discussed in the Economic Case.

3.50 Should there be an operating surplus, there will be a benefit to the taxpayer if it is available to the Government to meet the additional subsidy requirement for conventional services. This surplus could be in the form of an improvement in the annual subsidy/premium balance for Britain's railways, or the receipt of an up-front capital sum. A decision has not yet been taken on how these monies would be recovered by the Government as this will depend on future decisions on the operating and commercial model for HS2, and will be influenced by the recently published Williams-Shapps Plan for Rail and ultimately Great British Railways

(GBR). To recover some or all of this surplus via the Infrastructure Manager, the Government maintains the option for HS2 Ltd to levy an Investment Recovery Charge on all operators using HS2 infrastructure.

Inflation management

3.51 NERA Economic Consulting (NERA) is the independent inflation expert (IIE) for the HS2 project and is responsible for measuring outturn and forecasting inflation for each cost pillar. The approach to forecasting inflation was first used for the HS2 Phase One FBC. Both the Economic Case and the Financial Case use NERA's forecast between until 2024/25 before converging linearly to NERA's estimate of average historic HS2 construction cost inflation.

3.52 Inflation risk is recognised as a DfT retained risk event as set out in the Development Agreement. HS2 Ltd will actively manage this risk for the Secretary of State, using mitigations to reduce this risk exposure where possible.

3.53 DfT and HM Treasury will continue to make decisions on the appropriate inflation methodologies and construction cost inflation profiles.

Accounting implications

3.54 HS2 Ltd is funded by HM Treasury, with DfT providing direct capital contribution payments to HS2 Ltd for the development of the project.

3.55 Accounting for the expenditure of HS2 Ltd will follow international accounting standards and the FReM (Financial Reporting Manual).

3.56 Land and property acquired by the project will remain on the DfT balance sheet, reflecting that HS2 Ltd has acquired land in the name of the Secretary of State. Any income and operating expenses associated with the land and property portfolio will be recorded in DfT's financial statements.

3.57 HS2 Ltd's accounts will continue to be consolidated into DfT's Group accounts and consequently its accounting policies and bases will need to demonstrate consistency with those of the Group.

VAT

3.58 In 2014, HS2 Ltd applied for and was granted 'intending trader' status by Her Majesty's Revenue and Customs (HMRC). HMRC revised that decision in 2019, resulting in VAT liability for the construction of HS2.

3.59 Following this, HM Treasury put in place procedures to allow HS2 Ltd to reclaim VAT via a Statutory Instrument and Treasury Order. As a result, HS2 Ltd's costs exclude most VAT from the start of 2020/21 financial year, except for payments to vendors of opt-to-tax properties.

Annexes

Annex 1: Appraisal Framework

Measuring benefits

A.1 By applying TAG principles, a wide range of benefits are quantified in monetary terms. The benefits measured include:

- Direct effects: These are measured by monetising transport user benefits (Level 1 benefits) from travel time savings, reductions in crowding and improvements in reliability. These benefits, as well as revenues, are drawn from the PLANET Framework Model (PFM) version 10.1 which models changes in travel behaviour brought about by the introduction of HS2 services.
- Level 2 Wider Economic Impacts (WEIs): These are estimated using DfT's Wider Impacts in Transport Appraisal (WITA) tool using version 2.0 developed by Atkins. This aims to capture the WEIs that are expected to arise without land use change and includes the benefits of knowledge sharing through static agglomeration, as well as output change in imperfectly competitive markets and labour supply impacts
- Level 3 benefits: These are WEIs that arise when land use is permitted to change, and people are assumed to move. The Oakervee Review sets out that "work is needed by the DfT and HS2 Ltd for future HS2 business cases to review and quantify the level 3 impacts in the benefit-cost ratio given the prominence of these impacts in the strategic case." These impacts largely constitute second order transformational effects, i.e. those impacts which are not a direct result of the transport investment – such as travel time savings. The approach used in this business case to measure these benefits is to consider a variety of methodologies, using outputs from a CGE model, and evaluation evidence. The results are not included within the BCR but provide a measure of additional benefits not quantified in previous business cases. These can include:
  - dynamic clustering: Businesses relocate to be closer together forming clusters around well-connected places to benefit from knowledge sharing
  - workers moving to more productive jobs: In response to changes in transport costs, workers move to areas with higher levels of productivity due to a variety of factors such as agglomeration and capital

Appraisal Framework Methodology

A.2 The Economic Case is intended to support investment decisions to proceed with the Proposed Scheme. To this end, the Economic Case assesses the incremental effect of the Phase 2b WL where it is assumed Phase One and Phase 2a of the scheme are both already in service, and as such the benefits and costs measured in the economic case are solely from the Phase 2b WL increment. This is also true for the alternative scenario estimating the incremental effect of the Phase 2b WL with no link to WCML north of Crewe.

A.3 The HS2 Phase One, Phase 2a and Phase 2b WL scenario assesses the impact of HS2 WL against the alternative where there are no HS2 services. This scenario is different to the one modelled for the Phase One FBC as it also incorporated a Phase 2b Eastern Leg network.

A.4 Phase 2b WL has been compared against a range of alternatives in the Strategic Alternatives document produced by Mott MacDonald which will be published separately. These alternatives are summarised in the Strategic Case. Further work on strategic alternatives will continue until the Full Business Case (FBC) stage.

A.5 The economic appraisal outlined in this document aims to provide a complete value for money assessment, including both positive and negative impacts, as well as the associated risks and uncertainties, such that the decision maker is provided with a full assessment of the outcomes of different courses of action. Where possible, these impacts are expressed in monetary terms, and it is from these valuations that the BCR is calculated. In order to ensure comparability with previous business cases or with the analysis undertaken for Phases One and 2a, the benefits and costs are appraised using a 2015 price year. Updating the analysis to a more recent price base year does not materially change the BCR.

A.6 The Economic Case draws on modelling and economic analysis undertaken by HS2 Ltd. These have been appropriately assured in a manner similar to previous work for the Phase One FBC.

A.7 The BCR is a measure of the return on investment, i.e. for each pound spent how many pounds in net benefits does that then generate.

Benefits

A.8 The range of monetised and non-monetised impacts of the Proposed Scheme follow TAG principles and are set out in the section below and are summarised in Figure A.1.

A.9 The PLANET Framework Model (PFM) version 10.1 is the model used to assess changes in travel behaviour by the introduction of HS2 services. This is an update to the version of the model that was used for the Phase One FBC, but is essentially predicated on the same methodology and approach. It is a peer-reviewed complex model that provides a strategic view of the road, rail and air markets, drawing on detailed information on passenger travel from ticket sales and other data. PFM assesses the impact of HS2 on the behaviour of existing travellers who may now use a different mode, switching to HS2 or make a different trip. It also assesses the extent to which HS2 and the associated capacity released on the existing network attracts new travel demand (although the potential for additional services on the existing network, which are made possible by the released capacity, is not fully reflected in PFM). The model forms the basis of the benefits and revenue assessments.

Figure A.1: Monetised and non-monetised impacts of the Proposed Scheme

Initial BCR Well established monetised impacts	Adjusted BCR Monetised impacts with developing evidence	Monetised impacts not included in the BCR	Non-monetised impacts
Level 1 Journey Time Savings (In-vehicle, walk and wait, access and egress)	Level 2 Wider Economic Impacts (WEIs):	Landscape	Townscape
Crowding	Agglomeration	Level 3 Wider Economic Impacts (WEIs):	Biodiversity
Noise	Productivity	CGE model outputs	Landscape
Carbon Impact	Labour Supply Impacts	Evaluation evidence	Heritage
Accidents	Imperfect Competition		Water Environment
Infrastructure			Severance
Indirect Tax Revenue			Physical Activity
Reliability			Accessibility
Air Quality			Journey Quality
Operational Revenues			Option Values
			Security

Breakdown of the Benefits of the Proposed Scheme

A.10 Figure A.2 below sets out the detailed breakdown of the monetised benefits for the Proposed Scheme included in the Initial and Adjusted BCR as described above in the economic case.

Figure A.2: Breakdown of benefits for Phase 2b WL

Grouped benefit	Disaggregated benefit	Benefit value (PV, 2015 prices, £m)
Transport user benefits	Improved access	-1
Transport user benefits	Reduction in crowding	1,730
Transport user benefits	Improvements in interchange	10
Transport user benefits	Reduction in waiting	2,370
Transport user benefits	Reduction in walking	-190
Transport user benefits	Reduction in train journey times	4,570
Transport user benefits	Greater reliability	1,760
Transport user benefits	Benefits to road users	30
Transport user benefits	Total	10,280
Other quantifiable benefits	Reduction of car noise	2
Other quantifiable benefits	Carbon	20
Other quantifiable benefits	Reduction in car accidents	30
Other quantifiable benefits	Noise from HS2 trains	-10
Other quantifiable benefits	Reduced damage to road Infrastructure	1
Other quantifiable benefits	Total	40
Indirect Tax	Loss to Government of Indirect tax	-370
Net Transport Benefits		**9,950**
Wider economic impacts	Agglomeration (fixed land use)	2,800
Wider economic impacts	Imperfect competition	740
Wider economic impacts	Increased labour force participation (fixed land use)	200
Wider economic impacts	Total	3,750
Net Benefits including Wider Economic Impacts		**13,700**

Other quantifiable benefits

A.11 A noise model (owned by HS2 Ltd) assesses the monetised level of noise disbenefit due to the introduction of HS2. The inputs to the model are monetised noise disbenefits provided by ARUP and are consistent with analysis in the Environmental Statement. The model discounts and sums the noise disbenefits over the relevant appraisal period. The noise disbenefits are calculated in line with DfT's TAG guidance. The Proposed Scheme will produce a noise disbenefit of £10m along the line of route. However, there is also an estimated benefit of £2m due to modal shift from road to rail causing lower levels of car noise. The consequent impact of reduced numbers of road accidents has also been monetised, with an estimated benefit of £30m.

A.12 Non-traded (not included in the UK Emissions Trading System (ETS)) emissions saved from any mode shift have been monetised and used in the appraisal. Petrol and diesel emissions are non-traded, and hence can be monetised. Aviation emissions and emissions from electricity consumption in the transport sector (e.g. electric Conventional Rail Network services) are traded under the UK ETS, and are not monetised. This is in accordance with Transport Analysis Guidance.

A.13 The emissions model assesses modal shift from road and air to conventional rail and HS2, forecasting the emissions impact on the transport network and monetising this, where appropriate and consistent with TAG. The inputs into the model are based on TAG guidance, PFM outputs and HS2 Kilometrage calculated using the iTSS. The emissions model is owned by HS2 Ltd and has been assured by external auditors.

A.14 Phase 2b WL is forecast to reduce operational emissions by 750,000 tonnes CO_2e over the 60-year appraisal period. Of this total, Non-traded emissions account for around 200,000 tonnes of CO_2e, with the monetised emissions impact estimated at £20m.

Costs

A.15 Our assessment of the costs incorporates the expected costs of the HS2 scheme which are presented in Net Present Value (NPV) terms. This includes the capital costs of building the Proposed Scheme and procuring rolling stock and operating costs of running the railway once opened. It is from this that the revenue arising from additional rail passengers is deducted to calculate the net impact to the public sector.

A.16 Should an operating surplus be generated, this assessment relies upon reverting to Government, to offset in part the initial construction costs. To ensure that this is possible under a range of different commercial models for HS2, the Government maintains the option that the HS2 Infrastructure Manager will levy an Investment Recovery Charge on all users of HS2 infrastructure. More detail on the Investment Recovery Charge is contained in the Financial Case.

A.17 Though Phase 2b costs were provided for the Phase One FBC, the associated capital costs have been further developed and refined. Capital cost estimates originate from HS2 Ltd's Baseline 2.1W exercise, which undertook a detailed cost estimation and supplemented this with an allowance to reflect the risks and uncertainties associated with the estimates.

A.18 The capital costs used in the Economic Case uses Reference Class Forecasting (RCF) at the arithmetic mean of all risk levels on the RCF curve, as a measure to include risk/optimism bias, consistent with TAG. This results in an uplift of 37.9% on the capital cost estimates.

A.19 For the purpose of appraisal, these costs are inflated with construction cost inflation using the 'Independent Inflation Expert' (IIE) forecast between 2015/16 and 2020/21 and NERA (National Economic Research Associates) Economic Consulting's forecast between 2020/21 and 2024/25. Thereafter, inflation forecasts are assumed to linearly converge over a four-year period to the average historic real inflation rate developed by NERA. This approach is TAG-compliant. These costs are then discounted to present values (2021/22) and converted to market prices.

A.20 The operating costs have been estimated using the Baseline Operating Cost Model (BOCM) using 'Operating Cost Estimate' (OCE) version 3.0Wi, which draws together detail on the operating characteristics of HS2 and the existing rail network based on knowledge of the cost of operating rail services. The model considers both the operating costs of running HS2 services as well as the savings on the conventional network.

iTSS

A.21 The results presented in this Economic Case are modelled with two potential iTSS that could be operated with HS2 in place: one with a link to the West Coast Main Line north of Crewe, which is the main reference case, and one without the link. All scenarios and sensitivities are built from the main reference case, which includes the link to the West Coast Main Line. The central case iTSS used for modelling purposes is shown diagrammatically in Annex 2.

A.22 This analysis is intended to give the Government sufficient confidence in the project to proceed, but design and analysis will continue to be refined as the project develops.

Appraisal Framework: methodology updates

A.23 A number of updates have been made to improve the modelling and appraisal framework, ensuring the most up-to-date information is being used and there is consistency with the latest guidance in rail scheme appraisal.

A.24 The Proposed Scheme has not been presented in previous business cases however the modelling updates for PLANET Framework Model 10.1 (PFM10.1) can be compared to PFM9 as used in the Phase One FBC. This includes changes in

benefits and revenues only. The capital and operational costs have been created specifically for the Proposed Scheme, i.e. there is no benchmark against which to compare cost changes.

A.25 Moving from PFMv9 to PFMv10.1 has led to a reduction in transport user benefits and revenues, driven by weaker long-term OBR population and economic forecasts, as with the reference case.

A.26 Level 2 WEIs improve relatively as they are not as sensitive to reductions in demand as transport user benefits. The reduced demand forecasts cause a small fall in the imperfect competition element of the WEIs. However, this fall is more than offset by an increase in agglomeration benefits, driven by reduced Generalised Transports Costs as a result of the demand rebasing in the PLANET South Model.

A.27 Reduced present value capital costs mainly driven by increased sunk costs and lower construction inflation forecasts.

A.28 Operating costs see a reduction due to later opening year assumptions, increasing the discounting impacts.

A.29 Infrastructure renewals remain similar, whilst the later opening years reduce the number of Rolling Stock renewals during the appraisal period, reducing the present value cost.

A.30 The following steps were undertaken which explains the changes in benefits and revenues:

- Network Updates: These include changes to Station Choice Model based on latest available data, Phase 2a Crewe – Birmingham reliability assumptions, removal of the Heathrow Access Model and simplification of the Pivot Process.
- Rebasing: PFMv9 used LENNON ticket sales data from 2014/15 to form its base rail demand matrices. This was updated, moving to a new base year of 2018/19, moving away from using LENNON data as the foundations of the matrices to the use of pre-processed 2018/19 MOIRA demand matrices. The highway and air matrices were also updated as part of the rebasing exercise, having been uplifted to 2018/19 using the DfT TEMPRO growth factors and Aviation Model forecasts.
- iTSS Update: Applying the latest information from the revised train service provision from the train operating companies (TOCs) sees a small increase in benefits and a small reduction in revenues. This is due to increases to reflect crowding relief from additional seats on the HS2 classic compatible services and journey time changes for Glasgow and Edinburgh High-Speed services. The revenues are reduced mainly due to improvements in the Do-Minimum supply between London and Scotland. Because the Do Minimum scenario has improved, the relative benefit of HS2 is reduced, and this reduces the volume of new rail trips which impacts revenues.

- Demand forecasts: PFMv9 rail demand forecasts were produced using June 2019 Demand Driver Generators (DDGs), which reflected economic and population forecasts published by the OBR in March 2019. The December 2020 DDGs used for PFMv10.1 include a reduction in medium/long term forecasts for population, employment, and GDP growth, consistent with OBR forecasts published in November 2020. These include the impact of COVID-19 on employment and GDP. The reductions in the macro-economic demand drivers have had a negative impact on rail passenger demand forecasts. This step reduces the forecast passenger rail demand by around 3% in the first forecast year (2029) and by 9% in the second forecast year, despite the second forecast year moving from 2039/40 to 2041/42 (i.e. incorporating 2 extra years of growth).
- TAG Updates: the May 2019 release of the Department for Transport TAG Databook values used in PFMv9 were replaced by the February 2021 Interim Databook. As highlighted above, the longer-term GDP and population forecasts have significantly reduced relative to the previous forecasts. These changes (i) reduce scheme benefits and revenues as they reduce the growth in the Value of Time (VoT), which drives growth in benefits over the appraisal, and (ii) reduce the growth in the real (i.e. inflation-adjusted) value of rail fares, which drives growth in revenues over the appraisal period. As a result, each forecast passenger journey generates fewer benefits and revenues.
- Model Re-calibration: Following the rebase to 2018/19 in PFMv10.1, the long distance demand model was recalibrated to reflect the changes in passenger travel patterns and industry guidance that have occurred since the previous recalibration, and to ensure the demand model parameters are consistent with the base year demand matrices and costs.
- Opening Schedule: changed from 2033 to 2038 for the Proposed Scheme. This has a negative impact as benefits and revenues are more heavily discounted the further they are into the future. However, changing the discount base year from 2019/20 to 2021/22 increases benefits and revenues due to delaying the point from which future benefits and revenues are discounted. However, it should be noted that costs are also adjusted for the new appraisal year, and thus the impact of this adjustment on the BCR is neutral.

A.31 These changes to PFM have been thoroughly assured, including by external auditors.

A.32 As with the 2020 FBC, Economic Case benefits and revenues have been extrapolated after 20 years in line with population projections, replacing the “demand cap”.

A.33 Costs incurred prior, up-to, and including March 2021 have not been included within the economic appraisal as they are sunk (except for some costs relating to Land and Property which may be redeemable).

Sensitivities

A.34 The WITA tool has not been used to estimate the WEIs of the Sensitivities. Instead, a 38% uplift based on the proportional difference between the estimate for direct Transport User Benefits and Wider Economic benefits from the reference case was used.

A.35 The following sensitivities have been produced using the same PFM model as the reference case (PFM10.1):

- cost sensitivities
- appraisal period
- schedule
- changes to regional population and employment growth
- third forecast year (demand cap at 2051)

A.36 The following sensitivities have been produced using a slightly earlier version of the PFM model (PFM10) and have had off-model adjustments applied to convert into (PFM10.1):

- High and Low Economy
- Medium and Low impact resulting from COVID-19 behavioural changes
- First Forecast year (demand cap at 2029)

A.37 The following sensitivities have not been run through PFM but have been produced off-model using PFMv10.1 outputs:

- West Coast demand growth
- positive mode shift
- high impact resulting from COVID-19 behavioural changes

A.38 The following table shows the full BCRs of the sensitivities undertaken in the main text. It is presented as the BCR without any WEIs and with the level two WEIs. All BCRs are presented to one decimal place.

Figure A.3: Sensitivities for Phase 2b WL split by Level 1 and Level 2 BCRs

	BCR without WEIs	BCR with Level 2 WEIs
Reference Case	0.7	0.9
Lower Capital Cost (RCF30)	0.8	1.1
Higher Capital Costs (RCF70)	0.6	0.9
High Economy	1.3	1.7
Low Economy	0.4	0.6
High impact due to COVID-19 behavioural changes	0.3	0.4
Medium impact resulting from COVID-19 behavioural changes	0.4	0.6
Low impact resulting from COVID-19 behavioural changes	0.6	0.9
Changes to Regional population and employment growth	0.7	0.9
West Coast Demand Growth lower bound	0.7	1.0
West Coast Demand Growth upper bound	1.0	1.4
Appraisal Period (100 years)	0.9	1.2
First Forecast year (demand cap at 2029)	0.6	0.8
Third Forecast year (demand cap at 2051)	0.7	1.0
Schedule (Delayed opening by 1 year)	0.6	0.9

Design option without a link to the WCML north of Crewe

A.39 As highlighted in the Strategic Case, the Union Connectivity Review, undertaken by Sir Peter Hendy, identified that there could be opportunities to further improve capacity and journey times to Scotland with an alternative HS2 connection to the WCML from that assumed in this business case, and recommended that the Government should review alternative options. The Government is considering its response to UCR recommendations, that it review options for alternative northerly connections between HS2 and the West Coast Main Line. It is the Government's intention to deliver the right infrastructure for long term benefits to the rail network, to the North and to Scotland. To this end a modelling sensitivity has been taken on a design option for the Proposed Scheme with no link to the WCML north of Crewe. This results in the removal of all HS2 services between London and Edinburgh and between Birmingham and Scotland, as well as reducing the number of HS2 services between London and Glasgow from 2tph to 1tph, shown in Annex 2. This scenario is shown to have a BCR of 0.6 with Level 2 WEIs.

Figure A.4: BCR Components for the Proposed Scheme with no link to WCML north of Crewe

PV, £bn 2015 prices	The Proposed Scheme with no link to WCML north of Crewe
(1) Net transport benefits	5.1
(2) Wider Economic Impacts (WEIs)[71]	2.2
(3) Net benefits including WEIs= (1) + (2)	7.3
(4) Capital costs	11.0
(5) Operating costs	2.0
(6) Rolling Stock & Infrastructure Renewal Costs	0.6
(7) Total costs= (4) + (5) + (6)	13.6
(8) Revenues	2.0
(9) Net costs to Government= (7) – (8)	11.6
(10) BCR without WEIs (ratio)= (1)/(9)	0.4
(11) BCR with WEIs (ratio) = (3)/(9)	0.6

Assumptions for the Phase One and 2a Network updated analysis

A.40 The approach to modelling and appraisal for the Phase One and 2a has not changed from the approach used for the Phase One FBC. The change from the previous modelling is the use of an updated version of the model, with updated economic and train service/network assumptions.

A.41 This section sets out differences in modelling assumptions between the Phase 2b WL reference case and assumptions for the Phase One and 2a used to inform the Phase One, Phase 2a and Phase 2b WL scenario and the Phase One and 2a scenario.

A.42 Figure A.5 below compares Train Service assumptions used for the Phase 2b (Crewe to Manchester) increment assessment to updated analysis for the Phase One and 2a network.

[71] The WEIs included here only assume fixed land use (level 2 impacts). WEIs that assume land use change (level 3) have been estimated in the Wider Economic Impacts Section.

Figure A.5 : Train Service assumptions for the reference case, Phase One + Phase 2a, and Phase One + Phase 2a + Phase 2b WL

Assumption	Phase 2b WL (Crewe to Manchester) Increment	Phase One + 2a	Phase One + Phase 2a + Phase 2b WL (Crewe to Manchester)
Services from Old Oak Common		3tph terminating at Old Oak Common – 2030	3tph terminating at Old Oak Common – 2030
	6 trains per hour (tph) terminating at Old Oak Common using Phase 2a infrastructure - 2029	6tph terminating at Old Oak Common using Phase 2a infrastructure - 2032	6tph terminating at Old Oak Common using Phase 2a infrastructure - 2032
Services from Euston	10tph terminating at Euston - 2034	10tph terminating at Euston – 2033	10tph terminating at Euston – 2033
Phase 2b WL (Crewe to Manchester)	11tph terminating at Euston - 2038		11tph terminating at Euston - 2038

For the Phase One + 2a + 2b WL results the appraisal period is assumed to be 60 years from when the last phase commences into service. In this case the appraisal period is 60 years from 2038, so until 2098. This means that the overall appraisal period from when Phase One is first in operation (2030) is 68 years. An off-model assessment of the scheme just assessing each phase over 60 years would reduce the BCR by roughly 0.1 (to 1 decimal place). Similarly for the Phase One +2a scenario, the full appraisal period is 63 years in total from the 2030 Old Oak Common first delivery into service date.

Annex 2: indicative Train Service Specification (iTSS)

Figure A.6: HS2 Phase 2a iTSS – the 'Do Minimum'

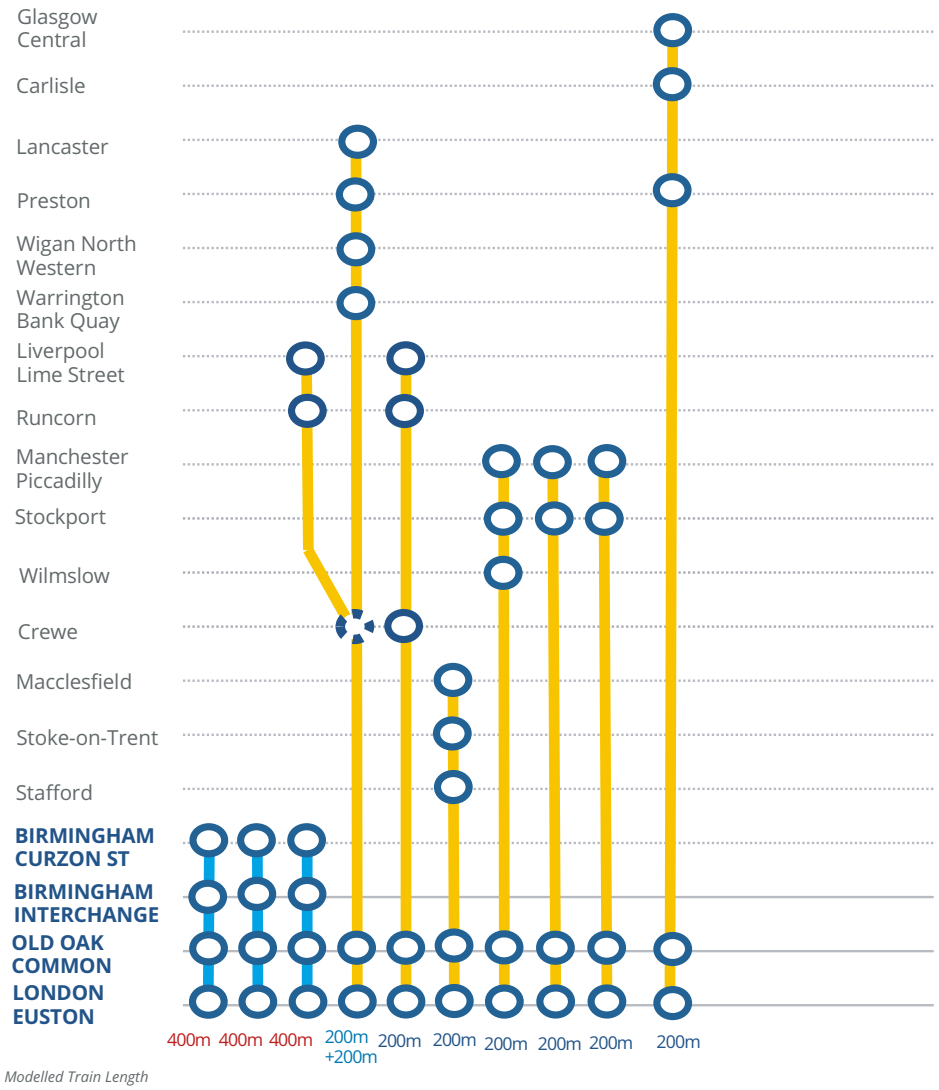


Figure A.7: HS2 Phase 2b WL (Crewe to Manchester) iTSS – the 'Do Something'

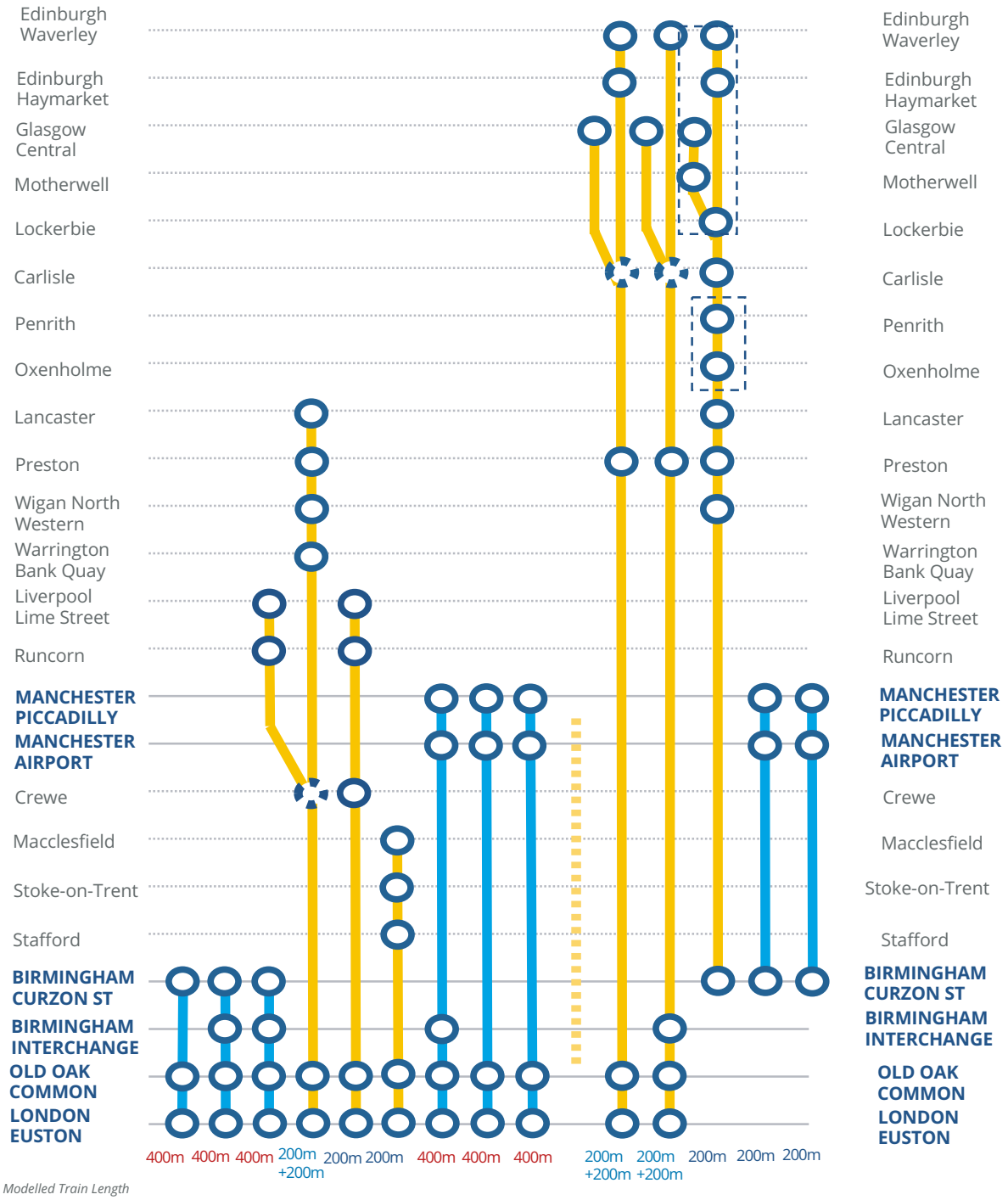
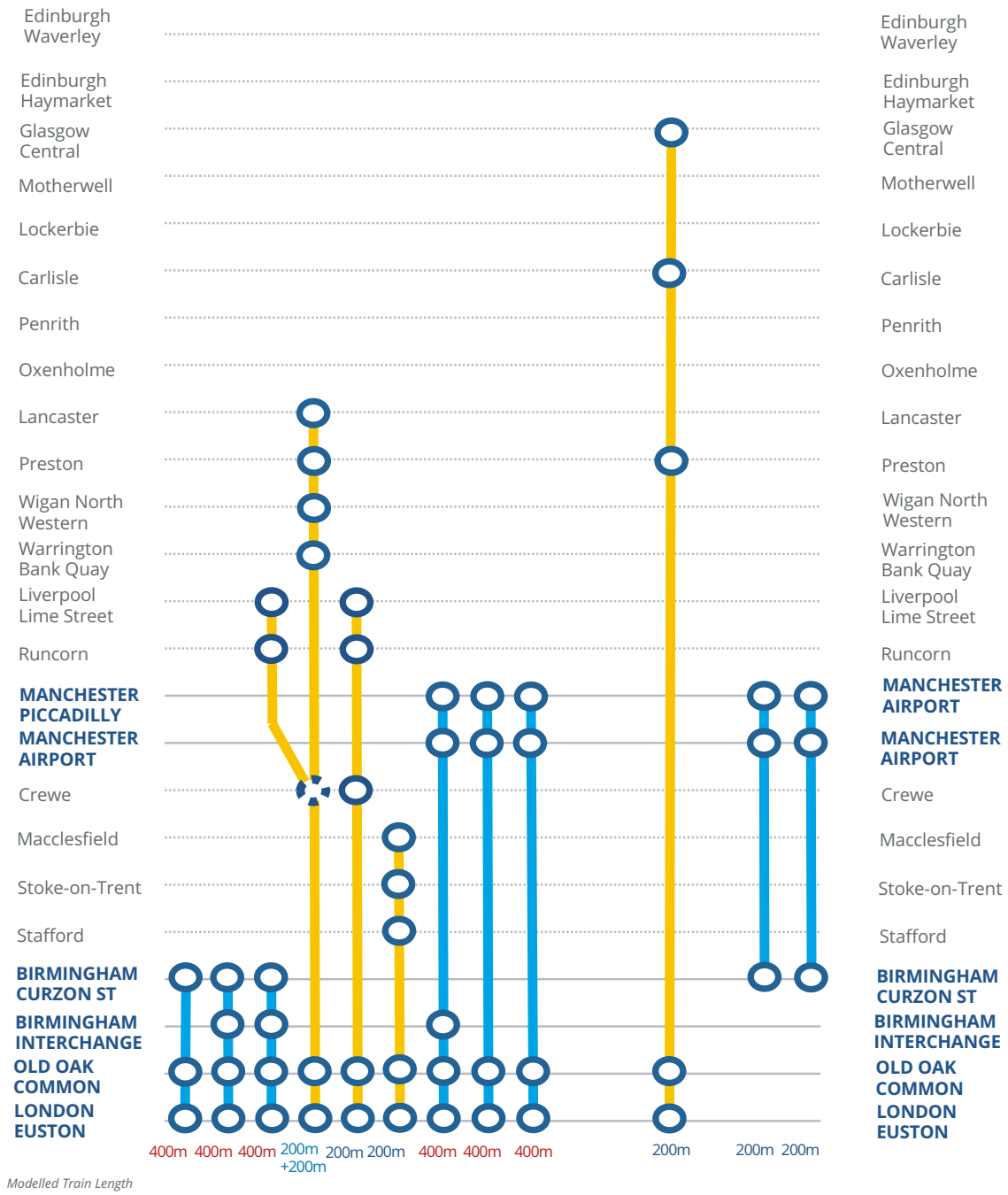


Figure A.8: HS2 Phase 2b (Crewe to Manchester) iTSS – the 'Do Something' with no link to WCML north of Crewe



Annex 3: Wider Economic impacts supplementary analysis

Wider economic impacts analysis throughout this document draws on multiple sources of evidence: a review of international evaluation evidence on high speed rail, a meta-analysis of the evaluation evidence on the impacts of transport infrastructure investments, and spatial computable general equilibrium (S-CGE) modelling. This Annex provides further detail on the two key pieces of evaluation evidence.

In 2020, DfT commissioned the What Works Centre for Local Economic Growth to do a rapid evidence review of the local economic impacts of rail investment.[72] The What Works Centre reviewed evaluation evidence on the local economic impacts of investment in light rail, subway, heavy rail, and high-speed rail. They looked for studies that examined the effects of rail investment on local economic outcomes including employment, business performance, and property prices.

The table below provides detail on the evidence available for investments in high-speed rail.

Figure A.9: What Works Centre review of international evidence

International case studies	Evidence for (more productive) clusters arising?	Scale of impact	Evidence on business relocation?	Negative impacts
Spain HSR	Yes	HS corridor saw a 3.3% increase in the number of firms and 1.1% increase in labour productivity. In provinces connected to HSR, the number of businesses in the service sector increases by 18.3%, in tourism activities by 8.6%, and in knowledge-intensive sectors – i.e. sectors where at least one-third of the employees have tertiary education – by 10.6%. There are no effects in the manufacturing sector.	Not evaluated	HSR negatively affected air traffic

[72] What Works Centre for Local Economic Growth (2021) Rapid evidence review

Japan HSR	Yes	Study finds that the productivity gap of businesses within 30km of stations, compared to businesses further away, widened after the introduction of HSR. Results indicate that for input-intensive firms, sales per employee increase 42% due to firms being able to find better suppliers.	Yes	Has led to shrinkages in induced investment in large cities Tokyo (6.5%) and Kyoto-saka (4.5%)
Germany (trans-European HSR)	Yes	Six years after the opening of the Cologne-Frankfurt HSR line, GDP had risen by an average of 8.5% above the counterfactual trend in the three counties where there are intermediate stops. Montabaur, a small town connected to the line, became more attractive as a business location. A leading web hosting company relocated their headquarters to Montabaur, employing 1600 people. Media reports claim that 1,800 new jobs were established in Montabaur because of the HSR line.	Yes	
HS1	Mixed	Estimated changes in the level of GVA (2009 to 2011) associated with changing employment profile was higher in the HS1 corridor than in two of the three control corridors.	Not evaluated	No significant increase in office supply to date; employment data for the HS1 corridor highlights relatively poor performance, even when considering the 2008/09 recession.
France HSR	Yes	Qualitative evidence suggests that regional centres, such as Lille, Le Mans and Rheims experienced economic growth since the inauguration of HSR, dispersed from Paris. HSR has allowed multi-office companies (generally headquartered in Paris) to create jobs in regional offices (e.g. Lyon), thus enhancing functional specialization and productivity. Managerial jobs relocated to central HQs while more production jobs were created in regions connected by HSR. HSR has boosted profit margins for firms by 0.6 to 0.8 percentage points.	Not evaluated	

Melo et al output elasticity application

A.43 Melo et al (2013) is a meta-analysis of the elasticity of GDP with respect to transport infrastructure investments. The authors find the mean elasticity is 0.060 with a standard deviation of 0.288 based on analysis of 563 estimates from 33 studies.

A.44 The mean elasticity for rail schemes (0.037) has been used for this analysis.

A.45 The studies included are time series analyses, and therefore we interpret the elasticity as a one-off shock to GDP, with a ramping up period at the beginning.

Methodology

A.46 HS2 Phase 2b WL capital investment is compared to the size of total UK infrastructure capital stock and the percentage is calculated as a *% change in capital stock*

A.47 The percentage change in GDP is predicted as *output elasticity of 0.037 * % change in capital stock*

A.48 The percentage change in GDP is applied to total UK GDP, incorporating a 10-year period post-opening that the increase accumulates over.

Results

A.49 If GDP impacts estimated in the top-down output elasticity approach are achieved, we can expect impacts within the range of £11bn to £19bn, which are additional to commuter and leisure user benefits of £2.9bn.

A.50 When then subtracting the Level 1 and Level 2 benefits that could be considered double counting, the implied additional Level 3 benefits are up to £8bn.

A.51 All figures are consistent with the Phase 2b WL SOBC assumptions: discounted over a 60 year appraisal period, 2015 prices.

A.52 The results are sensitive to varying assumptions about the size of infrastructure capital stock.

Figure A.10: A table setting out the potential GDP impacts of the Proposed Scheme using the Melo et al output elasticity application

Assumed size of infrastructure capital stock (2020)	Total GDP impact of HS2 WL based on elasticity	Level 1 and 2 GDP impacts	Implied additional Level 3 benefit
£0.54 trillion (ONS, shorter lifespan of capital)	£19bn	£11bn	£8bn
£0.92 trillion (ONS, longer lifespan of capital)	£11bn	£11bn	£0bn

Interpretation guidance

A.53 This analysis aims to produce a range for a rough order of magnitude of the impact of Phase 2b WL on GDP over a long timescale, based on evaluation evidence of other rail schemes.

A.54 The strength of this analysis is that it is conducted at a national level, and therefore provides evidence that the Proposed Scheme is likely to have an expansionary impact on the economy, beyond local impacts that may displace resources from other regions.

A.55 The limitation of this analysis is that it does not assess the value for money of the WL specifically, but rather the value for money of an 'average' rail scheme of its size. The results are most accurately interpreted as the likely impact of a generic rail investment on GDP, scaled for the size of the network, based on the mean value for money found for previous rail schemes.

A.56 The spreadsheet analysis has been produced by DfT analysts and quality assured by DfT and HS2 Ltd analysts. The methods have been based on previous applications of this methodology to 'sense check' the outputs of the Lower Thames Crossing SCGE modelling, in its peer review by James Laird and Adolf Stroombergen.

A.57 Melo et al synthesize findings from multiple international studies. We have assumed that these are largely national studies as most studies would be looking at national accounts data, and we therefore conduct our analysis at national level. However, there is a possibility some regional studies have been included in the meta-analysis.

A.58 Holgren and Merkel (2017) is a more recent study that employs similar methods to Melo et al (2013); however as the authors find a higher estimate and significant variation in results, we have chosen Melo et al (2013) as this is a conservative estimate of expected benefits and has previously also been used in the context of benchmarking results of other applications of CGE modelling.